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THE TRAC-P STANDARD TEST MATRIX**

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A DESCRIPTION OF THE TEST PROBLEMS IN THE TRAC-P STANDARD TEST MATRIX

by

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March 1996

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ABSTRACT

This report describes 15 different test problems in the TRAC-P standard test matrix of 42 test-problem calculations. Their TRACIN input-data files are listed in Appendix A. The description of each test problem includes the nature of what the test problem models and evaluates, the principal models of TRAC-P that the test problem serves to verify or validate, and the TRAC-P features and options that are being involved in its calculation. The test-problem calculations will determine the effect that changes made to a TRAC-P version have on the results. This will help the developers assess the acceptance of those changes to TRAC-P.

1.0. INTRODUCTION

Many TRAC-P users are unfamiliar with the test problems for verifying acceptance of TRAC-P versions in its standard test matrix. Some of the test problems are described in the Developmental Assessment Manual¹ for TRAC-PF1/MOD2 Version 5.4. To validate the TRAC models involved, however, the emphasis there is on a comparison of the test problem's TRAC-evaluated solution and its analytic or experimentally measured thermal-hydraulic behavior. A description of these test problems is interlaced with that comparison. To understand the nature of the other test problems required, the user must study the detailed input data of its TRACIN file.

This report provides TRAC-P users with an introductory description of each test problem in the standard test matrix. Each description has been limited to no more than a few pages, wherein is described the: (1) nature of what the test-problem

models and evaluates, (2) principal models of TRAC-P that the test problem serves to verify or validate, and (3) TRAC-P features and options that are involved in the test problem calculation. This identifies the phenomena and neutronic-thermal-hydraulic behavior involved in these test problems and the features and options of TRAC-P that are verified by their evaluation.

2.0. TEST PROBLEMS IN THE TRAC-P STANDARD TEST MATRIX

The standard test matrix set of test problems for TRAC-P consists of two problem series: (1) a short-running series of 10 test problems with 34 problem-calculation cases, and (2) a long-running series of 5 test problems with 8 problem-calculation cases. The test-problem names and their number of calculation cases (shown in brackets) are:

Short-Running Series

1. DRAIN [1]
2. HCOND#; # = 1,2,3,4,5 [5]
3. MARVIK [1]
4. MS#&; # = C,P,R,S,T,V; & = 2,L,V; #& = VR [19]
5. ROD2 [1]
6. TFPIPE2 [1]
7. TIN#; # = DWN,UP [2]
8. UTUBE [1]
9. W4LOOP [2]
10. ZIONPWR [1]

Long-Running Series

11. BANKOFF [1]
12. LEHIGH [1]
13. LOFTL26 [2]
14. UPTF8B [3]
15. UTUBE3D [1]

Four test problems in the short-running series (DRAIN, HCOND#, MARVIK, and UTUBE) and all five test problems in the long-running series are test problems in the Developmental Assessment Manual¹ for TRAC-PF1/MOD2 Version 5.4. Short-running test problems TINDWN and TINUP are described in the TEE Component Offtake Model Section 7.4 of the TRAC-PF1/MOD2 Theory Manual.²

This section gives an introductory description of the 15 different test problems in the standard test matrix. This was done to acquaint the reader with the nature of each problem and its purpose of verifying or validating models, features, and options in TRAC-P. The TRACIN input-data file listing for each of the 42 (34+8) test-problem calculations is shown in Appendix A. Each test-problem description refers to figure(s) of its TRAC-P component-model geometry (and for experiments, its

experimental-apparatus geometry). Each TRACIN file shows (after the initial title information) a component-network diagram of the TRAC-P system model. Both of these are user aids for visualizing the TRAC-P system model of the test problem's physical geometry.

The purpose of these test problems in the standard test matrix is to verify their correct evaluation as a requirement for acceptance of each TRAC-P version. The procedure for verifying their correct evaluation for a new version of TRAC-P is based on comparing the TRCOUT-file output results from each test problem with the results from the previous accepted version of TRAC-P. Until recently, this was done manually for a few selected sensitive parameters of each test problem. Any value change in those results became a judgment call as to acceptability. The TRAC-P code custodian accepted minor changes (third or larger least significant digit) and referred larger changes to appropriate code developers for an acceptance/rejection decision. Large changes are acceptable when TRAC-P model, feature, or option changes that affect those parameters are also being made in the new TRAC-P test version. Large changes that are not consistent with version changes need to be traced to a potential programming error in the test version. These errors must be corrected before TRAC-P can be accepted. A new automated testing procedure has been implemented because the manual-comparison task took too long to perform on four different computing platforms (Cray, Sun, HP, and IBM-RISC). Reference 3 has a detailed description of this test procedure. Besides a significant reduction in comparison time, a more extensive parameter-value comparison is conducted based on acceptance criteria appropriate for each test problem. The manual comparison effort previously conducted by the TRAC-P code custodian is done much more efficiently and extensively by the computer. For example, the computer produces a tabulation of all large changes that fail the test problem's acceptance criteria. The results of that tabulation (as before) is examined by appropriate code developers who must make an acceptance/rejection decision.

2.1. DRAIN Test Problem

2.1.1. Problem Description. DRAIN is a vertical, 12-in.-diam, U-tube, double-standpipe drain and fill transient test problem. It consists of a vertical PIPE component with a BREAK-component vapor constant-pressure boundary condition of 0.1 MPa (14.5 psia) at the top of the PIPE and a FILL-component liquid mass flow vs time boundary condition at the bottom of the PIPE, as shown in Fig. 1. Initially,

Fig. 1. TRAC-P model of the DRAIN test problem.

the 15-cell PIPE has its lower cells 1 to 10 filled with liquid and its upper cells 11 to 15 filled with vapor. The FILL drains liquid from 10 to 95 s through a small-orifice 0.01 m^2 (0.10764 ft^2) flow area at the bottom of the PIPE, lowering the liquid level to the center of cell 5, and then fills liquid from 110 to 195 s, raising the liquid level to its original level at the top of cell 10. The purpose of this test problem is to verify that TRAC-P accurately evaluates the gravity-head effect on coolant pressure, doesn't encounter numerical instability as the liquid level crosses a mesh-cell interface, and conserves liquid inventory during this 195 s drain and fill transient.

2.1.2. TRAC-P Features and Options Tested. This test problem provides a simple test of the hydraulic solution of a PIPE component with constant-pressure and time-varying liquid-mass-flow boundary conditions. The TRAC-P features and options tested are listed below:

- FILL mass-flow table with ramp and step
- Gravity-head term in motion equation
- Choked-flow model with option multipliers (OFF)
- K-factor form losses input
- No noncondensable gas
- Water-packing option
- Wall-surface roughness
- Subcooled liquid and vapor
- Liquid-vapor interface crosses cell interface
- Components: 1 BREAK, 1 FILL, and 1 PIPE

2.2. HCOND#, #=1,2,3,4,5 Test Problem

2.2.1. Problem Description. HCOND# is a test problem with five different cases that evaluate one- and two-dimensional (1D and 2D) conduction and convection heat-transfer transients for representative structure and fuel-rod geometries. It is a simple four-component test problem involving a ROD HTSTR component with outer-surface convection heat-transfer coupling to a vertical PIPE component with no-flow liquid coolant. The ROD has an adiabatic inner-surface boundary condition and a constant 1000.0 W (3412.1 Btu/h) power source. No flow is defined by a FILL-component zero-velocity boundary condition at the lower JUN1 interface of the PIPE component. A constant-pressure boundary condition is defined in the BREAK component cell across the upper JUN2 interface of the PIPE component. The combination of a power source in the ROD and no-flow liquid coolant in the PIPE results in a transient heatup calculation in all five cases that are evaluated for 5.0 s

of problem time. The results of each case can be compared with an analytical solution for the purpose of verifying the accuracy of conduction and convection heat transfer evaluated by the HTSTR component.

Two different variations of this test problem, shown in Fig. 2, are evaluated as:

1. HCOND#, #=1,3,4 is a fuel rod with no clad ROD HTSTR component coupled to the vertical PIPE with two mesh cells. Initially the three node rows of the ROD and cell 1 of the PIPE are at a temperature of 300.0 K (80.3°F) and cell 2 of the PIPE is at 500.0 K (440.3°F). The ROD has a radial fine mesh of 11 nodes, an axial node-row coarse mesh of 3 node rows, and models a 2D radial and axial heat-transfer evaluation. HCOND1 evaluates axial heat transfer implicitly (by Namelist-variable option NRSLV=1). HCOND3 is the same as HCOND1 but with a 0.001-s trip-initiated application of an axial node-row fine mesh that increases the number of axial node rows from 3 (coarse) to 21 (fine). HCOND4 is the same as HCOND1 but with an explicit evaluation of axial heat transfer (by the NRSLV=0 default). During the first few seconds of the transient, heat transfers radially inward from cell 2 of the PIPE to the upper portion of the ROD, axially downward from the upper to the lower portion of the ROD, and radially outward from the lower portion of the ROD to cell 1 of the PIPE. Eventually, the power source in the ROD results in radial heat transfer outward from the ROD to both cells of the PIPE.
2. HCOND#, #=2,5 is a typical fuel-rod ROD HTSTR component with 12 node intervals of fuel, 1 node interval of gap gas, and 4 node intervals of clad radially coupled to the vertical PIPE with one mesh cell. Initially, the two node rows of the ROD and one cell of the PIPE are at 300.0 K (80.3°F). 1D radial fine-mesh heat transfer results from a power-source heatup in the fuel. No axial heat transfer is evaluated because IAXCND=0. Both node rows evaluate the same transient radial-temperature profile. HCOND2 with NRSLV=1 and HCOND5 with NRSLV=0 are the same (except for their value of NRSLV) and evaluate the same solution because neither implicit or explicit axial heat transfer is evaluated by their problem form.

Fig. 2. TRAC-P model of the HCOND#, #1,2,3,4,5 test problem.

2.2.2. TRAC-P Features and Options Tested. This test problem and its five cases (with two geometry variations) provide a simple test of the commonly used features of a ROD HTSTR component with outer-surface heat-transfer coupling to a hydraulic component. The TRAC-P features and options tested are:

- 1D radial conduction heat transfer
- 2D radial and axial conduction heat transfer
- Axial heat transfer implicit and explicit numerics
- Convection heat transfer with constant HTC's
- Material-properties data
- Fuel and fuel/gap-gas/clad materials
- Axial fine-mesh option in ROD
- Constant power source in ROD
- Adiabatic inner-surface
- Outer-surface convection heat-transfer to liquid
- Transient startup calculation
- Components: 1 BREAK, 1 FILL, 1 PIPE, and 1 ROD HTSTR

2.3. MARVIK Test Problem

2.3.1. Problem Description. MARVIK is the TRAC-P test problem for the Marviken Test 4, full-scale, critical-flow experiment with the longest minimum-flow area test nozzle. The experiment is modeled and evaluated by TRAC-P to assess TRAC's ability to predict a large pressure-vessel blowdown depressurization. TRAC-P accurately predicts the measured pressure and liquid mass flow vs time. The 1.5-m (4.92-ft) long test nozzle is modeled by a single mesh cell (cell 17 in PIPE 3 of Fig. 3) with the choked-flow model evaluated at its outlet-interface junction to a BREAK-component, atmospheric-pressure, boundary condition. This single-cell, choked-flow model is as accurate as a fine-mesh model of the nozzle without a choked-flow model evaluation. The 0.509-m- (1.67-ft) diam nozzle is connected by PIPE-component piping that expands upward into a 5.136-m- (16.85-ft) diam pressure vessel partially filled with deionized water. The top of the PIPE-component vessel is modeled as closed with a no-flow FILL-component boundary condition. Before the experiment, the water is heated by removing liquid from the pressure-vessel bottom, passing it through an electric heater, and returning it as saturated liquid to the steam dome at the top of the vessel. This resulted in an axial temperature profile of 475.0 K (395.3°F) at the bottom nozzle, 499.0 K (438.5 °F) at the bottom of the cylindrical vessel 8.32 m (27.3 ft) above the nozzle, and 536.2 K (505.5°F) at the

Fig. 3. TRC-P model of the MARVIK test problem.

liquid level 15.0 m (49.2 ft) above the vessel bottom. The experiment's transient was initiated by breaking a rupture disk at the nozzle's bottom outlet. This simulated break exposed the nozzle's liquid at a pressure of 5.129 MPa (743.9 psia) to the atmospheric pressure of 0.1017 MPa (14.75 psia). Liquid flow through the nozzle choked after ~2 s of the 56 s blowdown transient calculation.

2.3.2. TRAC-P Features and Options Tested. This two-PIPE component TRAC-P model of the Marviken outlet piping and pressure vessel has representative coarse-size mesh cells that are used to model blowdown transients. The choked-flow model accurately predicts critical flow at the minimum-flow area test-nozzle outlet because the experiment's long test nozzle minimizes nonequilibrium effects between coolant phases at the location where the coolant flow chokes. The TRAC-P features and options tested are:

- Choked-flow model option
- Blowdown transient calculation
- Abrupted flow-area change form losses
- Gravity-head term in motion equation
- Evaporation-condensation model
- Components: 1 BREAK, 1 FILL, and 2 PIPEs

2.4. MS#&, #=C,P,R,S,T,V And &=2,L,V And #&=VRL Test Problem

2.4.1. Problem Description. MS#& is an isothermal, abrupt flow-area change, single or multiple-in-parallel, vertical coolant-flow channel test problem that models the same flow geometry with six different TRAC-component models (#=Cell, Pipe, Reverse, Single, Tee, and Vessel) for three different coolant-phase conditions (&=2-phase liquid and vapor, &=Liquid, &=Vapor). This provides a 6 x 3 matrix of 18 test-case transient calculations that are each evaluated for 10,000 s of problem time. The #=Vessel component model with &=Liquid coolant is restarted from its 10,000 s TRCDMP edit and evaluated for 10,000 s more as the (#&=VRL) transient-restart 19th test case.

The main purpose of the MS#& test-problem matrix is to test that different TRAC-component models of the same flow geometry give the same hydraulic solution for different coolant-phase conditions. Also tested are the conditions of equal-flow splitting under symmetric-geometry conditions, numerical-model component orientation not affecting the hydraulic solution, and numerical stability when

evaluating asymptotic, steady-state conditions at a convective-flow material-Courant-number limit (MCNL) of 1000.

Coolant flow is driven by a difference in the BREAK-component pressure boundary condition at each end of the vertical coolant-flow channel. The top-end pressure is constant at 1.0 MPa (145.038 psia), and the bottom-end pressure is ramped in 1 s from 1.0 to 1.4045 MPa (203.705 psia) for liquid, 1.1384 MPa (165.111 psia) for 2-phase, 1.0017585 MPa (145.293 psia) for vapor coolant, and held constant thereafter. Each of these bottom-end pressure boundary-condition values was selected to give an asymptotic steady-state maximum coolant velocity of 10.0 m/s (32.8 ft/s) flowing in the upward direction.

Following are the six different TRAC-component model MS#& cases, as shown in Fig. 4.

1. #=S A Single PIPE with 22 mesh cells.
2. #=P The single PIPE in (1) is replaced by 4 three-cell PIPES and 10 one-cell PIPEs to test internal- and junction-interface evaluation logic.
3. #=C Two one-cell PIPEs in (2) are replace by two single-Cell PLENUM components to test that a one-cell PIPE and a one-cell PLENUM with one junction on each side evaluate the same hydraulic results.
4. #=T The 4 three-cell PIPEs in (3) are replaced by 6 four-cell TEEs having side-leg and lower-numbered primary-leg flow split in half. $\Phi=0^\circ$ and 4 one-cell PIPEs in (3) are replaced by 12 one-cell PIPEs to receive the split flow of 2 TEEs and the doubly-split flow of 4 TEEs (the 8 one-cell PIPEs receiving the doubly-split flow change the PLENUM JUNS2-side connection 1 junction to 4 junctions) . . . this tests the ability of $\Phi=0^\circ$ TEEs to split flow equally and apply flow-area change reversible and irreversible flow losses correctly.
5. #=V The 6 TEEs are replaced by 6 three-cell VESSELS where their 1D axial level 1 and level 3 cells have 2 and 1 source-connection junctions, respectively (MSVL was the original version of this test problem with

Fig. 4. TRAC-P model of the MS#&, #=C,P,R,S,T,V test problem.

MS standing for Multiple Source connection because the level 1 cell has two source-connection junctions to a single z interface) . . this tests the equivalence of flow-splitting TEEs and multiple-source connection VESSELS.

6. #=R Two VESSELS (having parallel flow with two other VESSELS) have their orientation Reversed so that there are two source-connection junctions to the level 3 cell and one source-connection junction to the level 1 cell to test that VESSEL cell orientation and coupling to 1D hydraulic components doesn't affect the hydraulic solution.

In Fig. 4. and in the TRACIN-file component network diagrams of Appendix A, Sections A-4.1 to A-4.19, the axial midpoint is a mirror (reflected) plane of the components and their orientation on each side. This doubles the size of the model for the purpose of testing flow on one side being in the opposite component-orientation direction than flow on the other side of the mirror plane (except for the #=S test).

The transient calculation approaches asymptotic steady-state conditions after 5 s. Hydraulic-solution output edits occur at 10 s (MCNL= ~ 30), 100 s (MCNL= ~ 300), 1000 s (MCNL=1000), and 10,000 s (MCNL=1000). At 10,000 s, the six different TRAC-component models evaluate the same pressure distribution to six significant digits and velocity distribution to four significant digits for &=Liquid and &=Vapor single-phase coolant. The agreement is less for &=2-phase coolant where the pressure distribution is the same to four significant digits and the velocity distribution is the same to two significant digits. The agreement is one significant digit better for the &=2-phase coolant solutions at the 10 s edit where the thirty-times smaller timestep size effect on numerical stability of the TRAC-P solution is much greater.

2.4.2. TRAC-P Features and Options Tested. The 19 TRAC-calculation cases of this test problem verify the calculational reproducibility of the hydraulic solution among TRAC-P components and the numerical stability of slow-transient, single- and two-phase coolant hydraulics evaluated with large timesteps (large material-Courant-limit numbers). The TRAC-P features and options tested are:

- 1D and 3D SETS evaluation at MCNL = 1000
- Restart calculation with large initial timestep
- K-factor form losses input
- Constant interfacial-drag coefficient input
- Only pressure boundary conditions
- Constant and ramp pressure boundary conditions
- NFF = -1 abrupt flow-area change losses
- Single- and two-phase liquid and vapor
- Parallel-flow $\phi=0^\circ$ TEE flow splitting
- Multiple-source connections to cell face
- Explicit network coupling to PLENUM
- Internal interface and junction evaluation logic
- Hydraulic solution independent component orientation
- Vessel matrix based on multiple VESSELS
- PLENUM JUNS1 to JUNS2 momentum convection
- Calculation reproducibility among components
- Components: 2 BREAKs, 1 to 16 PIPEs, 2 PLENUMs, 6 TEEs, and 6 VESSELS

2.5. ROD2 Test Problem

2.5.1. Problem Description. ROD2 is a test problem that evaluates 2D radial and axial conduction heat transfer in an annular-ROD HTSTR component with radial convection heat transfer from the ROD inner surface to a super-heated vapor-coolant PIPE component and from the ROD outer surface to a subcooled liquid-coolant PIPE component. Boric-acid solute is dissolved in the liquid coolant and plates out on the wall of the super-heated vapor-coolant PIPE. The main purpose of the ROD2 test problem is to test the evaluation of convection heat transfer from both the inner surface and outer surface of an annular ROD.

Each vertical PIPE has 4 cells with different coolant temperatures in each cell. The lower JUN1 interface of each PIPE is connected to a no-flow FILL-component boundary condition that results in stagnant-coolant heatup. The upper JUN2 interface of each PIPE is connected to a BREAK-component, constant-pressure boundary condition of 2.7 MPa (391.6 psia). Each of the five axial node rows of the ROD is set to a different temperature. The node-row and cell-coolant temperatures are randomly initialized with temperatures between 300.0 K (80.3°F) and 600.0 K (620.3°F), as shown in Fig. 5.

There are eight radial nodes with zircaloy in the first and last node intervals and mixed-oxide fuel in the five node intervals in between. The mixed-oxide fuel has a

Fig. 5. TRAC-P model of the ROD2 test problem.

power source of 21.0 MW (7.1655×10^7 Btu/h) in a core region of 6136 fuel rods. Both an average-power and peak-power (RPKF=2.26) ROD element are modeled. Axial heat conduction is evaluated with explicit numerics. A fine axial-mesh evaluation, which can change the number of node rows from 5 (coarse) to 25 (fine), is tripped on at 0.1 s after 7 timesteps. This heatup transient calculation is evaluated for a maximum of NSEND=20 timesteps or to time 0.3 s.

2.5.2. TRAC-P Features and Options Tested. This seven-component TRAC-P model for evaluating conduction and convection heat transfer goes beyond the one-surface convection heat transfer to subcooled liquid coolant of the HCOND# test problem by modeling convection heat transfer at both the inner and outer surfaces of an HTSTR component to superheated-vapor and subcooled-liquid coolant. The random temperature initialization of the model results in local heat transfer being in all directions initially until the mixed-oxide fuel power-source heatup later results in radial heat transfer from the fuel to the two coolant channels. The TRAC-P features and options tested are:

- 2D radial and axial condition heat transfer
- Inner and outer surfaces convection heat transfer
- Axial heat conduction explicit numerics
- Convection heat transfer to superheated vapor
- Trip-controlled axial fine-mesh option
- Convection heat transfer to subcooled liquid
- Constant-power HTSTR
- Clad/fuel/clad HTSTR materials
- Calculation stops after NSEND timesteps
- Dissolved/plated-out solute option
- FA = 0.0 no-flow PIPE interfaces
- Average and peak-power ROD elements
- Components: 2 FILLS, 2 BREAKs, 2 PIPEs, and 1 ROD HTSTR

2.6. TFPIPE2 Test Problem

2.6.1. Problem Description

The TFPIPE2 test problem models conditions similar to the Edwards-pipe blowdown experiment. A break in a heated-wall pipe with high-pressure coolant causes it to depressurize as pressure-driven liquid is convected out the break with eventual liquid dryout at the heated-wall surface and liquid flashing when its saturation

pressure is reached. TFPIPE2 tests TRAC's ability to simulate the rapid-transient time-dependent behavior of liquid-coolant blowdown and dryout.

Four PIPE components are connected in series with a FILL-component no-flow boundary condition at one end and a BREAK-component 0.1 MPa (14.50 psia) atmospheric-pressure boundary condition at the other end, as shown in Fig. 6. Initially, liquid coolant flows toward the FILL-component no-flow end with the same volumetric flow of $0.0006902 \text{ m}^3/\text{s}$ ($0.02438 \text{ ft}^3/\text{s}$) in all four PIPES. The liquid-coolant temperature increases from 518.5 K (473.6°F) at the BREAK end to 579.0 K (582.5°F) at the FILL end. The second PIPE from the FILL is vertical, 4 m (13.1-ft) long with a 0.021-m (0.0689-ft) inside diam and 0.002-m (0.00656-ft) wall thickness, and has a wall heat source of 189.4 MW ($6.4626 \times 10^8 \text{ Btu/h}$) with external-surface convection heat transfer to 300.0 K (80.3°F) air. The PIPES on each side are sloped downward toward the FILL. The fourth PIPE, connected to the BREAK, is horizontal and higher than the other three PIPES. The walls of those three PIPES are not heated. Initially, the coolant pressure at the break end of the fourth PIPE is 9.92 MPa (1438.8 psia). During the 0.02 s blowdown transient calculation, liquid-coolant flow reverses direction (it starts at the BREAK end and works its way back to FILL end by $\sim 0.013 \text{ s}$). In the heated-wall second PIPE at 0.02 s, the liquid coolant in cell 1 begins to flash and in cells 2 to 7 undergoes subcooled boiling. The transient needs to be evaluated longer for liquid-coolant dryout to occur on the inner surface of the heated-wall second PIPE.

2.6.2. TRAC-P Features and Options Tested. This blowdown simulation is a very rapid depressurization transient that provides an extreme numerical-stability test of liquid-coolant stretch (pack) numerics. The large coefficient of expansion of solid liquid causes a huge decrease (increase) in coolant pressure from very little liquid expansion (contraction). The initial liquid-coolant flow toward the no-flow FILL end requires pack numerics to deaccelerate that flow in a stable fashion. During blowdown, the strong coupling between the pressure distribution, liquid convection toward the BREAK, and liquid flashing to vapor (vapor condensing to liquid) make the numerical solution very sensitive to small changes. A reasonable timestep size requires implicit time-dependent numerics. TRAC-P features and options tested are:

Fig. 6. TRAC-P model of the TFPIPE2 test problem.

- Large-break blowdown transient calculation
- Subcooled boiling model
- Evaporation/condensation model
- Implicitness of momentum-convection term
- Liquid pack and stretch numerics
- Gravity-head term
- QPPP power source in hydraulic-component wall
- Exterior-surface convection heat transfer from component wall
- Abrupt flow-area change form losses
- No-flow and constant-pressure boundary condition
- Phenomena-rate timestep-size control
- Components: 1 BREAK, 1 FILL, and 4 PIPES

2.7. TIN#, #=DWN, Up Test Problem

2.7.1. Problem Description. TINDWN and TINUP are the downward- and upward-oriented side-leg cases, respectively, of the TEE-component offtake-model test problem discussed in Section 7.4 of the TRAC-PF1/MOD2 Theory Manual.² These cases verify that for low-velocity, horizontal-stratified flow through the horizontal (GRAV=0.0) main leg of an offtake-modeled TEE, a small flow-area $\phi=90^\circ$ side leg at the bottom or top of the main-leg channel (side-leg GRAV=1.0 or -1.0) removes only liquid or vapor, respectively, from the main leg. The main-leg two-phase coolant flow is mostly liquid (ALPHA=0.1) in case TINDWN, and mostly vapor (ALPHA=0.9) in case TINUP to avoid any entrainment of minor-phase coolant in the major-phase coolant flowing to the TEE-side leg in these tests.

The TRAC-P model shown in Fig. 7 consists of two TEE components. TEE 1 evaluates the offtake model (IENTRN=1 and IOFFTK=1) and satisfies the requirement that its main leg be horizontal and its $\phi=90^\circ$ side leg be vertical (for downward or upward orientation). TEE 2 does not evaluate the offtake model (IENTRN=0) because its main leg is vertical (its horizontal side-leg JUN3 is connected to main-leg JUN2 of TEE 1). TEE 1 models a hot- or cold-leg pipe with a small bottom or top side break, while TEE 2 models a large drain tank (such as a vessel). JUN1 of TEE 1 connects to FILL component 11, which defines a low-velocity boundary condition of mostly liquid (ALPHA=0.1) mass flow of 12.5 kg/s (27.558 lb_m/s) in case TINDWN, and mostly vapor (ALPHA=0.9) mass flow of 5.0 kg/s (11.023 lb_m/s) in case TINUP, which flows into TEE 1. JUN2 of TEE 2 connects to FILL component 22 with a no-flow boundary condition. The side-leg JUN3 of TEE 1 and main-leg JUN2 of TEE 2 are connected to BREAK components 12 and 21, respectively. Their 2.3 MPa (333.6

Fig. 7. TRAC-P model of the TINDWN and TINDUP test problem.

psia) and 2.4 MPa (348.1 psia) constant-pressure boundary conditions, respectively, assure TEE 1 offtake-modeled side-leg outflow to BREAK 12 during the 30 s transient because of FILL 11 inflow and BREAK 12 having the minimum modeled-system pressure.

2.7.2. TRAC-P Features and Options Tested. The main purpose of these two test-problem cases is to test the downward- and upward-geometry offtake-model options of the TEE component. Downward liquid or upward vapor outflow is simulated from a small break at the bottom or top of a hot- or cold-leg pipe with horizontal stratified flow. The choked-flow model is applied at the BREAK junction to the offtake outflow. The TRAC-P features and options tested are:

- TEE offtake model with downward- and upward-offtake geometry
- ICFLOW=1 choked-flow model at BREAK-junction interfaces
- NFF=-1 abrupt flow-area change form losses
- Two-phase mass-flow, no-flow, and constant-pressure boundary conditions
- Vapor-condensation model [TSAT(P=2.3 MPa) = 492.234 K > TV = 487.0 K inflow]
- EPSO=0.5 outer-iteration pressure-convergence criterion (not converged well)
- Small-break transient calculation
- Components: 2 BREAKs, 2 FILLs, and 2 TEEs ($\phi=90^\circ$ side-leg orientation)

2.8. UTUBE Test Problem

2.8.1. Problem Description. UTUBE models a 12-in.-diam, U-tube shaped, vertical standpipe with each side leg 7.5 m (24.606 ft) high. The top ends of the U-tube shaped PIPE component are connected to BREAK components with constant 0.1 MPa (14.50 psia) atmospheric-pressure boundary conditions, as shown in Fig. 8. Initially, the at-rest liquid level in one side leg is 1.0 m (3.2808 ft) higher than the liquid level in the other side leg of the PIPE, with a total liquid length of $L=4.0$ m (13.123 ft). This test problem verifies TRAC's ability to predict an undamped manometer oscillation of the liquid level with its amplitude undamped by no wall-drag [NFF=0 with $EPSW=3.0 \times 10^{-6}$ m (9.8425×10^{-6} ft) surface roughness] and no form-loss (FRIC=0.0 K-factors) flow resistance and its oscillation having a derived half-period (time for the side-leg liquid level to move between its minimum and maximum heights) of

$$\tau = 2 \cdot \pi \cdot \sqrt{L / (2 \cdot g)} = 2 \cdot \pi \cdot \sqrt{4.0 \text{ m} / (2 \cdot 9.8 \text{ m/s}^2)} = 2.84 \text{ s}$$

Fig. 8. TRC-P model of the UTUBE test problem.

The 50 s transient calculation evaluates ~9 manometer-oscillation periods with little change in the 1.0 m (3.2808 ft) amplitude change in liquid-level height on each side of the PIPE.

2.8.2. TRAC-P Features and Options Tested. The UTUBE manometer oscillation is driven by the gravity-head term pressure difference on each side of the U-tube shaped coolant channel and by momentum convection as the liquid coolant flows from one side of the U-tube to the other side. The TRAC-P features and options tested are:

- gravity-heat term
- momentum-convection term
- water-packing option
- choked-flow model, no interfaces specified
- mesh-cell center elevations input
- K-factors with 0.0 values input
- $EPSW=3.0 \times 10^{-6}$ m surface roughness
- $NFF=0$ wall-drag friction factor of zero
- vapor condensation [$TSAT(P=0.1 \text{ MPa}) = 373.0 \text{ K} > TV = 298.3 \text{ K}$]
- liquid level reaches cell interface at minimum and maximum height
- components: 2 BREAKs and 1 PIPE

2.9. W4LOOP And W4LOOPR Test Problem

2.9.1. Problem Description. W4LOOP and W4LOOPR are the steady-state and transient calculation test-problem cases, respectively, for evaluating a large-break loss-of-coolant accident (LBLOCA) in the Westinghouse four-loop Zion pressurized water reactor (PWR). A 153% flow-area side break is assumed to occur in the cold leg between the pump and vessel of one of the primary-coolant loops (the broken loop). The break is modeled by the one-cell side leg of a TEE component, a one-cell VALVE component, and a constant atmospheric-pressure boundary-condition BREAK component. The break-flow channel has a flow length of 0.60437 m [$0.35437+0.1+0.1+0.05$ m, (1.9828 ft)] from the center of the cold-leg pipe to the location at the 0.1 MPa (14.50 psia) atmospheric pressure. The adjustable flow-area interface of the VALVE is closed during the steady-state calculation and opens fully in 0.1 s at the start of the transient calculation. The other three loops of the plant model are combined into a single intact loop.

A system-network geometry diagram is shown in Fig. 9, and its component-network diagram is shown in the TRACIN listing of Appendix A, Sections 9.1 and 9.2. Its ($r=2$, $\theta=4$, $z=7$) 3-D VESSEL component has 2 hot-leg and 5 cold-leg source-connection junctions to the broken and intact loops, respectively. One hot-leg connection to the three combined loops of the intact loop provides a poor modeling approximation of the three separate hot-leg connections to the vessel. Four cold-leg connections to the three combined loops of the intact loop, however, correctly model the three separate cold-leg connections to the vessel. One loop splits its flow into two flow channels (PIPEs 43 and 44) with separate source connections in order to test having two multiple source connections to the same face of a VESSEL mesh cell.

The W4LOOP steady-state calculation satisfies its $EPSS=0.0001$ convergence criterion after 210 s of problem time, 180 timesteps, and ~660 s of SUN Sparc II workstation central processing unit (CPU) time. Its W4LOOPR restart transient calculation evaluates blowdown depressurization after the break for 5 s of problem time, 260 timesteps, and ~940 s of SUN CPU time. This is the longest running test-problem case in the short-running series. Only 5 s of the transient are evaluated to reduce the run time required for version verification by the short-running series. The W4LOOP and W4LOOPR test problem's main purpose is to exercise the many features and options of TRAC-P in a full-plant model for both a quick-converging steady-state calculation and a rapid-depressurization transient calculation. For a major-release version of TRAC-P, the transient end time should be extended to 120 or 180 s to evaluate the entire blowdown, dryout, refill, and reflood transient. In this extended analysis, the ($ID=IRFTR2=0$ of ROD 140) trip-controlled, core-reflood model should be turned ON; i.e., set Namelist variable NEWRFD=1 and define a IRFTR2 controlling trip that is set ON.

The current W4LOOP plant model has been upgraded from its original model. The ACCUM component in the intact loop was replaced by no-flow FILL and PIPE components, and each STGEN component in the broken and intact loops was replaced by 2 HTSTR, 2 PIPE, and 2 TEE components. The old STGEN component's once-through, secondary-side PIPE was replaced by two TEE components to model a

Fig. 9. TRAC-P model of the W4LOOP and W4LOOPR test problem.

liquid-recirculation downcomer and a steam-separator interface in the steam dome. The steam-generator, secondary-side model is still simple but more realistic in its boiler and steam-dome, thermal-hydraulic solution.

Constrained steady-state (CSS) controllers are applied during the steady-state calculation to the broken and intact loops to adjust the pump-impeller speed to achieve a desired primary-coolant mass flow, to adjust the secondary-side feedwater mass inflow to equal the steam mass outflow, and to adjust the steam-generator tube h and k heat-transfer coefficients to achieve a desired downstream primary-coolant temperature. In the later controller, the CSS type-4 controller for a STGEN component was replaced by a CSS type-5 controller for a HTSTR component. Now a better initial estimate of the thermal-hydraulic steady-state solution is provided by the hydraulic-path steady-state initialization procedure.

2.9.2. TRAC-P Features and Options Tested. The W4LOOP and W4LOOPR test problem is the most popular test problem used by code developers for initial testing of their update changes to TRAC. It is a quick running test problem that exercises the nature and phenomena of a prototypic multiple-loop plant model for both steady-state and rapid-transient conditions. The form of its input-data model has changed many times to test new features and options added to TRAC. The TRAC-P features and options tested are:

- Constrained steady-state calculation
- Hydraulic-path steady-state initialization
- 8 CSS type 1, 3, and 5 controllers
- DTSTR=0.01 s restart transient calculation
- SI units input and English units output
- (r=4, θ =2, z=7) 3-D VESSEL component
- Input data output to INLAB file
- 7 radial source connections to same VESSEL level
- VESSEL core and core/downcomer interface
- 2 source connection to same VESSEL cell face
- NOAIR=0 models noncondensable gas
- IACC=2 PIPE-accumulator option
- COST=0.5 and 0.61 TEE side leg
- Hydraulic-component wall heat transfer
- Abrupt flow-area change form losses
- OPTION=1 semiscale pump curves

- Negligible FRIC at TEE internal junction
- 3 combined-loop flow splitting by PLENUM
- Nonzero FRIC & CFZp-Z values input
- Secondary-side boiler/steam dome/downcomer
- FRIC=1.0E+30 steam-separator interface
- PRIZER heater/sprayer control option
- IPAK=1 water-packing option
- HPIS/LPIS velocity vs pressure FILL table
- Powered ROD HTSTR models fuel rods
- RODs with 1 and 2 convection heat-transfer sides
- 2 ROD HTSTRs to model U-tube top
- SLAB HTSTRs to model vessel structure
- No axial heat transfer evaluated
- Trip-controlled axial fine mesh fuel RODs
- Fuel/gas-gap/clad and structure HTSTRs
- Scrammed reactor-core power vs time table
- Absolute-pressure, trip-controlled, instantaneous-opening accumulator check valve
- Components: 3 BREAKs, 5 FILLs, 5 ROD and 10 SLAB HTSTRs, 10 PIPEs, 1 PLENUM, 1 PRIZER, 2 PUMPs, 8 TEEs, 2 VALVEs, and 1 VESSEL

2.10. ZIONPWR Test Problem

2.10.1. Problem Description. ZIONPWR is the simple pump, Zion-PWR core and valve model shown in Fig. 10. Originally, only the four-cell core and one-cell upper-plenum regions were modeled with a 1D VESSEL component having convection heat-transfer coupling to fuel ROD and structure SLAB HTSTR components. This test problem verifies the model of the ROD's IRPWTY=16 core-region, reactivity-feedback evaluation when going from hot, no-power; to hot, full-power reactor-core conditions. With this model, TRAC-P underpredicts by only a few percent the Zion PWR final safety analysis report (FSAR) quoted change in the reactor-multiplication constant keff from 1.1540 to 1.1386. This evaluation is based on fuel- and coolant-temperature reactivity coefficients with temperature dependence input from FSAR to TRAC-P data.

Later PUMP and VALVE components replaced two one-cell PIPE components connected to the VESSEL's inlet and outlet source-connection junctions to verify the correct evaluation of signal-variable parameters (some of which are defined by PUMP and VALVE components). Two-hundred signal variables define all 88 different signal-variable parameters (but not undefined parameter numbers 1 to 17)

Fig. 10. TRAC-P model of the ZIONPWR test problem.

with an assortment of parameter-value forms (single, minimum, maximum, volume-averaged, or time/space difference value) in different components for each parameter. Recently, 132 control blocks were added to evaluate all 66 different control-block functions and test both their internal-TRAC-P and user-specified (by CBBON2) value initializations. All these control-procedure signal variables and control blocks are specified in this test problem for the sole purpose of testing whether they are initialized and evaluated correctly.

During ZIONPWR's 60 s transient, liquid coolant flows vertically upward through the PUMP, 1D VESSEL, and VALVE components. The PUMP impeller rotates at its rated speed of 370 rad/s (3533 rpm), and the VALVE adjustable interface has a constant flow-area fraction of 0.95. The FSAR-quoted liquid-coolant mass flow through the reactor-core region of 17007 kg/s (1.3498×10^8 lb_m/h) is the defined constant mass-flow lower boundary condition of a FILL component connected to the PUMP. The FSAR-quoted primary hot-leg pressure of 15.13 MPa (2194.4 psia) defines the constant pressure, upper boundary condition of a BREAK component connected to the VALVE. Initially, the liquid-coolant temperature below and above the PUMP impeller interface is spatially constant at 550.40 K (531.05°F, the primary cold-leg temperature) and 573.80 K (573.17°F, the core-region power-distribution-squared-weighted volume-averaged coolant temperature), respectively. From 0 to 1 s, the reactor-core power is ramped from zero to 3250 MW (1.1089×10^{10} Btu/h) and is held constant at this steady-state power level for the remaining 59 s of the transient calculation. At the end of the calculation, the axial liquid-coolant temperature distribution at steady-state conditions has a core-region, power-distribution-squared-weighted, volume-averaged value equal to its initial value of 573.80 K (573.17°F). The core region has gone from hot, no power; to hot, full power.

2.10.2. TRAC-P Features and Options Tested. This problem tests the reactivity-feedback model against FSAR data and the initialization and evaluation of all signal variables and control blocks in the control-procedure of TRAC. The TRAC-P features and options tested are:

- Reactivity-feedback model (temperature-dependent fuel- and coolant-temperature reactivity coefficients)
- Power-sq-wt. avg. feedback parameters
- Asymptotic steady-state transient calculations
- All signal-variable parameters evaluated

- All control-block functions evaluated
- All signal-variable value forms
- Control-block values TRAC and user initialized
- Powered RODs and unpowered SLABs
- Power vs time table in ROD
- INLAB-file input data in English units
- TRCGRF graphics data in English units
- TRCMMSG/TRCOUT files in English units
- User-defined units labels input
- Signal-experiment trip to test units-label input
- Two control-parameter evaluation passes
- NOAIR=0 noncondensable gas modeled
- Courant limit controls 3DSETS evaluation
- Wall heat transfer in PUMP and VALVE
- OPTION=2 built-in LOFT pump curves
- Constant mass-flow boundary condition
- Constant pressure boundary condition
- Single connections to VESSEL-cell axial faces
- Abrupt flow-area change form losses
- EPSW= 1.0×10^{-5} m surface roughness
- Initial velocities consistent w/mass flow
- 2-D radial-axial conduction heat transfer
- Axial heat transfer implicit numerics
- Fuel/gas-gap/clad materials in ROD
- Structure material in SLAB
- Average- and peak-power ROD elements
- SLAB inner- and ROD outer-surface conduction heat transfer
- Dissolved solute in liquid coolant
- Components: 1 BREAK, 1 FILL, 1 ROD and 1 SLAB HTSTRs, 1 PUMP, 1 VALVE, and 1 1D VESSEL

2.11. BANKOFF Test Problem

2.11.1. Problem Description. BANKOFF is a separate-effects test problem that verifies the countercurrent flow limitation (CCFL) model in TRAC. This is a test of TRAC's ability with the CCFL model to predict liquid reflood that must penetrate countercurrent steam flow. CCFL occurs at flow-area restrictions where liquid flows downward through rising gas or steam. In a PWR during reflood, this occurs in the tie-plate region where the upward flow of steam can prevent or limit the downward flow of liquid. Rather than relying on mechanistic models applied to detailed geometry, TRAC-P provides the option of applying a CCFL-correlation model at a specific mesh-cell interface where CCFL is expected to occur. The CCFL correlation is

based on experimentally measured liquid flow vs gas flow conditions in a prototypic flow-restriction geometry.

The BANKOFF experiment provides such a geometry with a perforated plate having 15 (3x5) circular holes that correspond to a small segment of the upper tie plate of a PWR. Its vertical coolant channel with saturated steam and subcooled liquid inflow and outflow connections is shown in Fig. 11. Steam is injected below and liquid is injected above the perforated plate. Liquid that doesn't flow through the perforated plate and out the bottom of the channel accumulates above the plate to a specified height where it drains through a side hole. Steam flow through the plate holes bubbles through this liquid and flows out the top of the channel. The TRAC-P model of this BANKOFF test apparatus is shown in Fig. 12.

The CCFL model is based on input-specified characteristic flooding-curve parameters for a specific flow geometry and location. Experimental data correlates well with the relationship $\sqrt{H_g} = C - M \cdot \sqrt{H_l}$ where H_g is a dimensionless gas-(steam-) flow parameter and H_l is a dimensionless liquid-flow parameter. The CCFL model in TRAC-P for a specified mesh-cell interface applies this H_g vs H_l correlation in a manner that the liquid velocity and interfacial-drag coefficient are consistent with the upward-flowing gas velocity and the mass and momentum conservation equations. The CCFL correlation is not applied when the gas flows downward.

The BANKOFF test problem evaluation of the BANKOFF experiment (based on the BANKOFF-experiment CCFL correlation being applied at the perforated plate) verifies that the CCFL model applies its H_g vs H_l correlation correctly to evaluate the countercurrent flow conditions of the experiment. During the 25 s transient calculation at the perforated-plate mesh-cell interface, the upward steam velocity increases from zero, and the downward liquid velocity decreases according to the correlation until liquid flow goes to zero at the $\sqrt{H_g} = C$ gas flow countercurrent flow limit.

2.11.2. TRAC-P Features and Options Tested. The CCFL model constrains the flow condition at the perforated-plate interface to be that of the BANKOFF experiment as fit by its $\sqrt{H_g} = C - M \cdot \sqrt{H_l}$ correlation. Agreement between the correlation and the

Fig. 11. Bankoff perforated-plate steam-liquid countercurrent flow test facility.

Fig. 12. TRAC-P model of the BANKOFF test problem.

plate-interface two-phase flow condition is expected from a numerically stable and reasonable timestep solution. The TRAC-P features and options tested are:

- CCFL model (Wallis, Kutateladze, and BANKOFF-correlation scaling each evaluated; BANKOFF-correlation scaling used at 2 axial interfaces in 1D VESSEL)
- K-factors input • water-packing option
- mass flow vs time FILL-table boundary condition
- constant atmospheric-pressure boundary condition
- abrupt flow-area change form losses
- countercurrent two-phase flow
- interfacial heat transfer
- (x=1, y=1, z=11) 1-D VESSEL
- components: 2 BREAKs, 3 FILLs, 5 PIPEs, and 1 VESSEL

2.12. LEHIGH Test Problem

2.12.1. Problem Description. LEHIGH is a separate-effects test problem used to validate the TRAC-P core-reflood model on a Lehigh University rod-bundle, post-critical-heat-flux (post-CHF), subcooled-liquid reflood experiment. During the experiment, advance cooling (by steam convection and axial conduction heat transfer) slowly propagates upward through a superheated shroud and rod-bundle test section as a liquid quench front advances behind it. The quench-front velocity provides a sensitive test of the integrated features of the TRAC-P core-reflood model in rewetting heated surfaces. The interaction between heat transfer and phase change causes the quench-front velocity and gas volume fraction to oscillate. Differences between the TRAC-P calculation and this experiment have been traced to aspects of the core-reflood model that need modeling adjustment.

A diagram of the experimental apparatus and a cross section of its rod bundle and shroud test section are shown in Figs. 13 and 14. Dimensions of the rods and shroud were selected to provide the same hydraulic diameter in all subchannels within the shroud. A rod spacer grid is located in the test section. The Inconel 625 alloy shroud was heated externally by radiation heat transfer while the rods were heated internally by electric resistance ribbons embedded in boron nitride within a stainless-steel clad. Before the start of the experiment, the test-section shroud and rods were preheated to a selected post-CHF superheated state with convection cooling by flowing steam. Steady two-phase coolant flow (with a desired flow rate, pressure, and enthalpy) was established in an equivalent-channel bypass around the

Fig. 13. Lehigh University rod-bundle test facility.

Fig. 14. Cross section of the Lehigh University rod-bundle and shroud test section.

test section. The experiment began when coolant flow through the test section was switched from steam to two-phase.

TRAC-P models only the test section of the experiment with an unheated SLAB HTSTR component for the shroud and a single-element heated ROD HTSTR component for the 3 x 3 rod bundle. Radiation heat transfer to the outer surface of the SLAB is approximated by a constant convection heat-transfer coefficient of $50.0 \text{ W/m}^2/\text{K}$ ($8.8055 \text{ Btu/h/ft}^2/^\circ\text{F}$) and external temperature of 1193.0 K (1687.7°F). The initial axial temperature distributions in the SLAB and ROD are input specified from the experiment. The vertical coolant channel within the shroud is modeled by

Fig. 15. TRAC-P model of the LEHIGH test problem.

a 1D VESSEL component with mesh-cell centers positioned at rod spacer grid, thermocouple, and probe locations, as shown in Fig. 15. FILL and PIPE components model the 15 K (27°F) subcooled constant 0.031832 kg/s (0.070178 lb_m/s) liquid mass inflow boundary condition and the unheated copper-block hot-patch channel at the inlet source connection to cell (level) 1 of the VESSEL. BREAK and PIPE components model the constant 0.1013 MPa (14.69 psia) atmospheric-pressure boundary condition and the top-patch channel at the outlet source connection to cell 11 of the VESSEL.

2.12.2. TRAC-P Features and Options Tested. The trip-controlled core-reflood model is applied to the heated ROD HTSTR component with convection heat-transfer coupling to the 1D VESSEL component during the entire 300 s transient calculation. Outer-surface heat transfer through the unheated SLAB HTSTR component to the 1D VESSEL component is evaluated normally without axial fine-mesh and core-reflood models. The TRAC-P features and options tested are:

- Core-reflood model applied to ROD
- Core-reflood interfacial-drag coefficient model
- Axial fine-mesh model applied to ROD
- All inverted-annular flow regimes
- Nucleate and transition boiling
- Bubbly, churn, and annular-mist flow regimes
- Constant power in 9-rods ROD element
- Empirical-constants flow-regime transition
- HTSTR heat-transfer diameters input
- Water-packing option
- (r=1, θ =1, z=11) 1-D VESSEL reactor core
- Rod spacer grid modeled in VESSEL
- Constant liquid mass flow boundary condition
- Constant pressure boundary condition
- Axial conduction heat transfer implicit numerics
- Axial conduction heat transfer in ROD and SLAB
- components: 1 BREAK, 1 FILL, 1 ROD & 1 SLAB HTSTRs, 2 PIPEs, and 1 VESSEL

2.13. LOFTL26 And LOFTL26R Test Problem

2.13.1. Problem Description. LOFT L2-6 is a cold-leg 200% double-ended guillotine (DEG) LBLOCA experiment in the loss-of-flow test (LOFT) facility. This integral-test experiment is simulated by TRAC-P with a LOFTL26 steady-state calculation to

provide the transient initial condition and a LOFTL26R transient calculation with the TRCRST restart-data file from the converged steady-state calculation to evaluate 120 s of the transient experiment.

The LOFT facility represents a 1/60-scale model of a typical 1000 MWe commercial four-loop PWR. Three primary-coolant loops are simulated by a single LOFT intact loop scaled to have the same volume-to-power ratio. The fourth primary-coolant loop, where the DEG break is postulated to occur, is simulated by a single LOFT broken loop. The facility and TRAC-P model consist of a reactor vessel (3D VESSEL) with a nuclear-fueled core (initially at 47 MW power in the L2-6 experiment) as shown in Fig. 16; an intact loop with an active pressurizer, steam generator, two primary-coolant pumps in parallel, and an emergency core coolant (ECC) cold-leg injection system as shown in Fig. 17; and a broken loop with a pipe-simulated steam generator and pump with blowdown quick-opening hot- and cold-leg valves, a steam-suppression tank, and low-flow warmup lines connected to the intact loop, as shown in Fig. 18. The ECC has a low-pressure injection system (LPIS), a high-pressure injection system (HPIS), and an accumulator. The steam-generator secondary side has a U-tube boiler, steam dome, downcomer, main steam-flow control valve, and a feedwater (pump and valve) control system, as shown in Fig. 19.

The transient begins at steady-state operating conditions and at time 0 s simultaneously opens the broken-loop hot- and cold-leg quick-opening blowdown valves in ~0.02 s. Primary-side depressurization trips a reactor-core power scram at 0.1 s (followed by experiment-measured power decay) and trips a primary-coolant pump coastdown at 0.8 s under flywheel inertia until uncoupled at 19 s (differing from LOFT tests L2-2 and L2-3 where the pumps are not tripped). The secondary-side steam-flow control valve closes in ~10 s and feedwater flow stops in ~2 s. The pressurizer empties at 15.5 s, accumulator ECC injection begins at 17.5 s and ends at ~45 s, and delayed (due to a loss of off-site power assumption) HPIS and LPIS ECC injection begins at 21.8 s and 34.8 s, respectively. Subcooled blowdown occurs for ~4 s followed by a two-phase blowdown, vessel downcomer and lower-plenum refill, and core reflood. During blowdown depressurization, liquid coolant is lost from the core region by pressure-driven convection and phase-change flashing. This loss of heat sink for the fuel rods results in their rapid heatup to a peak clad temperature of 1074 K (1473.5°F). During blowdown and refill, slugs of liquid

Fig. 16. TRAC-P model of the LOFTL26 and LOFTL26R test-problem reactor vessel.

Fig. 17. TRAC-P model of the LOFTL26 and LOFTL26R test-problem intact loop.

Fig. 18. TRAC-P model of the LOFTL26 and LOFTL26R test-problem broken loop.

Fig. 19. TRAC-P model of the LOFTL26 & LOFTL26R test-problem steam generator.

periodically flow upward into the core region to core elevations up to 1.25 m (4.101 ft) causing fuel-rod clad rewet and significant temperature quenching. After the passage of such liquid slugs, fuel-rod clad dryout and heatup reoccur until bottom-up core reflood begins after 40 s.

The LOFT L2-6 experiment is a scaled-PWR integral test of an extreme and complex blowdown, core dryout, refill, and reflood transient. Experimental data are available to benchmark the TRAC-predicted timing and behavior of depressurization, large-break mass flows, safety-system operation, core dryout, vessel downcomer and lower-plenum refill, fuel-rod clad rewet, and core reflood under prototypic conditions. The purpose of this test problem is to verify TRAC's ability to predict the transient behavior of this complex phenomena using its core-reflood model option. This transient is very sensitive to phenomenological changes made in TRAC. The effect of such changes can be measured and better understood by having this test problem in the standard test-problem matrix when different model changes are done in successive versions of TRAC.

2.13.2. TRAC-P Features and Options Tested. The LOFTL26 steady-state calculation and LOFTL26R transient calculation simulation of the LOFT L2-6 experiment is the most complex model in the standard test-problem matrix. It exercises aspects of many TRAC-P features and input-data selected model options. This very useful test problem carries the penalty of a long-running computer-evaluation transient calculation for the full 120 s of the experiment. On a Cray-YMP, the steady-state calculation requires ~10 min, and the transient calculation requires ~16 h. The TRAC-P features and options tested are:

- Constrained steady-state (CSS) calculation
- Hydraulic-path steady-state initialization
- CSS PUMP controller for mass flow
- Water-packing option
- CSS VALVE controller for pressure
- Choked-flow model with input multipliers
- CSS FILL controller for mass flow
- Core/downcomer flow areas input
- CSS HTSTR controller for liquid temperature
- Two-way 1D loss coefficients input
- Axial heat-transfer implicit numerics
- Noncondensable gas modeled
- 12 signal variables, 15 control blocks,

- Control procedure has 2 evaluation passes (secondary-side liquid-inverted controller), and 8 trips
- SI-units I/O w/control-block units labels
- All control blocks are TRAC initialized
- Trip-controlled core power vs time table
- 12 average- and 5 peak-power fuel rods
- Fine-axial-mesh option for core fuel rods
- HTSTRs, PIPEs, and TEEs remodel STGEN
- PUMP friction torque and various inertia input
- LOFT built-in pump curves used
- Critical heat-flux calculation option
- Check value opens when trip set ON
- Accumulator modeled by IACC=1 PIPE
- HPIS & LPIS trip-controller FILL velocity table
- Tube-sheet FRIC gives 4.7 steam generator recirculating ratio
- FRIC=1.0e+30 secondary-side steam separator
- NFF=-1 abrupt flow-area change losses
- Hydro-component wall heat transfer
- Hydro-component wall HOUT>0 heat loss
- Core-region spacer grids modeled
- HTSTR 1 and 2 surface convection heat transfer
- Powered and unpowered HTSTRs
- HTSTR 1 surface constant HTC and temperature
- Fuel/gas-gap/clad and structure materials
- HTSTR 1 surface adiabatic boundary conditions
- ROD and SLAB geometry HTSTRs
- Large break modeled by press. vs time boundary conditions
- 1-D horizontal-stratified flow and heat transfer
- Vessel-region (dc,lp,core,up) correlations
- Restart transient calculation
- Reflood model with/controlling trip set ON at 200 s
- 3-D ($r=4$, $\theta=4$, $z=12$) VESSEL
- Four VESSEL-junction source connections
- Components: 1 or 3 BREAKs and 7 or 5 FILLs (steady-state or transient calculation),
- 18 ROD and 136 SLAB HTSTRs, 6 PIPEs, 1 PLENUM, 1 PRIZER,
- 2 PUMPs, 8 TEEs, 2 VALVES, and 1 VESSEL

2.14. UPTF8B#, #=1,2,3 Test Problem

2.14.1. Problem Description. UPTF8B# is a separate-effects test problem used to investigate the thermal-hydraulic phenomena that occur in the loops of a PWR as a result of accumulator and low-pressure ECC liquid injection into the cold leg during the end of blowdown, refill, and reflood phases of a postulated LOCA. Test 8 (Phase b, Part 1, Run 111) in the Upper Plenum Test Facility (UPTF) is simulated by a

TRAC-P transient calculation evaluated over three time intervals (from 23 to 50 s, from 50 to 80 s, and from 80 to 225 s) of the experiment. The current UPTF model has been upgraded from the Code Scaleability, Applicability, and Uncertainty (CSAU) UPTF model used to assess TRAC-PF1/MOD1. The upgrade changes provide better agreement with the initial conditions of the experiment and correct some features of the hardware model.

The hydraulic phenomena of interest in Test 8 is the oscillatory movement of an ECC subcooled-liquid plug in the cold-leg pipe between its ECC injection port and the vessel-downcomer connection. After blowdown, saturated steam flow from the hot leg to the cold leg of a loop establishes a pressure gradient that pushes the injected ECC liquid toward the vessel-downcomer connection. As a plug of liquid, the upstream and downstream liquid-steam interfacial areas are not sufficient to condense much steam and affect this pressure-gradient driving force. If and when the liquid plug is pushed past its ECC injection port, however, subsequent liquid is injected into steam with a large interfacial surface area that condenses the steam and reduces the coolant pressure upstream of the liquid plug. This reverses the pressure gradient driving the liquid plug causing the plug to deaccelerate and eventually flow back toward the ECC injection port. Once that movement covers the ECC injection port, the liquid-steam interfacial area is reduced to that of the plug face, steam condensation is decreased significantly, and steam flow from the hot leg reestablishes the hot-leg to cold-leg pressure gradient across the liquid plug. Then the above process repeats itself resulting in oscillatory movement of the liquid plug in the cold-leg pipe. This phenomena has a significant effect on power-plant safety because it delays the arrival of ECC liquid to refill the downcomer and lower plenum, and reflood the reactor core after a LOCA. TRAC's ability to simulate this oscillatory movement of ECC liquid in the cold leg (which was originally predicted by early version of TRAC before being experimentally observed) enables its affect on safety to be assessed.

UPTF is a full-scale model of a four-loop 1300 MWe PWR including the downcomer, lower plenum, simulated core, and upper plenum of the reactor vessel and with four loops (three intact and one broken) having pump and steam-generator simulators. Steam production in the reactor core is simulated by direct steam injection. A diagram of the four-loop UPTF and its Test 8 boundary conditions is shown in Fig. 20. Both break valves of broken loop 4 were fully open

to model a 200% DEGB to the containment-simulator ~4 bar (0.375 to 0.405 MPa, 54.4 to 58.0 psia) pressure boundary condition. The loop 1 pump simulator was closed to model full blockage and no flow. The loop 2 and 3 pump simulators were set to model partial blockage and establish a 0.25 bar (0.0253 MPa, 3.67 psi) differential pressure between the upper plenum and downcomer. A TRAC-P noding diagram of loop 3 is shown in Fig. 21. Loops 1, 2, and 3 are identical except for loop 2 having a hot-leg pressurizer. ECC liquid injection only occurs in loop 2 during Test 8.

Initially saturated steam was present throughout the primary system except for liquid in the lower plenum, core, and downcomer of the vessel at a height of 4.2 m

Fig. 20. UPTF test facility and Test 8b, Part 1 boundary conditions.

Fig. 21. TRAC-P model of the UPTF8B#, #=1,2,3 test-problem loop 3.

(13.78 ft) and in the intact-loop steam-generator simulator and broken-loop steam/water separator drains. Core-simulator steam injection was initiated at 23 s with a 2 s ramp to 115.3 kg/s (254.2 lb_m/s) where it was held constant until 200 s. Loop 2 cold-leg ECC liquid injection at 311.0 K (100.1°F) [subcooled 102.4 K (184.3°F)] was initiated at 27 s with a 4 s ramp to 600 kg/s (1323 lb_m/s) followed by six 30-s time-interval steps at 600, 400, 250, 200, 150, and 80 kg/s. The oscillatory liquid plug behavior (described above) occurs during the large 250 to 600 kg/s ECC-liquid injection rates with the movement amplitude of the oscillation decreasing as the injection rate decreases. For ECC-liquid injection rates of 200 kg/s and lower, the flow regime in the loop 2 cold leg switches from oscillatory plug flow to a horizontally stratified flow regime with a reduced liquid-steam interfacial area.

2.14.2. TRAC-P Features and Options Tested. UPTF8B# is a larger TRAC-P model than LOFTL26, but it requires less calculative effort. It doesn't require a steady-state calculation for transient initial conditions. Rapid transient behavior with small timesteps occurs only during the 60 s of 600 kg/s and 400 kg/s ECC-liquid injection. Interpreting the calculated results is easier because our interest is focused on the thermal-hydraulic behavior in the cold leg of loop 2 where ECC-liquid injection occurs. The TRAC-P features and options tested are:

- Two-phase flow transient calculation
- Choked-flow model at specified interfaces
- VESSEL phasic mass flows to graphics
- VESSEL liquid-inventory control drain VALVE
- Noncondensable gas is modeled
- Interfacial heat-transfer model
- 18 signal variations, 38 control blocks and 23 trips
- Signal variables and trip-controlled-trip trip signals
- Trip set-point factor vs time tables
- Trip-controlled data dump and problem end
- (r=2, $\theta=4$, z=13) VESSEL
- 1D & Z 3D abrupt flow-area form losses
- Trip-controlled mass flow vs time FILL table
- FRIC and CFZp-d (d=R,T,Z) form losses
- Trip-controlled pressure vs time BREAK table
- Forward and reverse FRICs for 1D component
- Constant pressure boundary condition
- No back flow modeled by RVFRIC=1.0e+15
- 1D hydraulic-component wall heat transfer

- No forward flow modeled by $FRIC=1.0e+15$
- Evaporation and condensation model
- Water-packing option
- Component action tables with relative independent variables
- $COST=-1.0, 0.0, 0.5, 1.0$ TEE components
- Unheated SLABs with outer surface convection heat transfer
- Components: 4 BREAKs, 24 FILLs, 16 SLAB HTSTRs, 30 TEEs, 7 VALVES, and 1 VESSEL

2.15. UTUBE3D Test Problem

2.15.1. Problem Description. UTUBE3D models a 12-in.-diam, U-tube shaped, vertical standpipe with each side leg 7.5 m (24.6 ft) high. The top ends of the U-tube have vertical one-cell PIPE components connected to BREAK components with constant 0.1 MPa (14.50 psia) atmospheric-pressure boundary conditions. These PIPE components are connected to vertical six-cell (axial level) 1D VESSEL components. The VESSEL components are connected at the bottom of the U-tube by a horizontal one-cell PIPE component, as shown in Fig. 22. Initially, the at-rest liquid level in one side leg is 1.0 m (3.2808 ft) higher than the liquid level in the other side leg of the U-tube VESSELS with a total liquid length of $L = 4.0$ m (13.123 ft). This test problem verifies TRAC's ability to predict an undamped manometer oscillation of the liquid level with its amplitude undamped by no wall-drag ($NFF=0$ with $EPSW=3.0 \times 10^{-6}$ m [9.8425×10^{-6} ft] surface roughness) and no form-loss ($FRIC=0.0$ K-factors) flow resistance and its oscillation having a derived half-period (time for the side-leg liquid level to move between its minimum and maximum heights) of

$$\tau = 2 \cdot \pi \cdot \sqrt{L / (2 \cdot g)} = 2 \cdot \pi \cdot \sqrt{4.0 \text{ m} / (2 \cdot 9.8 \text{ m/s}^2)} = 2.84 \text{ s}$$

The 50 s transient calculation evaluates ~9 manometer-oscillation periods with little change in the 1.0 m (3.2808 ft) amplitude change in liquid-level height on each side of the U-tube VESSELS.

UTUBE3D models the same U-tube geometry and undamped manometer oscillation transient as the short-running series UTUBE test problem. The only difference is that the 15-cell PIPE component in UTUBE is modeled by two 6-cell 1D VESSEL components and three 1-cell PIPE components in UTUBE3D. UTUBE3D is not a 3D VESSEL test problem. UTUBE3D, like UTUBE, is a short-running test problem that should be in the short-running series rather than long-running series of standard test matrix problems. They both should be considered the same test

Fig. 22. TRAC-P model of the UTUBE3D test problem.

problem UTUBE#; #=P,V with problem-calculation cases #=P for the single PIPE and #=V for the two 1-D VESSELS and three PIPEs.

2.15.2. TRAC-P Features and Options Tested. The UTUBE3D manometer oscillation is driven by the gravity-head term pressure difference on each side of the U-tube shaped coolant channel and by momentum convection as the liquid coolant flows from one side of the U-tube to the other side. The TRAC-P features and options tested are:

- gravity-heat term
- momentum-convection term
- water-packing option
- choked-flow model with no faces specified
- mesh-cell center elevations input
- K-factors with 0.0 values input
- EPSW= 3.0×10^{-6} m surface roughness
- NFF=0 wall-drag friction factor of zero
- vapor condensation (TSAT(P=0.1 MPa) = 373.0 K > TV = 298.3 K)
- liquid level reaches cell (level) interface at minimum and maximum height
- components: 2 BREAKs, 3 PIPEs, and 2 VESSELS

3.0. SUMMARY AND CONCLUSIONS

The purpose of this report is to provide an introductory description of the test problems in the TRAC-P standard test matrix. These test problems are used to verify their correct evaluation by each (interim and major-release) version of TRAC-P as a requirement for version acceptance. This report should be the TRAC-P user's first reference for obtaining a quick understanding of the nature of each of the 15 different test problems and 42 different test-problem calculations in the test matrix. The nature of the phenomena, neutronic-thermal-hydraulic behavior, and TRAC-P models, features, and options evaluated by each test problem needs to be documented as information for the TRAC-P users because that and only that is what is verified and validated with the acceptance of each TRAC-P version. Major-release versions of TRAC-P (such as TRAC-PF1/MOD2 Version 5.3 in 1990 and Version 5.4 in 1993) are tested further on additional experimental test problems on which

evaluated results are compared with experimental data and documented in a developmental assessment manual for that major-release version of TRAC-P.

Knowing what is tested for acceptance of TRAC-P versions provides the user with a measure of confidence that those aspects are being evaluated correctly in his application. All other aspects of TRAC-P that are not involved in the test-problem evaluations were tested for their correct evaluation when implemented in TRAC. Not testing them with each version on an appropriate test problem in the standard test matrix, however, means that their continuing correct evaluation has not been verified. Changes made to TRAC-P with each version may indirectly affect the correct evaluation of existing models, features, and options. Users need to use those unverified aspects of TRAC-P with some caution in their application.

Ideally all features and options of TRAC-P should be tested by test problems in the standard test matrix. I estimate that only one-third of all TRAC-P models, features, and options (and selected variations within them) are evaluated currently by the standard test matrix. Doubling that to two-thirds would require three or four times more test-problem calculations unless the added test problems are created or modified specifically to test features and options that are not being evaluated currently. One of our goals is to extend the standard test matrix coverage of TRAC-P models, features, and options. Preparing this report is a step in that direction. It documents where we are currently in that coverage of phenomena, neutronic-thermal-hydraulic behavior, and TRAC-P models, features, and options evaluated. The complement of those aspects of TRAC-P needs to be prioritized and a limited set of quick-running test problems that maximize coverage of that prioritized complement needs to be added to the standard test matrix.

REFERENCES

1. J. C. Lin, V. Martinez, and J. W. Spore, "TRAC-PF1/MOD2 Developmental Assessment Manual," Los Alamos National Laboratory draft report (August 1993).
2. J. W. Spore, et al., "TRAC-PF1/MOD2 Theory Manual," Los Alamos National Laboratory draft report (July 1993).
3. D. Page "Automated Testing of the TRAC-PF1/MOD2 Standard Test Matrix Problems," Los Alamos National Laboratory report LA-UR-96-1056 (March 1996).

A-1 DRAIN Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              4              1              1              0              0
9 *--*--*TEST PROBLEM DRAIN , Time = 195.0 s
10 *****
11 * 12-inch diameter double-standpipe drain model *
12 *****
13 *
14 *          #####
15 *          # break# p = 1.0000e+05 pa
16 *          # 702 # alpha=1.0, tv=298.3 k
17 *          #####
18 *          702
19 *          #####
20 *          #cell15#
21 *          #-----#
22 *          #cell14#
23 *          #-----#
24 *          #cell13# o
25 *          #-----# |
26 *          #cell12# |
27 *          #-----# |
28 *          #cell11# alpha=1.0, tv=298.3 k
29 *          #-----# --- initial condition
30 *          #cell10# alpha=0.0, tl=298.3 k
31 *          #-----# |
32 *          #cell 9# |
33 *          #-----# |
34 *          #cell 8# o
35 *          #-----#
36 *          #cell 7#
37 *          #-----#
38 *          #cell 6# pipe
39 *          #-----# 700
40 *          #cell 5#
41 *          #-----#
42 *          #cell 4#
43 *          #-----# o
44 *          #cell 3# |
45 *          #-----# |
46 *          #cell 2# |
47 *          #-----# fa=0.14593 m2
48 *          #cell 1#
49 *          ##### fa=0.01 m2, k-factor=1.0
50 *          701
51 *          #####
52 *          # fill # liquid mass flow
53 *          # 701 # vs time
54 *          #####
55 *
56 *****
57 * namelist data *
58 *****
59 *
60 &inopts

```

```

61 iadded=10, icflow=2, ikfac=1, noair=1, cpuflg=1,
62 iddiag=4, nsdl=0, nsdu=5, nspl=0, nsdu=5
63 &end
64 *
65 *          dstep          timet
66 *          0          0.0000e+00
67 *          stdyst          transi          ncomp          njun          ipak
68 *          0          1          3          2          1
69 *          epso          epss
70 *          1.0000e-05          1.0000e-04
71 *          oitmax          sitmax          isolut          ncontr          nccfl
72 *          10          10          0          0          0
73 *          ntsv          ntcbl          ntcf          ntrp          ntcp
74 *          1          0          0          0          1
75 *
76 *****
77 * component-number data *
78 *****
79 *
80 * iorder*          700          701          702e
81 *
82 *****
83 * control-parameter data *
84 *****
85 *
86 * signal variables
87 *          idsv          isvn          ilcn          icn1          icn2
88 *          1          0          0          0          0
89 *
90 *****
91 * component data *
92 *****
93 *
94 ***** type          num          id          ctitle
95 pipe          700          700 $700$ u-tube double standpipe
96 *          ncells          nodes          jun1          jun2          epsw
97 *          15          0          701          702          3.0000e-06
98 *          ichf          iconc          iacc          ipow
99 *          0          0          0          0
100 *          radin          th          houtl          houtv          toutl
101 *          1.5240e-01          1.2700e-02          0.0000e+00          0.0000e+00          2.9830e+02
102 *          toutv
103 *          2.9830e+02
104 *
105 * dx * f 1.0000e+00e
106 * vol * f 1.4593e-01e
107 * fa * 1.0000e-02r15 1.4593e-01e
108 * fric * 1.0000e+00r15 0.0000e+00e
109 * grav * f 1.0000e+00e
110 * hd * f 3.0480e-01e
111 * icflg * f 0e
112 * nff * f 1e
113 * alp * r10 0.0000e+00r05 1.0000e+00e
114 * vl * f 0.0000e+00e
115 * vv * f 0.0000e+00e
116 * tl * f 2.9830e+02e
117 * tv * f 2.9830e+02e
118 * p * f 1.0000e+05e
119 * pa * f 0.0000e+00e
120 *
121 ***** type          num          id          ctitle
122 fill          701          701 $701$ mass flow bc

```

```

123 *      jun1      ifty      ioff
124      701      5      0
125 *      iftr      ifsv      nftb      nfsv      nfrf
126      0      1      8      0      0
127 *      twtold      rfmix      concin      felv
128      0.0      1.0000e+11      0.0000e+00      0.0000e+00
129 *      dxin      volin      alpin      vlin      tlin
130      1.0000e+00      1.4593e-01      0.0000e+00      0.0000e+00      2.9830e+02
131 *      pin      pain      flowin      vvin      tvin
132      2.4700e+05      0.0000e+00      0.0000e+00      0.0000e+00      2.9830e+02
133 *      vmscl      vvscl
134      1.0000e+00      1.0000e+00
135 *
136 * vmtbm - liquid mass flow vs time table
137 *
138 *      time (s)      mass flow (kg/s)
139 *
140      0.0000e+00      0.0000e+00s
141      1.0000e+01      0.0000e+00s
142      2.0000e+01      -1.0000e+01s
143      9.5000e+01      -1.0000e+01s
144      9.5100e+01      0.0000e+00s
145      1.1000e+02      0.0000e+00s
146      1.2000e+02      1.0000e+01s
147      1.9500e+02      1.0000e+01e
148 *
149 *****      type      num      id      ctitle
150 break      702      702 $702$      pressure bc
151 *      jun1      ibty      isat      ioff
152      702      0      0      0
153 *      dxin      volin      alpin      tin      pin
154      1.0000e+00      1.4593e-01      1.0000e+00      2.9830e+02      1.0000e+05
155 *      pain      concin      rbmx      poff      belv
156      0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00      1.6000e+01
157 *
158 end
159 *
160 *****
161 * time-step data *
162 *****
163 *
164 *      dtmin      dtmax      tend      rtwfp
165      1.0000e-03      2.0000e-02      1.0000e+01      1.0000e+03
166 *      edint      gfint      dmpint      sedint
167      1.0000e+01      5.0000e-01      2.0000e+02      5.0000e+00
168 *
169 *      dtmin      dtmax      tend      rtwfp
170      1.0000e-03      3.0000e-02      2.0000e+01      1.0000e+03
171 *      edint      gfint      dmpint      sedint
172      1.0000e+01      5.0000e-01      2.0000e+02      5.0000e+00
173 *
174 *      dtmin      dtmax      tend      rtwfp
175      1.0000e-03      4.0000e-02      3.0000e+01      1.0000e+03
176 *      edint      gfint      dmpint      sedint
177      1.0000e+01      5.0000e-01      2.0000e+02      5.0000e+00
178 *
179 *      dtmin      dtmax      tend      rtwfp
180      1.0000e-03      5.0000e-02      4.0000e+01      1.0000e+03
181 *      edint      gfint      dmpint      sedint
182      1.0000e+01      5.0000e-01      2.0000e+02      5.0000e+00
183 *
184 *      dtmin      dtmax      tend      rtwfp

```

185	1.0000e-03	1.0000e-01	1.9500e+02	1.0000e+03
186 *	edint	gfint	dmpint	sedint
187	1.0000e+01	5.0000e-01	2.0000e+02	5.0000e+00
188 *				
189 *	endflag			
190	-1.0000e+00			

A-2.1 HCOND1 Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *          11              0              1              1              0
9 ***-TEST PROBLEM HCOND1 , Time = 5.0 s
10 2 d heat conduction problem with
11 transient heatup & noflow liquid
12 case : cond2d01 fine radial nodding case
13 hydraulic-channel cells = 2
14 number of radial nodes = 11
15 number of axial node rows = 3
16 rod radius = 5.0 mm
17 heat conduction = 2.0 w/k/m
18 fluid temperature = 300.0 and 500.0 k
19 initial rod temperature = 300.0 k
20 *
21 *
22 *          #####
23 *          # break# alpha=0.0
24 *          # 92 # tl=500.0 k
25 *          node          #####
26 *          row          2
27 * tw=300.0 k 3 ++++++-----##### vl=0.0 m/s
28 *          +          +---# cell # alpha=0.0
29 *          +          +---# 2 # tl=500.0 k
30 * tw=300.0 k 2 +++rod99+----#pipe01# vl=0.0 m/s
31 *          +          +---# cell # alpha=0.0
32 *          +          +---# 1 # tl=300.0 k
33 * tw=300.0 k 1 ++++++-----##### vl=0.0 m/s
34 *          0mm          5mm          1
35 *          #####
36 *          no # fill # alpha=0.0
37 *          flow # 91 # tl=300.0 k
38 *          #####
39 *****
40 * namelist data *
41 *****
42 *
43 &inopts
44 nrslv=1, nhtstr=1, iconht=1, htcwl=1000.0, htcwv=0.0,
45 idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5, cpuflg=1
46 &end
47 *
48 *          dstep          timet
49 *          0          0.0000e+00
50 *          stdyst          transi          ncomp          njun          ipak
51 *          0          1          4          2          0
52 *          epso          epss
53 *          1.0000e-03          1.0000e-05
54 *          oitmax          sitmax          isolut          ncontr          nccfl
55 *          10          0          10          0          0
56 *          ntsv          ntcb          ntcf          ntrp          ntcp
57 *          1          0          0          1          0
58 *
59 *****
60 * component-number data *

```

```

61 *****
62 *
63 * iorder*          1          91          92          99e
64 *
65 *****
66 * material-properties data *
67 *****
68 *
69 * matb *          51e
70 * ptbln *          2e
71 *
72 *   prptb(1,i)   prptb(2,i)   prptb(3,i)   prptb(4,i)   prptb(5,i)
73   2.0000e+02   1.0000e+00   1.0000e+00   2.0000e+00   1.0000e+00
74   4.0000e+05   1.0000e+00   1.0000e+00   2.0000e+00   1.0000e+00
75 e
76 *
77 *****
78 * control-parameter data *
79 *****
80 *
81 *
82 * signal variables
83 *       idsv       isvn       ilcn       icn1       icn2
84       1           0           0           0           0
85 *
86 * trips
87 *       ntse       ntct       ntsf       ntdp       ntsd
88       0           0           0           0           0
89 *       idtp       isrt       iset       itst       idsg
90       101         2           0           1           1
91 *       setp(1)     setp(2)
92   0.0000e+00   1.0000e-05
93 *       dtsp(1)     dtsp(2)
94   0.0000e+00   0.0000e+00
95 *       ifsp(1)     ifsp(2)
96       0           0
97 *
98 *****
99 * component data *
100 *****
101 *
102 *****   type          num          id          ctitle
103 fill          91          91
104 *       jun1          ifty          ioff
105       1           1           0
106 *       twtold          rfmix          concin          felv
107   0.0000e+00   1.0000e+20   0.0000e+00   0.0000e+00
108 *       dxin          volin          alpin          vlin          tlin
109   1.0000e-01   3.1416e-02   0.0000e+00   0.0000e+00   3.0000e+02
110 *       pin          pain          flowin          vvin          tvin
111   1.0000e+07   0.0000e+00   0.0000e+00   0.0000e+00   3.0000e+02
112 *
113 *****   type          num          id          ctitle
114 pipe          1          1 test section
115 *       ncells          nodes          jun1          jun2          epsw
116       2           0           1           2   0.0000e+00
117 *       ichf          iconc          iacc          ipow
118       0           0           0           0
119 *       radin          th          hout1          houtv          tout1
120   1.0000e-01   0.0000e+00   0.0000e+00   0.0000e+00   3.0000e+02
121 *       toutv
122   3.0000e+02

```



```

123 *
124 * dx      * f    1.0000e-01e
125 * vol     * f    3.1416e+02e
126 * fa      * f    3.1416e+03e
127 * fric    * f    0.0000e+00e
128 * grav     * f    1.0000e+00e
129 * hd      * f    2.0000e-01e
130 * nff      * f          0e
131 * alp      * f    0.0000e+00e
132 * vl       * f    0.0000e+00e
133 * vv       * f    0.0000e+00e
134 * tl       *      3.0000e+02    5.0000e+02e
135 * tv       *      3.0000e+02    5.0000e+02e
136 * p        * f    1.0000e+07e
137 * pa       * f    0.0000e+00e
138 *
139 *****      type          num          id          ctitle
140 break                92                92 upper boundary
141 *                  jun1          ibty          isat          ioff
142 *                  2              0              0              1
143 *                  dxin          volin          alpin          tin          pin
144 *                  1.0000e-01    3.1416e+02    0.0000e+00    5.0000e+02    1.0000e+07
145 *                  pain          concin          rbmx          poff          belv
146 *                  0.0000e+00    0.0000e+00    1.0000e+20    0.0000e+00    0.0000e+00
147 *
148 *****      type          num          id          ctitle
149 rod                99                99 test heat conductor
150 *                  ncrx          ncrz
151 *                  1              2
152 *                  nopowr          nrldr          modez          liqlev          iaxcnd
153 *                  0              1              0              0              1
154 *                  idbci          idbco          hdri          hdro
155 *                  0              2    0.0000e+00    2.0000e-01
156 *                  nrods          nodes          irftr          nzmax
157 *                  1              11             101             30
158 *                  dtxht (1)      dtxht (2)      dznht          hgapo          shelv
159 *                  1.0000e+03    1.0000e+03    1.0000e+02    1.0000e+03    0.0000e+00
160 *                  irpwty          ndgx          ndhx          nrts          nhist
161 *                  5              0             -11             10              0
162 *                  izpwtr          izpwsv          nzpwtr          nzpwsv          nzpwrf
163 *                  0              1              1              0              0
164 *                  nmwrx          nfcil          nfcil
165 *                  0              0              0
166 *                  nzpwz          nzpwi          nfbpwt
167 *                  0              0              0
168 *                  react          tneut          rpwoff          rrpwmx          rpwscl
169 *                  0.0000e+00    0.0000e+00    0.0000e+00    0.0000e+00    1.0000e+00
170 *                  rpowri          zpwin          zpwoff          rzpwmx
171 *                  1.0000e+03    0.0000e+00    0.0000e+00    1.0000e+20
172 *                  extsou          pldr          pdrat          fucrac
173 *                  0.0000e+00    0.0000e+00    1.0000e+01    1.0000e+00
174 * nhcomo*          91r02          1              92e
175 * nhcelo* r02      1              2              1e
176 * z              0.0000e+00    1.0000e-01    2.0000e-01e
177 * grav * f        1.0000e+00e
178 * idrod *          1e
179 * rdx *          1.0000e+00e
180 * radrd *          0.0000e+00    5.0000e-04    1.0000e-03    1.5000e-03    2.0000e-03
181 * radrd *          2.5000e-03    3.0000e-03    3.5000e-03    4.0000e-03    4.5000e-03
182 * radrd *          5.0000e-03e
183 * matrd * f        51e
184 * nfax * f          9e

```

```

185 * rftn * f 3.0000e+02e
186 * rdpwr * f 1.0000e+00e
187 * cpowr * 1.0000e+00e
188 * zpwtb * f 1.0000e+00e
189 * fpuo2 * 0.0000e+00e
190 * ftd * 1.0000e+00e
191 * gmix * 1.0000e+00r06 0.0000e+00e
192 * gmles * 1.0000e+00e
193 * pgapt * 1.0000e+00e
194 * plvol * 1.0000e+00e
195 * pslen * 1.0000e+00e
196 * clennc * 1.0000e+00e
197 * burn * f 1.0000e+00e
198 *
199 end
200 *
201 *****
202 * time-step data *
203 *****
204 *
205 * dtmin dtmax tend rtwfp
206 * 1.0000e-03 1.0000e-01 1.0000e+00 1.0000e+03
207 * edint gfint dmpint sedint
208 * 1.0000e-01 1.0000e+01 1.0000e+06 1.0000e+06
209 *
210 *****
211 * time-step data *
212 *****
213 *
214 * dtmin dtmax tend rtwfp
215 * 1.0000e-03 1.0000e-01 5.0000e+00 1.0000e+03
216 * edint gfint dmpint sedint
217 * 1.0000e+00 1.0000e+01 1.0000e+06 1.0000e+06
218 *
219 *****
220 * time-step data *
221 *****
222 *
223 * endflag
224 * -1.0000e+00
223 * endflag
224 * -1.0000e+00

```

A-2.2 HCOND2 Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *          14              0              1              2              0
9 ***--*TEST PROBLEM HCOND2 , Time = 5.0 s
10 1d radial heat conduction problem
11 transient heatup & noflow liquid
12 case : cond1d01 fine radial nodding case
13 hydraulic-channel cells = 1
14 number of radial nodes = 18
15 number of axial node rows = 2
16 rod radius = 6.35 mm
17 clad inner radius = 6.426 mm
18 clad outer radius = 7.239 mm
19 rod heat conduction = 2.0 w/k/m
20 clad heat conduction = 13.8 w/k/m
21 fluid temperature = 300.0 k
22 initial rod temperature = 300.0 k
23 *
24 *          #####
25 *          # break# alpha=0.0
26 *          # 92 # tl=500.0 k
27 *          node          #####
28 *          row          2
29 * tw=300.0 k 2 ++++rod99++++gcccc--##### vl=0.0 m/s
30 *          +          c--# pipe # alpha=0.0
31 *          +          c--# 01 # tl=300.0 k
32 * tw=300.0 k 1 ++++++gcccc--##### vl=0.0 m/s
33 *          0mm          7.239mm          1
34 *          #####
35 *          no # fill # alpha=0.0
36 *          flow # 91 # tl=300.0 k
37 *          #####
38 *
39 *****
40 * namelist data *
41 *****
42 *
43 &inopts
44 nrs1v=1, nhtstr=1, iconht=1, htcw1=2836.0, htcwv=0. ,
45 idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5, cpuf1g=1
46 &end
47 *
48 *          dstep          timet
49 *          0          0.0000e+00
50 *          stdyst          transi          ncomp          njun          ipak
51 *          0          1          4          2          0
52 *          epso          epss
53 *          1.0000e-03          1.0000e-05
54 *          oitmax          sitmax          isolut          ncontr          nccfl
55 *          10          0          10          0          0
56 *          ntsv          ntcb          ntcf          ntrp          ntcp
57 *          1          0          0          1          0
58 *
59 *****
60 * component-number data *

```

```

61 *****
62 *
63 * iorder*          1          91          92          99e
64 *
65 *****
66 * material-properties data *
67 *****
68 *
69 * matb *          51          52e
70 * ptbln * f          2e
71 *
72 *   prptb(1,i)   prptb(2,i)   prptb(3,i)   prptb(4,i)   prptb(5,i)
73   2.0000e+02   1.0000e+00   1.0000e+00   2.0000e+00   1.0000e+00
74   4.0000e+05   1.0000e+00   1.0000e+00   2.0000e+00   1.0000e+00
75 e
76 *
77 *   prptb(1,i)   prptb(2,i)   prptb(3,i)   prptb(4,i)   prptb(5,i)
78   2.0000e+02   1.0000e+00   1.0000e+00   1.3800e+01   1.0000e+00
79   4.0000e+05   1.0000e+00   1.0000e+00   1.3800e+01   1.0000e+00
80 e
81 *
82 *****
83 * control-parameter data *
84 *****
85 *
86 *
87 * signal variables
88 *       idsv       isvn       ilcn       icn1       icn2
89       1           0           0           0           0
90 *
91 * trips
92 *       ntse       ntct       ntsf       ntdp       ntsd
93       0           0           0           0           0
94 *       idtp       isrt       iset       itst       idsg
95       101         2           0           1           1
96 *       setp(1)    setp(2)
97   1.0000e+02   1.0001e+02
98 *       dtsp(1)    dtsp(2)
99   0.0000e+00   0.0000e+00
100 *       ifsp(1)    ifsp(2)
101       0           0
102 *
103 *****
104 * component data *
105 *****
106 *
107 *****   type          num          id          ctitle
108 fill          91          91
109 *       jun1          ifty          ioff
110       1           1           0
111 *       twtold          rfmix          concin          felv
112   0.0000e+00   1.0000e+20   0.0000e+00   0.0000e+00
113 *       dxin          volin          alpin          vlin          tlin
114   1.0000e-01   3.1416e-02   0.0000e+00   0.0000e+00   3.0000e+02
115 *       pin          pain          flowin          vvin          tvin
116   1.0000e+07   0.0000e+00   0.0000e+00   0.0000e+00   3.0000e+02
117 *
118 *****   type          num          id          ctitle
119 pipe          1           1 test section
120 *       ncells          nodes          jun1          jun2          epsw
121       1           0           1           2          0.0000e+00
122 *       ichf          iconc          iacc          ipow

```

```

123      0      0      0      0
124 *      radin      th      houtl      houtv      toutl
125      1.0000e-01      0.0000e+00      0.0000e+00      0.0000e+00      3.0000e+02
126 *      toutv
127      3.0000e+02
128 *
129 * dx *      1.0000e-01e
130 * vol *      3.1416e+02e
131 * fa * f      3.1416e+03e
132 * fric * f      0.0000e+00e
133 * grav * f      1.0000e+00e
134 * hd * f      2.0000e-01e
135 * nff * f      0e
136 * alp *      0.0000e+00e
137 * vl * f      0.0000e+00e
138 * vv * f      0.0000e+00e
139 * tl *      3.0000e+02e
140 * tv *      3.0000e+02e
141 * p *      1.0000e+07e
142 * pa *      0.0000e+00e
143 *
144 ***** type num id ctitle
145 break 92 92 upper boundary
146 * junl ibty isat ioff
147 2 0 0 1
148 * dxin volin alpin tin pin
149 1.0000e-01 3.1416e+02 0.0000e+00 5.0000e+02 1.0000e+07
150 * pain concin rbmx poff belv
151 0.0000e+00 0.0000e+00 1.0000e+20 0.0000e+00 0.0000e+00
152 *
153 ***** type num id ctitle
154 rod 99 99 test heat conductor
155 * ncrx ncrz
156 1 1
157 * nopowr nrldr modez liqlev iaxcnd
158 0 1 0 0 0
159 * idbci idbco hdri hdro
160 0 2 0.0000e+00 2.0000e-01
161 * nrods nodes irftr nzmax
162 1 18 101 30
163 * dtxht (1) dtxht (2) dznht hgapo shelv
164 1.0000e+03 1.0000e+03 1.0000e+02 1.0000e+03 0.0000e+00
165 * irpwt y ndgx ndhx nrts nhist
166 5 0 -11 10 0
167 * izpwtr izpwsv nzpwtb nzpwsv nzpwrf
168 0 1 1 0 0
169 * nmwrx nfc i nfcil
170 0 0 0
171 * nzpwz nzpwi nfbpwt
172 0 0 0
173 * react tneut rpwoff rrpwm x rpwscl
174 0.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00 1.0000e+00
175 * rpowri zpwin zpwoff rzpwm x
176 1.0000e+03 0.0000e+00 0.0000e+00 1.0000e+20
177 * extsou pldr pdrat fucrac
178 0.0000e+00 0.0000e+00 1.0000e+01 1.0000e+00
179 * nhcomo* 91 1 92e
180 * nhcelo* f 1e
181 * z * 0.0000e+00 1.0000e-01e
182 * grav * 1.0000e+00e
183 * idrod * 1e
184 * rdx * 1.0000e+00e

```

```

185 * radrd *      0.0000e+00      1.8300e-03      2.5900e-03      3.1750e-03      3.6700e-03
186 * radrd *      4.1000e-03      4.4900e-03      4.8500e-03      5.1850e-03      5.5000e-03
187 * radrd *      5.8000e-03      6.0800e-03      6.3500e-03      6.4260e-03      6.6700e-03
188 * radrd *      6.8400e-03      7.0400e-03      7.2390e-03e
189 * matrd * r12      51      3r04      52e
190 * nfax *      1e
191 * rftn * f      3.0000e+02e
192 * rdpwr * r13      1.0000e+00r05      0.0000e+00e
193 * cpowr *      1.0000e+00e
194 * zpwtb * f      1.0000e+00e
195 * fpuo2 *      0.0000e+00e
196 * ftd *      1.0000e+00e
197 * gmix *      1.0000e+00r06      0.0000e+00e
198 * gmles *      1.0000e+00e
199 * pgapt *      1.0000e+00e
200 * plvol *      1.0000e+00e
201 * pslen *      1.0000e+00e
202 * clenl *      1.0000e+00e
203 * burn * f      1.0000e+00e
204 *
205 end
206 *
207 *****
208 * time-step data *
209 *****
210 *
211 *      dtmin      dtmax      tend      rtwfp
212      1.0000e-03      1.0000e-01      1.0000e+00      1.0000e+03
213 *      edint      gfint      dmpint      sedint
214      1.0000e-01      1.0000e+01      1.0000e+06      1.0000e+06
215 *
216 *****
217 * time-step data *
218 *****
219 *
220 *      dtmin      dtmax      tend      rtwfp
221      1.0000e-03      1.0000e-01      5.0000e+00      1.0000e+03
222 *      edint      gfint      dmpint      sedint
223      1.0000e+00      1.0000e+01      1.0000e+06      1.0000e+06
224 *
225 *****
226 * time-step data *
227 *****
228 *
229 *      endflag
230      -1.0000e+00

```

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *          11              0              1              1              0
9 *--*TEST PROBLEM HCOND3 , Time = 5.0 s
10 2 d heat conduction problem with
11 transient heatup & noflow liquid
12 case : cond2d02 fine radial nodding with axial renoding
13 hydraulic-channel cells = 2
14 number of radial nodes = 11
15 number of axial node rows = 3 to 21
16 rod radius = 5.0 mm
17 heat conduction = 2.0 w/k/m
18 fluid temperature = 300.0 and 500.0 k
19 initial rod temperature = 300.0 k
20 *
21 *          #####
22 *          # break# alpha=0.0
23 *          # 92 # tl=500.0 k
24 *          node          #####
25 *          row          2
26 * tw=300.0 k 3 ++++++-----##### vl=0.0 m/s
27 *          +          +---# cell # alpha=0.0
28 *          +          +---# 2 # tl=500.0 k
29 * tw=300.0 k 2 +++rod99+++---#pipe01# vl=0.0 m/s
30 *          +          +---# cell # alpha=0.0
31 *          +          +---# 1 # tl=300.0 k
32 * tw=300.0 k 1 ++++++-----##### vl=0.0 m/s
33 *          0mm          5mm          1
34 *          #####
35 *          no # fill # alpha=0.0
36 *          flow # 91 # tl=300.0 k
37 *          #####
38 *
39 *****
40 * namelist data *
41 *****
42 *
43 &inopts
44 nrslv=1, nhtstr=1, iconht=1, htcwl=1000.0, htcwv=0. ,
45 idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5, cpuflg=1
46 &end
47 *
48 *          dstep          timet
49 *          0          0.0000e+00
50 *          stdyst          transi          ncomp          njun          ipak
51 *          0          1          4          2          0
52 *          epso          epss
53 *          1.0000e-03          1.0000e-05
54 *          oitmax          sitmax          isolut          ncontr          nccfl
55 *          10          0          10          0          0
56 *          ntsv          ntcb          ntcf          ntrp          ntcp
57 *          1          0          0          1          0
58 *
59 *****
60 * component-number data *

```

```

61 *****
62 *
63 * iorder*          1          91          92          99e
64 *
65 *****
66 * material-properties data *
67 *****
68 *
69 * matb *          51e
70 * ptbln *        2e
71 *
72 *   prptb(1,i)   prptb(2,i)   prptb(3,i)   prptb(4,i)   prptb(5,i)
73 *   2.0000e+02   1.0000e+00   1.0000e+00   2.0000e+00   1.0000e+00
74 *   4.0000e+05   1.0000e+00   1.0000e+00   2.0000e+00   1.0000e+00
75 e
76 *
77 *****
78 * control-parameter data *
79 *****
80 *
81 *
82 * signal variables
83 *       idsv       isvn       ilcn       icn1       icn2
84 *       1         0         0         0         0
85 *
86 * trips
87 *       ntse       ntct       ntsf       ntdp       ntsd
88 *       0         0         0         0         0
89 *       idtp       isrt       iset       itst       idsg
90 *       101       2         0         1         1
91 *       setp(1)     setp(2)
92 *       0.0000e+00  1.0000e-05
93 *       dtsp(1)     dtsp(2)
94 *       0.0000e+00  0.0000e+00
95 *       ifsp(1)     ifsp(2)
96 *       0         0
97 *
98 *****
99 * component data *
100 *****
101 *
102 *****   type          num          id          ctitle
103 fill          91          91
104 *       jun1          ifty          ioff
105 *       1             1             0
106 *       twtold          rfmX          concin          felv
107 *       0.0000e+00      1.0000e+20      0.0000e+00      0.0000e+00
108 *       dxin          volin          alpin          vlin          tlin
109 *       1.0000e-01      3.1416e-02      0.0000e+00      0.0000e+00      3.0000e+02
110 *       pin          pain          flowin          vvin          tvin
111 *       1.0000e+07      0.0000e+00      0.0000e+00      0.0000e+00      3.0000e+02
112 *
113 *****   type          num          id          ctitle
114 pipe          1          1 test section
115 *       ncells          nodes          jun1          jun2          epsw
116 *       2             0             1             2          0.0000e+00
117 *       ichf          iconc          iacc          ipow
118 *       0             0             0             0
119 *       radin          th          hout1          houtv          tout1
120 *       1.0000e-01      0.0000e+00      0.0000e+00      0.0000e+00      3.0000e+02
121 *       toutv
122 *       3.0000e+02

```



```

123 *
124 * dx      * f  1.0000e-01e
125 * vol     * f  3.1416e+02e
126 * fa      * f  3.1416e+03e
127 * fric    * f  0.0000e+00e
128 * grav    * f  1.0000e+00e
129 * hd      * f  2.0000e-01e
130 * nff      * f           0e
131 * alp      * f  0.0000e+00e
132 * vl      * f  0.0000e+00e
133 * vv      * f  0.0000e+00e
134 * tl      *      3.0000e+02      5.0000e+02e
135 * tv      *      3.0000e+02      5.0000e+02e
136 * p       * f  1.0000e+07e
137 * pa      * f  0.0000e+00e
138 *
139 ***** type          num          id          ctitle
140 break          92          92 upper boundary
141 *             jun1      ibty      isat      ioff
142             2          0          0          1
143 *             dxin      volin      alpin      tin          pin
144             1.0000e-01  3.1416e+02  0.0000e+00  5.0000e+02  1.0000e+07
145 *             pain      concin      rbmx      poff      belv
146             0.0000e+00  0.0000e+00  1.0000e+20  0.0000e+00  0.0000e+00
147 *
148 ***** type          num          id          ctitle
149 rod            99          99 test heat conductor
150 *            ncrx      ncrz
151             1          2
152 *            nopowr     nrldr      modez      liqlev      iaxcnd
153             0          1          0          0          1
154 *            idbci      idbco      hdri      hdro
155             0          2      0.0000e+00  2.0000e-01
156 *            nrods      nodes      irftr      nzmax
157             1          11         101         100
158 *            dtxht(1)    dtxht(2)    dznht      hgapo      shelv
159             1.0000e+00  1.0000e+01  1.0000e-04  1.0000e+03  0.0000e+00
160 *            irpwtly     ndgx      ndhx      nrts      nhist
161             5          0          -11         10          0
162 *            izpwtr      izpwsv      nzpwtb      nzpwsv      nzpwrf
163             0          1          1          0          0
164 *            nmwrx      nfcil      nfcil
165             0          0          0
166 *            nzpwz      nzpwi      nfbpwt
167             0          0          0
168 *            react      tneut      rpwoff      rrpwmx      rpwscl
169             0.0000e+00  0.0000e+00  0.0000e+00  0.0000e+00  1.0000e+00
170 *            rpowri      zpwin      zpwoff      rrpwmx
171             1.0000e+03  0.0000e+00  0.0000e+00  1.0000e+20
172 *            extsou      pldr      pdrat      fucrac
173             0.0000e+00  0.0000e+00  1.0000e+01  1.0000e+00
174 * nhcomo*          91r02          1          92e
175 * nhcelo* r02      1          2          1e
176 * z      *      0.0000e+00  1.0000e-01  2.0000e-01e
177 * grav * f  1.0000e+00e
178 * idrod *          1e
179 * rdx      *      1.0000e+00e
180 * radrd *      0.0000e+00  5.0000e-04  1.0000e-03  1.5000e-03  2.0000e-03
181 * radrd *      2.5000e-03  3.0000e-03  3.5000e-03  4.0000e-03  4.5000e-03
182 * radrd *      5.0000e-03e
183 * matrd * f          51e
184 * nfax * f          48e

```

```

185 * rftn * f 3.0000e+02e
186 * rdpwr * f 1.0000e+00e
187 * cpowr * 1.0000e+00e
188 * zpwtb * f 1.0000e+00e
189 * fpuo2 * 0.0000e+00e
190 * ftd * 1.0000e+00e
191 * gmix * 1.0000e+00r06 0.0000e+00e
192 * gmles * 1.0000e+00e
193 * pgapt * 1.0000e+00e
194 * plvol * 1.0000e+00e
195 * pslen * 1.0000e+00e
196 * clennc * 1.0000e+00e
197 * burn * f 1.0000e+00e
198 *
199 end
200 *
201 *****
202 * time-step data *
203 *****
204 *
205 *          dtmin          dtmax          tend          rtwfp
206      1.0000e-03      1.0000e-01      1.0000e+00      1.0000e+03
207 *          edint          gfint          dmpint          sedint
208      1.0000e-01      1.0000e+01      1.0000e+06      1.0000e+06
209 *
210 *****
211 * time-step data *
212 *****
213 *
214 *          dtmin          dtmax          tend          rtwfp
215      1.0000e-03      1.0000e-01      5.0000e+00      1.0000e+03
216 *          edint          gfint          dmpint          sedint
217      1.0000e+00      1.0000e+01      1.0000e+06      1.0000e+06
218 *
219 *****
220 * time-step data *
221 *****
222 *
223 *          endflag
224      -1.0000e+00

```

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *          11              0              1              1              0
9 *--*--*TEST PROBLEM HCOND4 , Time = 5.0 s
10 2 d heat conduction problem with
11 transient heatup & noflow liquid
12 case : cond2d01 fine radial nodding case
13 hydraulic-channel cells = 2
14 number of radial nodes = 11
15 number of axial node rows = 3
16 rod radius = 5.0 mm
17 heat conduction = 2.0 w/k/m
18 fluid temperature = 300.0 and 500.0 k
19 initial rod temperature = 300.0 k
20 *
21 *          #####
22 *          # break# alpha=0.0
23 *          # 92 # tl=500.0 k
24 *          node          #####
25 *          row          2
26 * tw=300.0 k 3 ++++++-----##### vl=0.0 m/s
27 *          +          +---# cell # alpha=0.0
28 *          +          +---# 2 # tl=500.0 k
29 * tw=300.0 k 2 +++rod99+---#pipe01# vl=0.0 m/s
30 *          +          +---# cell # alpha=0.0
31 *          +          +---# 1 # tl=300.0 k
32 * tw=300.0 k 1 ++++++-----##### vl=0.0 m/s
33 *          0mm          5mm          1
34 *          #####
35 *          no # fill # alpha=0.0
36 *          flow # 91 # tl=300.0 k
37 *          #####
38 *
39 *****
40 * namelist data *
41 *****
42 *
43 &inopts
44 nhtstr=1, iconht=1, htcwl=1000.0, htcwv=0.0,
45 idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5, cpuflg=1
46 &end
47 *
48 *          dstep          timet
49 *          0          0.0000e+00
50 *          stdyst          transi          ncomp          njun          ipak
51 *          0          1          4          2          0
52 *          epso          epss
53 *          1.0000e-03          1.0000e-05
54 *          oitmax          sitmax          isolut          ncontr          nccfl
55 *          10          0          10          0          0
56 *          ntsv          ntcb          ntcf          ntrp          ntcp
57 *          1          0          0          1          0
58 *
59 *****
60 * component-number data *

```

```

61 *****
62 *
63 * iorder*          1          91          92          99e
64 *
65 *****
66 * material-properties data *
67 *****
68 *
69 * matb *          51e
70 * ptbln *          2e
71 *
72 *   prptb(1,i)   prptb(2,i)   prptb(3,i)   prptb(4,i)   prptb(5,i)
73   2.0000e+02   1.0000e+00   1.0000e+00   2.0000e+00   1.0000e+00
74   4.0000e+05   1.0000e+00   1.0000e+00   2.0000e+00   1.0000e+00
75 e
76 *
77 *****
78 * control-parameter data *
79 *****
80 *
81 *
82 * signal variables
83 *       idsv       isvn       ilcn       icn1       icn2
84       1           0           0           0           0
85 *
86 * trips
87 *       ntse       ntct       ntsf       ntdp       ntsd
88       0           0           0           0           0
89 *       idtp       isrt       iset       itst       idsq
90       101         2           0           1           1
91 *       setp(1)     setp(2)
92   0.0000e+00   1.0000e-05
93 *       dtsp(1)     dtsp(2)
94   0.0000e+00   0.0000e+00
95 *       ifsp(1)     ifsp(2)
96       0           0
97 *
98 *****
99 * component data *
100 *****
101 *
102 *****   type          num          id          ctitle
103 fill          91          91
104 *       jun1          ifty          ioff
105       1           1           0
106 *       twtold          rfmix          concin          felv
107   0.0000e+00   1.0000e+20   0.0000e+00   0.0000e+00
108 *       dxin          volin          alpin          vlin          tlin
109   1.0000e-01   3.1416e-02   0.0000e+00   0.0000e+00   3.0000e+02
110 *       pin          pain          flowin          vvin          tvin
111   1.0000e+07   0.0000e+00   0.0000e+00   0.0000e+00   3.0000e+02
112 *
113 *****   type          num          id          ctitle
114 pipe          1          1 test section
115 *       ncells          nodes          jun1          jun2          epsw
116       2           0           1           2   0.0000e+00
117 *       ichf          iconc          iacc          ipow
118       0           0           0           0
119 *       radin          th          houtl          houtv          toutl
120   1.0000e-01   0.0000e+00   0.0000e+00   0.0000e+00   3.0000e+02
121 *       toutv
122   3.0000e+02

```

```

123 *
124 * dx      * f    1.0000e-01e
125 * vol     * f    3.1416e+02e
126 * fa      * f    3.1416e+03e
127 * fric    * f    0.0000e+00e
128 * grav    * f    1.0000e+00e
129 * hd      * f    2.0000e-01e
130 * nff      * f          0e
131 * alp      * f    0.0000e+00e
132 * vl      * f    0.0000e+00e
133 * vv      * f    0.0000e+00e
134 * tl      *      3.0000e+02    5.0000e+02e
135 * tv      *      3.0000e+02    5.0000e+02e
136 * p       * f    1.0000e+07e
137 * pa      * f    0.0000e+00e
138 *
139 *****      type          num          id          ctitle
140 break                92                92 upper boundary
141 *                  jun1          ibty          isat          ioff
142                  2                0                0                1
143 *                  dxin          volin          alpin          tin          pin
144          1.0000e-01    3.1416e+02    0.0000e+00    5.0000e+02    1.0000e+07
145 *                  pain          concin          rbmx          poff          belv
146          0.0000e+00    0.0000e+00    1.0000e+20    0.0000e+00    0.0000e+00
147 *
148 *****      type          num          id          ctitle
149 rod                99                99 test heat conductor
150 *                  ncrx          ncrz
151                  1                2
152 *                  nopowr          nrldr          modez          liqlev          iaxcnd
153                  0                1                0                0                1
154 *                  idbci          idbco          hdri          hdro
155                  0                2    0.0000e+00    2.0000e-01
156 *                  nrods          nodes          irftr          nzmax
157                  1                11             101             30
158 *                  dtxht(1)      dtxht(2)      dznht          hgapo          shelv
159          1.0000e+03    1.0000e+03    1.0000e+02    1.0000e+03    0.0000e+00
160 *                  irpwty          ndgx          ndhx          nrts          nhist
161                  5                0             -11             10                0
162 *                  izpwtr          izpwsv          nzpwtb          nzpwsv          nzpwrf
163                  0                1                1                0                0
164 *                  nmwrx          nfcil          nfcil
165                  0                0                0
166 *                  nzpwz          nzpwi          nfbpwt
167                  0                0                0
168 *                  react          tneut          rpwoff          rrpwmx          rpwscl
169          0.0000e+00    0.0000e+00    0.0000e+00    0.0000e+00    1.0000e+00
170 *                  rpowri          zpwin          zpwoff          rrpwmx
171          1.0000e+03    0.0000e+00    0.0000e+00    1.0000e+20
172 *                  extsou          pldr          pdrat          fucrac
173          0.0000e+00    0.0000e+00    1.0000e+01    1.0000e+00
174 * nhcomo*          91r02          1                92e
175 * nhcelo* r02      1                2                1e
176 * z              *    0.0000e+00    1.0000e-01    2.0000e-01e
177 * grav * f        1.0000e+00e
178 * idrod *          1e
179 * rdx *           1.0000e+00e
180 * radrd *          0.0000e+00    5.0000e-04    1.0000e-03    1.5000e-03    2.0000e-03
181 * radrd *          2.5000e-03    3.0000e-03    3.5000e-03    4.0000e-03    4.5000e-03
182 * radrd *          5.0000e-03e
183 * matrd * f        51e
184 * nfax * f         9e

```

```

185 * rftn * f 3.0000e+02e
186 * rdpwr * f 1.0000e+00e
187 * cpowr * 1.0000e+00e
188 * zpwtb * f 1.0000e+00e
189 * fpuo2 * 0.0000e+00e
190 * ftd * 1.0000e+00e
191 * gmix * 1.0000e+00r06 0.0000e+00e
192 * gmles * 1.0000e+00e
193 * pgapt * 1.0000e+00e
194 * plvol * 1.0000e+00e
195 * pslen * 1.0000e+00e
196 * clennc * 1.0000e+00e
197 * burn * f 1.0000e+00e
198 *
199 end
200 *
201 *****
202 * time-step data *
203 *****
204 *
205 * dtmin dtmax tend rtwfp
206 1.0000e-03 1.0000e-01 1.0000e+00 1.0000e+03
207 * edint gfint dmpint sedint
208 1.0000e-01 1.0000e+01 1.0000e+06 1.0000e+06
209 *
210 *****
211 * time-step data *
212 *****
213 *
214 * dtmin dtmax tend rtwfp
215 1.0000e-03 1.0000e-01 5.0000e+00 1.0000e+03
216 * edint gfint dmpint sedint
217 1.0000e+00 1.0000e+01 1.0000e+06 1.0000e+06
218 *
219 *****
220 * time-step data *
221 *****
222 *
223 * endflag
224 -1.0000e+00

```

A-2.5 HCOND5 Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8           14              0             1             2             0
9 ***--*TEST PROBLEM HCOND5 , Time = 5.0 s
10      1 d   r a d i a l   h e a t   c o n d u c t i o n   p r o b l e m
11      t r a n s i e n t   h e a t u p   &   n o f l o w   l i q u i d
12      case : condld01 fine radial nodding case
13            hydraulic-channel cells    = 1
14            number of radial nodes     = 18
15            number of axial node rows  = 2
16            rod radius                  = 6.35 mm
17            clad inner radius           = 6.426 mm
18            clad outer radius           = 7.239 mm
19            rod heat conduction         = 2.0 w/k/m
20            clad heat conduction       = 13.8 w/k/m
21            fluid temperature           = 300.0 k
22            initial rod temperature    = 300.0 k
23 *
24 *                                     #####
25 *                                     # break# alpha=0.0
26 *                                     # 92 # tl=500.0 k
27 *               node                                     #####
28 *               row                                     2
29 * tw=300.0 k  2 +++++rod99++++gcccc--##### vl=0.0 m/s
30 *                +                                   c--# pipe # alpha=0.0
31 *                +                                   c--# 01 # tl=300.0 k
32 * tw=300.0 k  1 ++++++gcccc--##### vl=0.0 m/s
33 *                0mm                 7.239mm        1
34 *                                     #####
35 *                                     no # fill # alpha=0.0
36 *                                     flow # 91 # tl=300.0 k
37 *                                     #####
38 *
39 *****
40 * namelist data *
41 *****
42 *
43 &inopts
44 nhtstr=1, iconht=1, htcwl=2836.0, htcwv=0.,
45 idiag=4, nsdl=0, nsdu=5, nspl=0, nsps=5, cpuflg=1
46 &end
47 *
48 *          dstep          timet
49           0          0.0000e+00
50 *          stdyst          transi          ncomp          njun          ipak
51           0              1              4              2              0
52 *          epso          epss
53      1.0000e-03      1.0000e-05
54 *          oitmax          sitmax          isolut          ncontr          nccfl
55           10              0              10              0              0
56 *          ntsv          ntcb          ntcf          ntrp          ntcp
57           1              0              0              1              0
58 *
59 *****
60 * component-number data *

```

```

61 *****
62 *
63 * iorder*          1          91          92          99e
64 *
65 *****
66 * material-properties data *
67 *****
68 *
69 * matb *          51          52e
70 * ptbln * f          2e
71 *
72 *   prptb(1,i)   prptb(2,i)   prptb(3,i)   prptb(4,i)   prptb(5,i)
73   2.0000e+02   1.0000e+00   1.0000e+00   2.0000e+00   1.0000e+00
74   4.0000e+05   1.0000e+00   1.0000e+00   2.0000e+00   1.0000e+00
75 e
76 *
77 *   prptb(1,i)   prptb(2,i)   prptb(3,i)   prptb(4,i)   prptb(5,i)
78   2.0000e+02   1.0000e+00   1.0000e+00   1.3800e+01   1.0000e+00
79   4.0000e+05   1.0000e+00   1.0000e+00   1.3800e+01   1.0000e+00
80 e
81 *
82 *****
83 * control-parameter data *
84 *****
85 *
86 *
87 * signal variables
88 *       idsv       isvn       ilcn       icn1       icn2
89       1           0           0           0           0
90 *
91 * trips
92 *       ntse       ntct       ntsf       ntdp       ntsd
93       0           0           0           0           0
94 *       idtp       isrt       iset       itst       idsg
95       101         2           0           1           1
96 *       setp(1)    setp(2)
97   1.0000e+02   1.0001e+02
98 *       dtsp(1)    dtsp(2)
99   0.0000e+00   0.0000e+00
100 *       ifsp(1)    ifsp(2)
101       0           0
102 *
103 *****
104 * component data *
105 *****
106 *
107 *****   type          num          id          ctitle
108 fill          91          91
109 *       jun1          ifty          ioff
110       1           1           0
111 *       twtold          rfmX          concin          felv
112   0.0000e+00   1.0000e+20   0.0000e+00   0.0000e+00
113 *       dxin          volin          alpin          vlin          tlin
114   1.0000e-01   3.1416e-02   0.0000e+00   0.0000e+00   3.0000e+02
115 *       pin          pain          flowin          vvin          tvin
116   1.0000e+07   0.0000e+00   0.0000e+00   0.0000e+00   3.0000e+02
117 *
118 *****   type          num          id          ctitle
119 pipe          1          1 test section
120 *       ncells          nodes          jun1          jun2          epsw
121       1           0           1           2   0.0000e+00
122 *       ichf          iconc          iacc          ipow

```


123		0	0	0	0	
124 *	radin		th	houtl	houtv	toutl
125	1.0000e-01	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	3.0000e+02
126 *	toutv					
127	3.0000e+02					
128 *						
129 * dx	*	1.0000e-01e				
130 * vol	*	3.1416e+02e				
131 * fa	* f	3.1416e+03e				
132 * fric	* f	0.0000e+00e				
133 * grav	* f	1.0000e+00e				
134 * hd	* f	2.0000e-01e				
135 * nff	* f	0e				
136 * alp	*	0.0000e+00e				
137 * vl	* f	0.0000e+00e				
138 * vv	* f	0.0000e+00e				
139 * tl	*	3.0000e+02e				
140 * tv	*	3.0000e+02e				
141 * p	*	1.0000e+07e				
142 * pa	*	0.0000e+00e				
143 *						
144 *****	type	num	id	ctitle		
145 break		92	92	upper boundary		
146 *	junl	ibty	isat	ioff		
147	2	0	0	1		
148 *	dxin	volin	alpin	tin	pin	
149	1.0000e-01	3.1416e+02	0.0000e+00	5.0000e+02	1.0000e+07	
150 *	pain	concin	rbmx	poff	belv	
151	0.0000e+00	0.0000e+00	1.0000e+20	0.0000e+00	0.0000e+00	
152 *						
153 *****	type	num	id	ctitle		
154 rod		99	99	test heat conductor		
155 *	ncrx	ncrz				
156	1	1				
157 *	nopowr	nridr	modez	liqlev	iaxcnd	
158	0	1	0	0	0	
159 *	idbci	idbco	hdri	hdro		
160	0	2	0.0000e+00	2.0000e-01		
161 *	nrods	nodes	irftr	nzmax		
162	1	18	101	30		
163 *	dtxht (1)	dtxht (2)	dznht	hgapo	shelv	
164	1.0000e+03	1.0000e+03	1.0000e+02	1.0000e+03	0.0000e+00	
165 *	irpwtv	ndgx	ndhx	nrtv	nhist	
166	5	0	-11	10	0	
167 *	izpwtr	izpwsv	nzpwtb	nzpwsv	nzpwrfr	
168	0	1	1	0	0	
169 *	nmwrx	nfcil	nfcil			
170	0	0	0			
171 *	nzpww	nzpwi	nfbpwt			
172	0	0	0			
173 *	react	tneut	rpwoff	rrpwmv	rpwscl	
174	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	1.0000e+00	
175 *	rpowri	zpwini	zpwoff	rzpwmv		
176	1.0000e+03	0.0000e+00	0.0000e+00	1.0000e+20		
177 *	extsou	pldr	pdrat	fucrac		
178	0.0000e+00	0.0000e+00	1.0000e+01	1.0000e+00		
179 *	nhcomo*	91	1	92e		
180 *	nhcelo* f	1e				
181 *	z	0.0000e+00	1.0000e-01e			
182 *	grav	1.0000e+00e				
183 *	idrod	1e				
184 *	rdx	1.0000e+00e				

```

185 * radrd *      0.0000e+00      1.8300e-03      2.5900e-03      3.1750e-03      3.6700e-03
186 * radrd *      4.1000e-03      4.4900e-03      4.8500e-03      5.1850e-03      5.5000e-03
187 * radrd *      5.8000e-03      6.0800e-03      6.3500e-03      6.4260e-03      6.6700e-03
188 * radrd *      6.8400e-03      7.0400e-03      7.2390e-03e
189 * matrd * r12      51      3r04      52e
190 * nfax *      1e
191 * rftn * f      3.0000e+02e
192 * rdpwr * r13      1.0000e+00r05 0.0000e+00e
193 * cpowr *      1.0000e+00e
194 * zpwtb * f      1.0000e+00e
195 * fpuo2 *      0.0000e+00e
196 * ftd *      1.0000e+00e
197 * gmix *      1.0000e+00r06 0.0000e+00e
198 * gmles *      1.0000e+00e
199 * pgapt *      1.0000e+00e
200 * plvol *      1.0000e+00e
201 * pslen *      1.0000e+00e
202 * clennd *      1.0000e+00e
203 * burn * f      1.0000e+00e
204 *
205 end
206 *
207 *****
208 * time-step data *
209 *****
210 *
211 *      dtmin      dtmax      tend      rtwfp
212      1.0000e-03      1.0000e-01      1.0000e+00      1.0000e+03
213 *      edint      gfint      dmpint      sedint
214      1.0000e-01      1.0000e+01      1.0000e+06      1.0000e+06
215 *
216 *****
217 * time-step data *
218 *****
219 *
220 *      dtmin      dtmax      tend      rtwfp
221      1.0000e-03      1.0000e-01      5.0000e+00      1.0000e+03
222 *      edint      gfint      dmpint      sedint
223      1.0000e+00      1.0000e+01      1.0000e+06      1.0000e+06
224 *
225 *****
226 * time-step data *
227 *****
228 *
229 *      endflag
230      -1.0000e+00

```

A-3 MARVIK Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              12              0              1              0              0
9 *--*--TEST PROBLEM MARVIK , Time = 56.0 s
10 *****
11 * marviken test 4 : critical-flow model nodding, 2 cell nozzle. *
12 * this file is a copy of the file located on Manjit Sahota's *
13 * directory: /091597/tracpf1/data/marviken/marviken4/data/trcinchok *
14 * except for 1) the 12 title cards, *
15 *                2) the component network diagram, *
16 *                3) the nff values were set to 1 on both pipes *
17 *                (they were previously 2), and *
18 *                4) the minimum time step had to be decreased from the *
19 *                original value of 1.0000e-02 s to 1.0000e-03 s. *
20 *****
21 *
22 *          fa          #####
23 *      (m2)          # fill #
24 *                  #  1  #
25 *                  #####
26 *                      1      vv = 0.0
27 *      1.7671          #####
28 *                      #      # cell 1
29 *                      #      #
30 *                      #      #
31 *                      #      #
32 *                      #      #
33 *                      #      #
34 *                      #      #
35 *                      #      #
36 *                      #      #
37 *                      #      #
38 *                      #      #
39 *      20.718          #      #
40 *                      #      #
41 *                      #      #
42 *                      #      #
43 *                      #      #
44 *                      #      #
45 *                      #      #
46 *                      #      #
47 *                      #      #
48 *                      #      #
49 *                      #      #
50 *                      #      #
51 *                      #      #
52 *                      #      #
53 *                      #      #
54 *      0.4441          #      #
55 *                      #      #
56 *                      #      #
57 *                      #      #
58 *                      #      #
59 *      0.20348          #      #
60 *                      #      #

```

```

61 *          # # t1 = 475.0 k
62 *          # # p = 5.129 mpa
63 *          ####
64 *          3
65 *          ####
66 *          # #
67 *          # # break 4
68 *          # #
69 *          # # p = 0.1017 mpa
70 *          # # alpha = 1.0
71 *          # # tv = 373.0 k
72 *          ####
73 *
74 *****
75 * namelist data *
76 *****
77 *
78 &inopts
79 icflow=2, idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5, cpuflg=1
80 &end
81 *
82 *          dstep          timet
83 *          0          0.0000e+00
84 *          stdyst          transi          ncomp          njun          ipak
85 *          0          1          4          3          0
86 *          epso          epss
87 *          1.0000e-03          1.0000e-02
88 *          oitmax          sitmax          isolut          ncontr          nccfl
89 *          30          80          0          0          0
90 *          ntsv          ntcb          ntcf          ntrp          ntcp
91 *          0          0          0          0          0
92 *
93 *****
94 * component-number data *
95 *****
96 *
97 * iorder*          1          2          3          4e
98 *
99 *****
100 * component data *
101 *****
102 *
103 ***** type          num          id          ctitle
104 fill          1          1 $1$ no-flow vessel top
105 *          jun1          ifty          ioff
106 *          1          1          0
107 *          twtold          rfmix          concin          felv
108 *          0.0000e+00          0.0000e+00          0.0000e+00          0.0000e+00
109 *          dxin          volin          alpin          vlin          tlin
110 *          1.5500e+00          2.7391e+00          1.0000e+00          0.0000e+00          5.3560e+02
111 *          pin          pain          flowin          vvin          tvin
112 *          4.9400e+06          0.0000e+00          0.0000e+00          0.0000e+00          5.3560e+02
113 *
114 ***** type          num          id          ctitle
115 pipe          2          2 $2$ pressure vessel
116 *          ncells          nodes          jun1          jun2          epsw
117 *          15          0          1          2          0.0000e+00
118 *          ichf          iconc          iacc          ipow
119 *          1          0          0          0
120 *          radin          th          hout1          houtv          tout1
121 *          2.6100e+00          1.0000e-01          0.0000e+00          0.0000e+00          3.0000e+02
122 *          toutv

```

```

123      3.0000e+02
124 *
125 * dx      *      1.5500e+00      1.6000e+00      1.0000e+00r02 1.4000e+00r10 1.5000e+00
126 e
127 * vol      *      2.7391e+00      2.8274e+00      9.5118e+00r02 2.9005e+01r10 3.1076e+01
128 e
129 * fa      * r03 1.7671e+00r13 2.0718e+01e
130 * fric      * f 0.0000e+00e
131 * grav      * f -1.0000e+00e
132 * hd      * r03 1.5000e+00r13 5.1360e+00e
133 * icflg      * f 0e
134 * nff      * r02 1r02 -1 1 -1r10 1
135 * nff      * e
136 * alp      * r05 1.0000e+00r10 0.0000e+00e
137 * vl      * f 0.0000e+00e
138 * vv      * f 0.0000e+00e
139 * tl      * r10 5.3620e+02 5.2300e+02 5.1000e+02r02 5.0600e+02 5.0100e+02
140 * tl      * e
141 * tv      * r10 5.3620e+02 5.2300e+02 5.1000e+02r02 5.0600e+02 5.0100e+02
142 * tv      * e
143 * p      * 4.9340e+06r03 4.9350e+06r02 4.9360e+06 4.9490e+06 4.9610e+06
144 * p      * 4.9730e+06 4.9850e+06 4.9970e+06 5.0090e+06 5.0220e+06
145 * p      * 5.0340e+06 5.0460e+06e
146 * pa      * f 0.0000e+00e
147 *
148 ***** type num id ctitle
149 pipe 3 3 $3$ disch.pipe/test nozzle
150 * ncells nodes jun1 jun2 epsw
151 17 0 2 3 0.0000e+00
152 * ichf iconc iacc ipow
153 1 0 0 0
154 * radin th hout1 houtv tout1
155 2.5500e-01 1.0000e-01 0.0000e+00 0.0000e+00 3.0000e+02
156 * toutv
157 3.0000e+02
158 *
159 * dx      * 6.0000e-01r08 5.0000e-01 7.9000e-01 6.1000e-01 6.0000e-01
160 * dx      * 5.6800e-01r02 5.0000e-01 1.5000e-01 1.5000e+00e
161 * vol      * 1.2104e+01 9.4300e+00 7.7925e+00 4.9886e+00 1.5474e+00
162 * vol      * r04 2.2210e-01 3.5090e-01 2.8110e-01 2.8670e-01 2.6180e-01
163 * vol      * r02 2.2210e-01 4.7308e-02 3.0522e-01e
164 * fa      * 2.0718e+01 1.9635e+01 1.8096e+01 1.3203e+01 7.0686e+00
165 * fa      * r06 4.4410e-01r02 4.7780e-01r03 4.4410e-01r02 2.0348e-01e
166 * fric      * f 0.0000e+00e
167 * grav      * f -1.0000e+00e
168 * hd      * 5.1360e+00 5.0000e+00 4.8000e+00 4.1000e+00 3.0000e+00
169 * hd      * r06 7.5200e-01r02 7.8000e-01r03 7.5200e-01r02 5.0900e-01e
170 * icflg      * r17 0 1e
171 * nff      * r04 1r02 -1r12 1e
172 * alp      * f 0.0000e+00e
173 * vl      * f 0.0000e+00e
174 * vv      * f 0.0000e+00e
175 * tl      * r05 4.9900e+02 4.9800e+02r02 4.9700e+02 4.9600e+02 4.9500e+02
176 * tl      * 4.9400e+02 4.9200e+02 4.8400e+02 4.7900e+02 4.7600e+02
177 * tl      * r02 4.7500e+02e
178 * tv      * r05 4.9900e+02 4.9800e+02r02 4.9700e+02 4.9600e+02 4.9500e+02
179 * tv      * 4.9400e+02 4.9200e+02 4.8400e+02 4.7900e+02 4.7600e+02
180 * tv      * r02 4.7500e+02e
181 * p      * 5.0550e+06 5.0600e+06 5.0640e+06 5.0680e+06 5.0720e+06
182 * p      * 5.0760e+06 5.0810e+06 5.0850e+06 5.0890e+06 5.0940e+06
183 * p      * 5.1000e+06 5.1050e+06 5.1100e+06 5.1150e+06 5.1190e+06
184 * p      * 5.1220e+06 5.1290e+06e

```

```

185 * pa      * f  0.0000e+00e
186 *
187 *****      type              num              id              ctitle
188 break              4              4  $4$  atm.pressure b.c.
189 *              jun1              ibty              isat              ioff
190 *              3              0              0              0
191 *              dxin              volin              alpin              tin              pin
192 *              1.5000e+00      3.0522e-01      1.0000e+00      3.7300e+02      1.0170e+05
193 *              pain              concin              rbmx              poff              belv
194 *              0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00
195 *
196 end
197 *
198 *****
199 * time-step data *
200 *****
201 *
202 *              dtmin              dtmax              tend              rtwfp
203 *              1.0000e-03      1.0000e+00      1.0000e-01      1.0000e+00
204 *              edint              gfint              dmpint              sedint
205 *              1.0000e-01      1.0000e-01      1.0000e-01      1.0000e-01
206 *
207 *              dtmin              dtmax              tend              rtwfp
208 *              1.0000e-03      1.0000e+00      5.6000e+01      1.0000e+00
209 *              edint              gfint              dmpint              sedint
210 *              5.0000e+00      5.0000e-01      1.0000e+01      1.0000e+00
211 *
212 *              endflag
213 *              -1.0000e+00

```

A-4.1 MSC2 Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              5              0              1              0              0
9 *--*--*TEST PROBLEM MSC2 , Time = 10000.0 s
10      mirrored flow channel with two-phase fluid
11      six 3-cell vessels replaced by six 3-cell pipes
12      twelve 1-cell pipes replaced by four 1-cell pipes
13      two pressure boundary conditions, .tl = tsat = tv = 455.0 k
14 *
15 *
16 *                                     nff    vl    vv    fa
17 *                                     (-) (m/s) (m/s) (m2)
18 *          *****
19 *          # break#
20 *          # 26 #   p = 1.0000e+06 pa
21 *          *****
22 *          32
23 *          *****
24 *          # pipe #
25 *          # 25 #
26 *          *****
27 *          31
28 *          *****
29 *          # plenum #
30 *          # 24 #
31 *          *****
32 *          27
33 *          *****
34 *          # pipe #
35 *          # 20 #
36 *          *****
37 *          23
38 *          *****
39 *          # cell #
40 *          # 1 #
41 *          #-----#
42 *          # pipe #
43 *          # 18 #
44 *          #-----#
45 *          # cell #
46 *          # 3 #
47 *          *****
48 *          21
49 *          *****
50 *          # pipe #
51 *          # 16 #
52 *          *****
53 *          19
54 *          *****
55 *          # cell #
56 *          # 1 #
57 *          #-----#
58 *          # pipe #
59 *          # 15 #
60 *          #-----#
61 *          # cell #
62 *          # 3 #

```

```

61 *          #####
62 *          18          1 -6.8 -7.0 1.0
63 *          #####
64 *          # pipe #
65 *          # 14 #
66 *          #####
67 * -- mirror plane -- 17 -- mirror plane -- 1 7.1 7.3 1.0
68 *          #####
69 *          # pipe #
70 *          # 13 #
71 *          #####
72 *          16          1 7.4 7.5 1.0
73 *          #####
74 *          # cell #
75 *          # 3 #
76 *          #-----#
77 *          # pipe #
78 *          # 12 #
79 *          #-----#
80 *          # cell #
81 *          # 1 #
82 *          #####
83 *          14          -1 8.2 8.1 1.0
84 *          #####
85 *          # pipe #
86 *          # 10 #
87 *          #####
88 *          12          1 4.0 4.2 2.0
89 *          #####
90 *          # cell #
91 *          # 3 #
92 *          #-----#
93 *          # pipe #
94 *          # 8 #
95 *          #-----#
96 *          # cell #
97 *          # 1 #
98 *          #####
99 *          8          -1 4.3 4.4 2.0
100 *          #####
101 *          # pipe #
102 *          # 4 #
103 *          #####
104 *          4          1 2.1 2.3 4.0
105 *          #####
106 *          # plenum #
107 *          # 3 #
108 *          #####
109 *          3          -1 8.8 9.1 1.0
110 *          #####
111 *          # pipe #
112 *          # 2 #
113 *          #####
114 *          2          1 9.8 10.0 1.0
115 *          #####
116 *          # break# p = 1.1384e+06 pa
117 *          # 1 #
118 *          #####
119 *
120 *****
121 * namelist data *
122 *****

```



```

123 *
124 &inopts
125   iadded=10, ikfac=1, nifsh=1, ccif=1.0e+05,
126   idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5, cpuflg=1
127 &end
128 *
129 *           dstep           timet
130           0           0.0000e+00
131 *           stdyst           transi           ncomp           njun           ipak
132           0           1           16           15           0
133 *           epso           epss
134           1.0000e-04           1.0000e-04
135 *           oitmax           sitmax           isolut           ncontr           nccfl
136           10           10           0           0           0
137 *           ntsv           ntcb           ntcf           ntrp           ntcp
138           1           0           0           0           0
139 *
140 *****
141 * component-number data *
142 *****
143 *
144 * iorder *   1 s   * break           pressure b.c. for pipe 2 inlet
145 * iorder *   2 s   * pipe           inlet pipe for plenum 3
146 * iorder *   3 s   * plenum        manifold plenum 3
147 * iorder *   4 s   * pipe           pipe that replaces pipes 4, 5, 6 & 7
148 * iorder *   8 s   * pipe           pipe that replaces vessels 8 & 9
149 * iorder *  10 s   * pipe           pipe that replaces pipes 10 & 11
150 * iorder *  12 s   * pipe           pipe that replaces vessel 12
151 * iorder *  13 s   * pipe           outlet pipe for pipe 12
152 * iorder *  14 s   * pipe           inlet pipe for pipe 15
153 * iorder *  15 s   * pipe           pipe that replaces vessel 15
154 * iorder *  16 s   * pipe           pipe that replaces pipes 16 & 17
155 * iorder *  18 s   * pipe           pipe that replaces vessels 18 & 19
156 * iorder *  20 s   * pipe           pipe that replaces pipes 20, 21, 22 & 23
157 * iorder *  24 s   * plenum        manifold plenum 24
158 * iorder *  25 s   * pipe           outlet pipe for pipe 24
159 * iorder *  26 e   * break           pressure b.c. for pipe 25 outlet
160 *
161 *****
162 * control parameters *
163 *****
164 *
165 * signal variable
166 *
167 *           idsv           isvn           icln           icn1           icn2
168           1           0           0           0           0
169 *
170 *****
171 * component data *
172 *****
173 *
174 *****   type           num           id           ctitle
175 break           1           1           1 pressure b.c. for pipe 2 inlet
176 *           jun1           ibty           isat           ioff
177           2           1           0           0
178 *           ibtr           ibsv           nbtr           nbsv           nbrf
179           0           1           2           0           0
180 *           dxin           volin           alpin           tin           pin
181           1.0000e+00           1.0000e+00           5.0000e-01           4.5500e+02           1.0000e+06
182 *           pain           concin           rbmx           poff           belv
183           0.0000e+00           0.0000e+00           1.3840e+05           0.0000e+00           0.0000e+00
184 *           pscl           tlcsl           tvscl           pascl           conscl

```

```

185      1.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00
186 *
187 * ptb      *      0.0000e+00      1.0000e+06      1.0000e+00      1.1384e+06e
188 *
189 *****      type      num      id      ctitle
190 pipe      2      2 inlet pipe for plenum 3
191 *      ncells      nodes      jun1      jun2      epsw
192      1      0      2      3      1.0000e-05
193 *      ichf      iconc      iacc      ipow
194      0      0      0      0
195 *      radin      th      hout1      houtv      tout1
196      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
197 *      toutv
198      4.5500e+02
199 *
200 * dx      * f      1.0000e+00e
201 * vol      * f      1.0000e+00e
202 * fa      * f      1.0000e+00e
203 * fric      * f      0.0000e+00e
204 * grav      * f      1.0000e+00e
205 * hd      * f      1.0000e+00e
206 * nff      *      1      -1e
207 * alp      * f      5.0000e-01e
208 * vl      * f      0.0000e+00e
209 * vv      * f      0.0000e+00e
210 * tl      * f      4.5500e+02e
211 * tv      * f      4.5500e+02e
212 * p      * f      1.0000e+06e
213 * pa      * f      0.0000e+00e
214 *
215 *****      type      num      id      ctitle
216 plenum      3      3 manifold plenum 3
217 *      npljn      iconc      juns1      juns2
218      2      0      1      1
219 *
220 * junj      *      3      4e
221 * dx      * f      1.0000e+00e
222 * vol      * f      4.0000e+00e
223 * elev      * f      2.0000e+00e
224 * alp      * f      5.0000e-01e
225 * tl      * f      4.5500e+02e
226 * tv      * f      4.5500e+02e
227 * p      * f      1.0000e+06e
228 * pa      * f      0.0000e+00e
229 *
230 *****      type      num      id      ctitle
231 pipe      4      4 pipe that replaces pipes 4, 5, 6 & 7
232 *      ncells      nodes      jun1      jun2      epsw
233      1      0      4      8      1.0000e-05
234 *      ichf      iconc      iacc      ipow
235      0      0      0      0
236 *      radin      th      hout1      houtv      tout1
237      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
238 *      toutv
239      4.5500e+02
240 *
241 * dx      *      1.0000e+00e
242 * vol      *      4.0000e+00e
243 * fa      *      4.0000e+00      2.0000e+00e
244 * fric      * f      0.0000e+00e
245 * grav      * f      1.0000e+00e
246 * hd      * f      1.0000e+00e

```

```

247 * nff      *          1          -1e
248 * alp      *      5.0000e-01e
249 * vl       * f      0.0000e+00e
250 * vv       * f      0.0000e+00e
251 * tl       *      4.5500e+02e
252 * tv       *      4.5500e+02e
253 * p        *      1.0000e+06e
254 * pa       *      0.0000e+00e
255 *
256 *****   type          num          id          ctitle
257 pipe          8          8 pipe that replaces vessels 8 & 9
258 *          ncells      nodes      jun1      jun2      epsw
259          3          0          8          12      1.0000e-05
260 *          ichf      iconc      iacc      ipow
261          0          0          0          0
262 *          radin      th      hout1      houtv      tout1
263      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
264 *          toutv
265      4.5500e+02
266 *
267 * dx      * f      1.0000e+00e
268 * vol     * f      2.0000e+00e
269 * fa      * f      2.0000e+00e
270 * fric    * f      0.0000e+00e
271 * grav    * f      1.0000e+00e
272 * hd      * f      1.0000e+00e
273 * nff     *          -1r03          1e
274 * alp     * f      5.0000e-01e
275 * vl      * f      0.0000e+00e
276 * vv      * f      0.0000e+00e
277 * tl      * f      4.5500e+02e
278 * tv      * f      4.5500e+02e
279 * p       * f      1.0000e+06e
280 * pa      * f      0.0000e+00e
281 *
282 *****   type          num          id          ctitle
283 pipe          10          10 pipe that replaces pipes 10 & 11
284 *          ncells      nodes      jun1      jun2      epsw
285          1          0          12          14      1.0000e-05
286 *          ichf      iconc      iacc      ipow
287          0          0          0          0
288 *          radin      th      hout1      houtv      tout1
289      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
290 *          toutv
291      4.5500e+02
292 *
293 * dx      *      1.0000e+00e
294 * vol     *      2.0000e+00e
295 * fa      *      2.0000e+00      1.0000e+00e
296 * fric    * f      0.0000e+00e
297 * grav    * f      1.0000e+00e
298 * hd      * f      1.0000e+00e
299 * nff     *          1          -1e
300 * alp     *      5.0000e-01e
301 * vl      * f      0.0000e+00e
302 * vv      * f      0.0000e+00e
303 * tl      *      4.5500e+02e
304 * tv      *      4.5500e+02e
305 * p       *      1.0000e+06e
306 * pa      *      0.0000e+00e
307 *
308 *****   type          num          id          ctitle

```

```

309 pipe 12 12 pipe that replaces vessel 12
310 * ncells nodes jun1 jun2 epsw
311 3 0 14 16 1.0000e-05
312 * ichf iconc iacc ipow
313 0 0 0 0
314 * radin th hout1 houtv tout1
315 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
316 * toutv
317 4.5500e+02
318 *
319 * dx * f 1.0000e+00e
320 * vol * f 1.0000e+00e
321 * fa * f 1.0000e+00e
322 * fric * f 0.0000e+00e
323 * grav * f 1.0000e+00e
324 * hd * f 1.0000e+00e
325 * nff * -1r03 1e
326 * alp * f 5.0000e-01e
327 * vl * f 0.0000e+00e
328 * vv * f 0.0000e+00e
329 * tl * f 4.5500e+02e
330 * tv * f 4.5500e+02e
331 * p * f 1.0000e+06e
332 * pa * f 0.0000e+00e
333 *
334 ***** type num id ctitle
335 pipe 13 13 outlet pipe for pipe 12
336 * ncells nodes jun1 jun2 epsw
337 1 0 16 17 1.0000e-05
338 * ichf iconc iacc ipow
339 0 0 0 0
340 * radin th hout1 houtv tout1
341 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
342 * toutv
343 4.5500e+02
344 *
345 * dx * 1.0000e+00e
346 * vol * 1.0000e+00e
347 * fa * f 1.0000e+00e
348 * fric * f 0.0000e+00e
349 * grav * f 1.0000e+00e
350 * hd * f 1.0000e+00e
351 * nff * f 1e
352 * alp * 5.0000e-01e
353 * vl * f 0.0000e+00e
354 * vv * f 0.0000e+00e
355 * tl * 4.5500e+02e
356 * tv * 4.5500e+02e
357 * p * 1.0000e+06e
358 * pa * 0.0000e+00e
359 *
360 ***** type num id ctitle
361 pipe 14 14 inlet pipe for pipe 15
362 * ncells nodes jun1 jun2 epsw
363 1 0 18 17 1.0000e-05
364 * ichf iconc iacc ipow
365 0 0 0 0
366 * radin th hout1 houtv tout1
367 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
368 * toutv
369 4.5500e+02
370 *

```

```

371 * dx      *      1.0000e+00e
372 * vol      *      1.0000e+00e
373 * fa      * f      1.0000e+00e
374 * fric    * f      0.0000e+00e
375 * grav    * f     -1.0000e+00e
376 * hd      * f      1.0000e+00e
377 * nff     * f           1e
378 * alp     *      5.0000e-01e
379 * vl      * f      0.0000e+00e
380 * vv      * f      0.0000e+00e
381 * tl      *      4.5500e+02e
382 * tv      *      4.5500e+02e
383 * p       *      1.0000e+06e
384 * pa      *      0.0000e+00e
385 *
386 *****      type          num          id          ctitle
387 pipe                    15          15 pipe that replaces vessel 15
388 *          ncells          nodes      jun1          jun2          epsw
389          3                  0          19          18          1.0000e-05
390 *          ichf          iconc      iacc          ipow
391          0                  0          0          0
392 *          radin          th          hout1          houtv          tout1
393          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
394 *          toutv
395          4.5500e+02
396 *
397 * dx      * f      1.0000e+00e
398 * vol      * f      1.0000e+00e
399 * fa      * f      1.0000e+00e
400 * fric    * f      0.0000e+00e
401 * grav    * f     -1.0000e+00e
402 * hd      * f      1.0000e+00e
403 * nff     *      -1r03          1e
404 * alp     * f      5.0000e-01e
405 * vl      * f      0.0000e+00e
406 * vv      * f      0.0000e+00e
407 * tl      * f      4.5500e+02e
408 * tv      * f      4.5500e+02e
409 * p       * f      1.0000e+06e
410 * pa      * f      0.0000e+00e
411 *
412 *****      type          num          id          ctitle
413 pipe                    16          16 pipe that replaces pipes 16 & 17
414 *          ncells          nodes      jun1          jun2          epsw
415          1                  0          21          19          1.0000e-05
416 *          ichf          iconc      iacc          ipow
417          0                  0          0          0
418 *          radin          th          hout1          houtv          tout1
419          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
420 *          toutv
421          4.5500e+02
422 *
423 * dx      *      1.0000e+00e
424 * vol      *      2.0000e+00e
425 * fa      *      2.0000e+00      1.0000e+00e
426 * fric    * f      0.0000e+00e
427 * grav    * f     -1.0000e+00e
428 * hd      * f      1.0000e+00e
429 * nff     *          1          -1e
430 * alp     *      5.0000e-01e
431 * vl      * f      0.0000e+00e
432 * vv      * f      0.0000e+00e

```

```

433 * tl      *      4.5500e+02e
434 * tv      *      4.5500e+02e
435 * p       *      1.0000e+06e
436 * pa      *      0.0000e+00e
437 *
438 *****      type          num          id          ctitle
439 pipe          18          18 pipe that replaces vessels 18 & 19
440 *          ncells        nodes        jun1        jun2        epsw
441          3          0          23          21        1.0000e-05
442 *          ichf          iconc          iacc          ipow
443          0          0          0          0
444 *          radin          th          hout1          houtv          tout1
445          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
446 *          toutv
447          4.5500e+02
448 *
449 * dx      * f      1.0000e+00e
450 * vol     * f      2.0000e+00e
451 * fa      * f      2.0000e+00e
452 * fric    * f      0.0000e+00e
453 * grav     * f     -1.0000e+00e
454 * hd      * f      1.0000e+00e
455 * nff      *          -1r03          1e
456 * alp      * f      5.0000e-01e
457 * vl      * f      0.0000e+00e
458 * vv      * f      0.0000e+00e
459 * tl      * f      4.5500e+02e
460 * tv      * f      4.5500e+02e
461 * p       * f      1.0000e+06e
462 * pa      * f      0.0000e+00e
463 *
464 *****      type          num          id          ctitle
465 pipe          20          20 pipe that replaces pipes 20,21,22&23
466 *          ncells        nodes        jun1        jun2        epsw
467          1          0          27          23        1.0000e-05
468 *          ichf          iconc          iacc          ipow
469          0          0          0          0
470 *          radin          th          hout1          houtv          tout1
471          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
472 *          toutv
473          4.5500e+02
474 *
475 * dx      *      1.0000e+00e
476 * vol     *      4.0000e+00e
477 * fa      *      4.0000e+00      2.0000e+00e
478 * fric    * f      0.0000e+00e
479 * grav     * f     -1.0000e+00e
480 * hd      * f      1.0000e+00e
481 * nff      *          1          -1e
482 * alp      *      5.0000e-01e
483 * vl      * f      0.0000e+00e
484 * vv      * f      0.0000e+00e
485 * tl      *      4.5500e+02e
486 * tv      *      4.5500e+02e
487 * p       *      1.0000e+06e
488 * pa      *      0.0000e+00e
489 *
490 *****      type          num          id          ctitle
491 plenum        24          24 manifold plenum 24
492 *          npljn        iconc          juns1          juns2
493          2          0          1          1
494 *

```

```

495 * junj * 31
496 * dx * f 1.0000e+00e
497 * vol * f 4.0000e+00e
498 * elev * f 2.1000e+01e
499 * alp * f 5.0000e-01e
500 * tl * f 4.5500e+02e
501 * tv * f 4.5500e+02e
502 * p * f 1.0000e+06e
503 * pa * f 0.0000e+00e
504 *
505 ***** type num id ctitle
506 pipe 25 25 outlet pipe for plenum 24
507 * ncells nodes jun1 jun2 epsw
508 1 0 32 31 1.0000e-05
509 * ichf iconc iacc ipow
510 0 0 0 0
511 * radin th houtl houtv toutl
512 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
513 * toutv
514 4.5500e+02
515 *
516 * dx * f 1.0000e+00e
517 * vol * f 1.0000e+00e
518 * fa * f 1.0000e+00e
519 * fric * f 0.0000e+00e
520 * grav * f -1.0000e+00e
521 * hd * f 1.0000e+00e
522 * nff * 1
523 * alp * f 5.0000e-01e
524 * vl * f 0.0000e+00e
525 * vv * f 0.0000e+00e
526 * tl * f 4.5500e+02e
527 * tv * f 4.5500e+02e
528 * p * f 1.0000e+06e
529 * pa * f 0.0000e+00e
530 *
531 ***** type num id ctitle
532 break 26 26 pressure b.c. pipe 25 outlet
533 * jun1 ibty isat ioff
534 32 0 0 0
535 * dxin volin alpin tin pin
536 1.0000e+00 1.0000e+00 5.0000e-01 4.5500e+02 1.0000e+06
537 * pain concin rbmx poff belv
538 0.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00 2.3000e+01
539 *
540 end
541 *
542 *****
543 * time-step data *
544 *****
545 *
546 * dtmin dtmax tend rtwfp
547 1.0000e-03 1.0000e+00 1.0000e+01 1.0000e+00
548 * edint gfint dmpint sedint
549 1.0000e+01 1.0000e+00 1.1000e+01 1.0000e+01
550 *
551 * dtmin dtmax tend rtwfp
552 1.0000e-03 5.0000e+00 1.0000e+02 1.0000e+00
553 * edint gfint dmpint sedint
554 9.0000e+01 2.5000e+00 9.5000e+01 9.0000e+01
555 *
556 * dtmin dtmax tend rtwfp

```

557	1.0000e-02	3.0000e+01	1.0000e+03	1.0000e+00
558 *	edint	gfint	dmpint	sedint
559	9.0000e+02	1.5000e+01	9.3000e+02	9.0000e+02
560 *				
561 *	dtmin	dtmax	tend	rtwfp
562	1.0000e-01	2.0000e+02	1.0000e+04	1.0000e+00
563 *	edint	gfint	dmpint	sedint
564	9.0000e+03	2.0000e+02	9.0000e+03	9.0000e+03
565 *				
566 *	endflag			
567	-1.0000e+00			

A-4.2 MSCL Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              5              0              1              0              0
9 *--*--*TEST PROBLEM MSCL , Time = 10000.0 s
10      mirrored flow channel with single-phase liquid
11      six 3-cell vessels replaced by six 3-cell pipes
12      twelve 1-cell pipes replaced by four 1-cell pipes
13      two pressure boundary conditions, t1 = 300.0 k
14 *
15 *
16 *
17 *          nff          vl          fa
18 *          (-)        (m/s)        (m2)
19 *
20 *          #####
21 *          # break# p = 1.0000e+06 pa
22 *          # 26 #
23 *          #####
24 *
25 *          32          1          -10.0          1.0
26 *          #####
27 *          # pipe #
28 *          # 25 #
29 *          #####
30 *          31          -1          -10.0          1.0
31 *          #####
32 *          #          plenum          #
33 *          #          24          #
34 *          #####
35 *          27          1          -2.5          4.0
36 *          #####
37 *          #          pipe          #
38 *          #          20          #
39 *          #####
40 *          23          -1          -5.0          2.0
41 *          #####
42 *          #          cell          #
43 *          #          1          #
44 *          #-----#
45 *          #          pipe          #
46 *          #          18          #
47 *          #-----#
48 *          #          cell          #
49 *          #          3          #
50 *          #####
51 *          21          1          -5.0          2.0
52 *          #####
53 *          #          pipe          #
54 *          #          16          #
55 *          #####
56 *          19          -1          -10.0          1.0
57 *          #####
58 *          # cell #
59 *          # 1 #
60 *          #-----#
61 *          # pipe #
62 *          # 15 #
63 *          #-----#
64 *          # cell #
65 *          # 3 #

```



```

123 *
124 &inopts
125   iadded=10, ikfac=1, cpuflg=1,
126   idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5
127 &end
128 *
129 *           dstep           timet
130           0           0.0000e+00
131 *           stdyst           transi           ncomp           njun           ipak
132           0           1           16           15           0
133 *           epso           epss
134           1.0000e-04           1.0000e-04
135 *           oitmax           sitmax           isolut           ncontr           nccfl
136           10           10           0           0           0
137 *           ntsv           ntcb           ntcf           ntrp           ntcp
138           1           0           0           0           0
139 *
140 *****
141 * component-number data *
142 *****
143 *
144 * iorder *   1 s   * break           pressure b.c. for pipe 2 inlet
145 * iorder *   2 s   * pipe           inlet pipe for plenum 3
146 * iorder *   3 s   * plenum        manifold plenum 3
147 * iorder *   4 s   * pipe           pipe that replaces pipes 4, 5, 6 & 7
148 * iorder *   8 s   * pipe           pipe that replaces vessels 8 & 9
149 * iorder *  10 s   * pipe           pipe that replaces pipes 10 & 11
150 * iorder *  12 s   * pipe           pipe that replaces vessel 12
151 * iorder *  13 s   * pipe           outlet pipe for pipe 12
152 * iorder *  14 s   * pipe           inlet pipe for pipe 15
153 * iorder *  15 s   * pipe           pipe that replaces vessel 15
154 * iorder *  16 s   * pipe           pipe that replaces pipes 16 & 17
155 * iorder *  18 s   * pipe           pipe that replaces vessels 18 & 19
156 * iorder *  20 s   * pipe           pipe that replaces pipes 20, 21, 22 & 23
157 * iorder *  24 s   * plenum        manifold plenum 24
158 * iorder *  25 s   * pipe           outlet pipe for pipe 24
159 * iorder *  26 e   * break           pressure b.c. for pipe 25 outlet
160 *
161 *****
162 * control parameters *
163 *****
164 *
165 * signal variable
166 *
167 *           idsv           isvn           icln           icn1           icn2
168           1           0           0           0           0
169 *
170 *****
171 * component data *
172 *****
173 *
174 *****   type           num           id           ctitle
175 break           1           1           1 pressure b.c. for pipe 2 inlet
176 *           jun1           ibty           isat           ioff
177           2           1           0           0
178 *           ibtr           ibsv           nbtr           nbsv           nbrf
179           0           1           2           0           0
180 *           dxin           volin           alpin           tin           pin
181           1.0000e+00           1.0000e+00           0.0000e+00           3.0000e+02           1.0000e+06
182 *           pain           concin           rbmx           poff           belv
183           0.0000e+00           0.0000e+00           4.0450e+05           0.0000e+00           0.0000e+00
184 *           pscl           tisc1           tvscl           pascl           conscl

```

```

185      1.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00
186 *
187 * ptb *      0.0000e+00      1.0000e+06      1.0000e+00      1.4045e+06e
188 *
189 *****      type      num      id      ctitle
190 pipe      2      2 inlet pipe for plenum 3
191 *      ncells      nodes      jun1      jun2      epsw
192      1      0      2      3      1.0000e-05
193 *      ichf      iconc      iacc      ipow
194      0      0      0      0
195 *      radin      th      hout1      houtv      tout1
196      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
197 *      toutv
198      3.0000e+02
199 *
200 * dx * f      1.0000e+00e
201 * vol * f      1.0000e+00e
202 * fa * f      1.0000e+00e
203 * fric * f      0.0000e+00e
204 * grav * f      1.0000e+00e
205 * hd * f      1.0000e+00e
206 * nff *      1      -1e
207 * alp * f      0.0000e+00e
208 * vl * f      0.0000e+00e
209 * vv * f      0.0000e+00e
210 * tl * f      3.0000e+02e
211 * tv * f      3.0000e+02e
212 * p * f      1.0000e+06e
213 * pa * f      0.0000e+00e
214 *
215 *****      type      num      id      ctitle
216 plenum      3      3 manifold plenum 3
217 *      npljn      iconc      juns1      juns2
218      2      0      1      1
219 *
220 * junj *      3      4e
221 * dx * f      1.0000e+00e
222 * vol * f      4.0000e+00e
223 * elev * f      2.0000e+00e
224 * alp * f      0.0000e+00e
225 * tl * f      3.0000e+02e
226 * tv * f      3.0000e+02e
227 * p * f      1.0000e+06e
228 * pa * f      0.0000e+00e
229 *
230 *****      type      num      id      ctitle
231 pipe      4      4 pipe that replaces pipes 4, 5, 6 & 7
232 *      ncells      nodes      jun1      jun2      epsw
233      1      0      4      8      1.0000e-05
234 *      ichf      iconc      iacc      ipow
235      0      0      0      0
236 *      radin      th      hout1      houtv      tout1
237      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
238 *      toutv
239      3.0000e+02
240 *
241 * dx *      1.0000e+00e
242 * vol *      4.0000e+00e
243 * fa *      4.0000e+00      2.0000e+00e
244 * fric * f      0.0000e+00e
245 * grav * f      1.0000e+00e
246 * hd * f      1.0000e+00e

```

```

247 * nff      *          1          -1e
248 * alp      *      0.0000e+00e
249 * vl       * f      0.0000e+00e
250 * vv       * f      0.0000e+00e
251 * tl       *      3.0000e+02e
252 * tv       *      3.0000e+02e
253 * p        *      1.0000e+06e
254 * pa       *      0.0000e+00e
255 *
256 *****      type          num          id          ctitle
257 pipe          8          8 pipe that replaces vessels 8 & 9
258 *      ncells          nodes          jun1          jun2          epsw
259 *          3          0          8          12          1.0000e-05
260 *      ichf          iconc          iacc          ipow
261 *          0          0          0          0
262 *      radin          th          houtl          houtv          toutl
263 *      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
264 *      toutv
265 *      3.0000e+02
266 *
267 * dx      * f      1.0000e+00e
268 * vol     * f      2.0000e+00e
269 * fa      * f      2.0000e+00e
270 * fric    * f      0.0000e+00e
271 * grav     * f      1.0000e+00e
272 * hd      * f      1.0000e+00e
273 * nff     *          -1r03          1e
274 * alp     * f      0.0000e+00e
275 * vl      * f      0.0000e+00e
276 * vv      * f      0.0000e+00e
277 * tl      * f      3.0000e+02e
278 * tv      * f      3.0000e+02e
279 * p       * f      1.0000e+06e
280 * pa      * f      0.0000e+00e
281 *
282 *****      type          num          id          ctitle
283 pipe          10          10 pipe that replaces pipes 10 & 11
284 *      ncells          nodes          jun1          jun2          epsw
285 *          1          0          12          14          1.0000e-05
286 *      ichf          iconc          iacc          ipow
287 *          0          0          0          0
288 *      radin          th          houtl          houtv          toutl
289 *      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
290 *      toutv
291 *      3.0000e+02
292 *
293 * dx      *      1.0000e+00e
294 * vol     *      2.0000e+00e
295 * fa      *      2.0000e+00      1.0000e+00e
296 * fric    * f      0.0000e+00e
297 * grav     * f      1.0000e+00e
298 * hd      * f      1.0000e+00e
299 * nff     *          1          -1e
300 * alp     *      0.0000e+00e
301 * vl      * f      0.0000e+00e
302 * vv      * f      0.0000e+00e
303 * tl      *      3.0000e+02e
304 * tv      *      3.0000e+02e
305 * p       *      1.0000e+06e
306 * pa      *      0.0000e+00e
307 *
308 *****      type          num          id          ctitle

```

```

309 pipe 12 12 pipe that replaces vessel 12
310 * ncells nodes jun1 jun2 epsw
311 3 0 14 16 1.0000e-05
312 * ichf iconc iacc ipow
313 0 0 0 0
314 * radin th houtl houtv toutl
315 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
316 * toutv
317 3.0000e+02
318 *
319 * dx * f 1.0000e+00e
320 * vol * f 1.0000e+00e
321 * fa * f 1.0000e+00e
322 * fric * f 0.0000e+00e
323 * grav * f 1.0000e+00e
324 * hd * f 1.0000e+00e
325 * nff * -1r03 1e
326 * alp * f 0.0000e+00e
327 * vl * f 0.0000e+00e
328 * vv * f 0.0000e+00e
329 * tl * f 3.0000e+02e
330 * tv * f 3.0000e+02e
331 * p * f 1.0000e+06e
332 * pa * f 0.0000e+00e
333 *
334 ***** type num id ctitle
335 pipe 13 13 outlet pipe for pipe 12
336 * ncells nodes jun1 jun2 epsw
337 1 0 16 17 1.0000e-05
338 * ichf iconc iacc ipow
339 0 0 0 0
340 * radin th houtl houtv toutl
341 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
342 * toutv
343 3.0000e+02
344 *
345 * dx * 1.0000e+00e
346 * vol * 1.0000e+00e
347 * fa * f 1.0000e+00e
348 * fric * f 0.0000e+00e
349 * grav * f 1.0000e+00e
350 * hd * f 1.0000e+00e
351 * nff * f 1e
352 * alp * 0.0000e+00e
353 * vl * f 0.0000e+00e
354 * vv * f 0.0000e+00e
355 * tl * 3.0000e+02e
356 * tv * 3.0000e+02e
357 * p * 1.0000e+06e
358 * pa * 0.0000e+00e
359 *
360 ***** type num id ctitle
361 pipe 14 14 inlet pipe for pipe 15
362 * ncells nodes jun1 jun2 epsw
363 1 0 18 17 1.0000e-05
364 * ichf iconc iacc ipow
365 0 0 0 0
366 * radin th houtl houtv toutl
367 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
368 * toutv
369 3.0000e+02
370 *

```

```

371 * dx      *      1.0000e+00e
372 * vol     *      1.0000e+00e
373 * fa      * f      1.0000e+00e
374 * fric    * f      0.0000e+00e
375 * grav    * f     -1.0000e+00e
376 * hd      * f      1.0000e+00e
377 * nff     * f              1e
378 * alp     *      0.0000e+00e
379 * vl      * f      0.0000e+00e
380 * vv      * f      0.0000e+00e
381 * tl      *      3.0000e+02e
382 * tv      *      3.0000e+02e
383 * p       *      1.0000e+06e
384 * pa      *      0.0000e+00e
385 *

```

```

386 *****      type              num              id              ctitle
387 pipe              15              15 pipe that replaces vessel 15
388 *              ncells          nodes          jun1          jun2          epsw
389              3              0              19              18          1.0000e-05
390 *              ichf          iconc          iacc          ipow
391              0              0              0              0
392 *              radin          th          hout1          houtv          tout1
393              5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
394 *              toutv
395              3.0000e+02
396 *

```

```

397 * dx      * f      1.0000e+00e
398 * vol     * f      1.0000e+00e
399 * fa      * f      1.0000e+00e
400 * fric    * f      0.0000e+00e
401 * grav    * f     -1.0000e+00e
402 * hd      * f      1.0000e+00e
403 * nff     *      -1r03
404 * alp     * f      0.0000e+00e
405 * vl      * f      0.0000e+00e
406 * vv      * f      0.0000e+00e
407 * tl      * f      3.0000e+02e
408 * tv      * f      3.0000e+02e
409 * p       * f      1.0000e+06e
410 * pa      * f      0.0000e+00e
411 *

```

```

412 *****      type              num              id              ctitle
413 pipe              16              16 pipe that replaces pipes 16 & 17
414 *              ncells          nodes          jun1          jun2          epsw
415              1              0              21              19          1.0000e-05
416 *              ichf          iconc          iacc          ipow
417              0              0              0              0
418 *              radin          th          hout1          houtv          tout1
419              5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
420 *              toutv
421              3.0000e+02
422 *

```

```

423 * dx      *      1.0000e+00e
424 * vol     *      2.0000e+00e
425 * fa      *      2.0000e+00      1.0000e+00e
426 * fric    * f      0.0000e+00e
427 * grav    * f     -1.0000e+00e
428 * hd      * f      1.0000e+00e
429 * nff     *              1          -1e
430 * alp     *      0.0000e+00e
431 * vl      * f      0.0000e+00e
432 * vv      * f      0.0000e+00e

```

```

433 * t1      *      3.0000e+02e
434 * tv      *      3.0000e+02e
435 * p       *      1.0000e+06e
436 * pa      *      0.0000e+00e
437 *
438 *****   type          num          id          ctitle
439 pipe              18          18 pipe that replaces vessels 18 & 19
440 *      ncells      nodes      jun1      jun2      epsw
441 *          3          0          23          21      1.0000e-05
442 *      ichf      iconc      iacc      ipow
443 *          0          0          0          0
444 *      radin      th      hout1      houtv      tout1
445 * 5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  3.0000e+02
446 *      toutv
447 * 3.0000e+02
448 *
449 * dx      * f      1.0000e+00e
450 * vol     * f      2.0000e+00e
451 * fa      * f      2.0000e+00e
452 * fric    * f      0.0000e+00e
453 * grav     * f     -1.0000e+00e
454 * hd      * f      1.0000e+00e
455 * nff      *      -1r03          1e
456 * alp      * f      0.0000e+00e
457 * vl      * f      0.0000e+00e
458 * vv      * f      0.0000e+00e
459 * t1      * f      3.0000e+02e
460 * tv      * f      3.0000e+02e
461 * p       * f      1.0000e+06e
462 * pa      * f      0.0000e+00e
463 *
464 *****   type          num          id          ctitle
465 pipe              20          20 pipe that replaces pipes 20,21,22&23
466 *      ncells      nodes      jun1      jun2      epsw
467 *          1          0          27          23      1.0000e-05
468 *      ichf      iconc      iacc      ipow
469 *          0          0          0          0
470 *      radin      th      hout1      houtv      tout1
471 * 5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  3.0000e+02
472 *      toutv
473 * 3.0000e+02
474 *
475 * dx      *      1.0000e+00e
476 * vol     *      4.0000e+00e
477 * fa      *      4.0000e+00  2.0000e+00e
478 * fric    * f      0.0000e+00e
479 * grav     * f     -1.0000e+00e
480 * hd      * f      1.0000e+00e
481 * nff      *          1          -1e
482 * alp      *      0.0000e+00e
483 * vl      * f      0.0000e+00e
484 * vv      * f      0.0000e+00e
485 * t1      *      3.0000e+02e
486 * tv      *      3.0000e+02e
487 * p       *      1.0000e+06e
488 * pa      *      0.0000e+00e
489 *
490 *****   type          num          id          ctitle
491 plenum          24          24 manifold plenum 24
492 *      npljn      iconc      juns1      juns2
493 *          2          0          1          1
494 *

```



```

495 * junj * 31
496 * dx * f 1.0000e+00e
497 * vol * f 4.0000e+00e
498 * elev * f 2.1000e+01e
499 * alp * f 0.0000e+00e
500 * tl * f 3.0000e+02e
501 * tv * f 3.0000e+02e
502 * p * f 1.0000e+06e
503 * pa * f 0.0000e+00e
504 *
505 ***** type num id ctitle
506 pipe 25 25 outlet pipe for plenum 24
507 * ncells nodes jun1 jun2 epsw
508 1 0 32 31 1.0000e-05
509 * ichf iconc iacc ipow
510 0 0 0 0
511 * radin th houtl houtv toutl
512 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
513 * toutv
514 3.0000e+02
515 *
516 * dx * f 1.0000e+00e
517 * vol * f 1.0000e+00e
518 * fa * f 1.0000e+00e
519 * fric * f 0.0000e+00e
520 * grav * f -1.0000e+00e
521 * hd * f 1.0000e+00e
522 * nff * 1 -1e
523 * alp * f 0.0000e+00e
524 * vl * f 0.0000e+00e
525 * vv * f 0.0000e+00e
526 * tl * f 3.0000e+02e
527 * tv * f 3.0000e+02e
528 * p * f 1.0000e+06e
529 * pa * f 0.0000e+00e
530 *
531 ***** type num id ctitle
532 break 26 26 pressure b.c. pipe 25 outlet
533 * jun1 ibty isat iooff
534 32 0 0 0
535 * dxin volin alpin tin pin
536 1.0000e+00 1.0000e+00 0.0000e+00 3.0000e+02 1.0000e+06
537 * pain concin rbmx poff belv
538 0.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00 2.3000e+01
539 *
540 end
541 *
542 *****
543 * time-step data *
544 *****
545 *
546 * dtmin dtmax tend rtwfp
547 1.0000e-03 1.0000e+00 1.0000e+01 1.0000e+00
548 * edint gfint dmpint sedint
549 1.0000e+01 1.0000e+00 1.1000e+01 1.0000e+01
550 *
551 * dtmin dtmax tend rtwfp
552 1.0000e-03 5.0000e+00 1.0000e+02 1.0000e+00
553 * edint gfint dmpint sedint
554 9.0000e+01 2.5000e+00 9.5000e+01 9.0000e+01
555 *
556 * dtmin dtmax tend rtwfp

```

557	1.0000e-02	3.0000e+01	1.0000e+03	1.0000e+00
558 *	edint	gfint	dmpint	sedint
559	9.0000e+02	1.5000e+01	9.3000e+02	9.0000e+02
560 *				
561 *	dtmin	dtmax	tend	rtwfp
562	1.0000e-01	2.0000e+02	1.0000e+04	1.0000e+00
563 *	edint	gfint	dmpint	sedint
564	9.0000e+03	2.0000e+02	9.0000e+03	9.0000e+03
565 *				
566 *	endflag			
567	-1.0000e+00			

A-4.3 MSCV Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              5              0              1              0              0
9 *--*--*TEST PROBLEM MSCV , Time = 10000.0 s
10      mirrored flow channel with single-phase vapor
11      six 3-cell vessels replaced by six 3-cell pipes
12      twelve 1-cell pipes replaced by four 1-cell pipes
13      two pressure boundary conditions, tv = 500.0 k
14 *
15 *
16 *                                     nff          vv          fa
17 *                                     (-)          (m/s)          (m2)
18 *          *****
19 *          # break# p = 1.0000e+06 pa
20 *          # 26 #
21 *          *****
22 *          32
23 *          1          -10.0          1.0
24 *          *****
25 *          # pipe #
26 *          # 25 #
27 *          *****
28 *          31
29 *          -1          -10.0          1.0
30 *          *****
31 *          # plenum #
32 *          # 24 #
33 *          *****
34 *          27
35 *          1          -2.5          4.0
36 *          *****
37 *          # pipe #
38 *          # 20 #
39 *          *****
40 *          23
41 *          -1          -5.0          2.0
42 *          *****
43 *          # cell #
44 *          # 1 #
45 *          #-----#
46 *          1          -5.0          2.0
47 *          # pipe #
48 *          # 18 #
49 *          #-----#
50 *          1          -5.0          2.0
51 *          # cell #
52 *          # 3 #
53 *          *****
54 *          21
55 *          1          -5.0          2.0
56 *          *****
57 *          # pipe #
58 *          # 16 #
59 *          *****
60 *          19
61 *          -1          -10.0          1.0
62 *          *****
63 *          # cell #
64 *          # 1 #
65 *          #-----#
66 *          1          -10.0          1.0
67 *          # pipe #
68 *          # 15 #
69 *          #-----#
70 *          1          -10.0          1.0
71 *          # cell #
72 *          # 3 #

```

```

61 *          #####
62 *          18                      1  -10.0    1.0
63 *          #####
64 *          # pipe #
65 *          # 14 #
66 *          #####
67 * -- mirror plane -- 17 -- mirror plane -- 1    10.0    1.0
68 *          #####
69 *          # pipe #
70 *          # 13 #
71 *          #####
72 *          16                      1    10.0    1.0
73 *          #####
74 *          # cell #
75 *          # 3 #
76 *          #-----#
77 *          # pipe #
78 *          # 12 #
79 *          #-----#
80 *          # cell #
81 *          # 1 #
82 *          #####
83 *          14                      -1    10.0    1.0
84 *          #####
85 *          # pipe #
86 *          # 10 #
87 *          #####
88 *          12                      1     5.0    2.0
89 *          #####
90 *          # cell #
91 *          # 3 #
92 *          #-----#
93 *          # pipe #
94 *          # 8 #
95 *          #-----#
96 *          # cell #
97 *          # 1 #
98 *          #####
99 *          8                      -1     5.0    2.0
100 *          #####
101 *          # pipe #
102 *          # 4 #
103 *          #####
104 *          4                      1     2.5    4.0
105 *          #####
106 *          # plenum #
107 *          # 3 #
108 *          #####
109 *          3                      -1    10.0    1.0
110 *          #####
111 *          # pipe #
112 *          # 2 #
113 *          #####
114 *          2                      1    10.0    1.0
115 *          #####
116 *          # break# p = 1001758.5 pa
117 *          # 1 #
118 *          #####
119 *
120 *****
121 * namelist data *
122 *****

```

```

123 *
124 &inopts
125 iadded=10, ikfac=1, cpuflg=1,
126 idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5
127 &end
128 *
129 *          dstep          timet
130          0          0.0000e+00
131 *          stdyst          transi          ncomp          njun          ipak
132          0          1          16          15          0
133 *          epso          epss
134          1.0000e-04          1.0000e-04
135 *          oitmax          sitmax          isolut          ncontr          nccfl
136          10          10          0          0          0
137 *          ntsv          ntcb          ntcf          ntrp          ntcp
138          1          0          0          0          0
139 *
140 *****
141 * component-number data *
142 *****
143 *
144 * iorder * 1 s * break          pressure b.c. for pipe 2 inlet
145 * iorder * 2 s * pipe          inlet pipe for plenum 3
146 * iorder * 3 s * plenum        manifold plenum 3
147 * iorder * 4 s * pipe          pipe that replaces pipes 4, 5, 6 & 7
148 * iorder * 8 s * pipe          pipe that replaces vessels 8 & 9
149 * iorder * 10 s * pipe         pipe that replaces pipes 10 & 11
150 * iorder * 12 s * pipe         pipe that replaces vessel 12
151 * iorder * 13 s * pipe         outlet pipe for pipe 12
152 * iorder * 14 s * pipe         inlet pipe for pipe 15
153 * iorder * 15 s * pipe         pipe that replaces vessel 15
154 * iorder * 16 s * pipe         pipe that replaces pipes 16 & 17
155 * iorder * 18 s * pipe         pipe that replaces vessels 18 & 19
156 * iorder * 20 s * pipe         pipe that replaces pipes 20, 21, 22 & 23
157 * iorder * 24 s * plenum        manifold plenum 24
158 * iorder * 25 s * pipe         outlet pipe for pipe 24
159 * iorder * 26 e * break        pressure b.c. for pipe 25 outlet
160 *
161 *****
162 * control parameters *
163 *****
164 *
165 * signal variable
166 *
167 *          idsv          isvn          icln          icn1          icn2
168          1          0          0          0          0
169 *
170 *****
171 * component data *
172 *****
173 *
174 *          type          num          id          ctitle
175 break          1          1          1          pressure b.c. for pipe 2 inlet
176 *          jun1          ibty          isat          ioff
177          2          1          0          0
178 *          ibtr          ibsv          nbtb          nbsv          nbrf
179          0          1          2          0          0
180 *          dxin          volin          alpin          tin          pin
181          1.0000e+00          1.0000e+00          1.0000e+00          5.0000e+02          1.0000e+06
182 *          pain          concin          rbmx          poff          belv
183          0.0000e+00          0.0000e+00          1.7585e+03          0.0000e+00          0.0000e+00
184 *          pscl          tisc1          tvscl          pascl          conscl

```

```

185      1.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00
186 *
187 * ptb      *      0.0000e+00      1.0000e+06      1.0000e+00      1001758.50e
188 *
189 *****      type      num      id      ctitle
190 pipe      2      2 inlet pipe for plenum 3
191 *      ncells      nodes      jun1      jun2      epsw
192      1      0      2      3      1.0000e-05
193 *      ichf      iconc      iacc      ipow
194      0      0      0      0
195 *      radin      th      hout1      houtv      tout1
196      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
197 *      toutv
198      5.0000e+02
199 *
200 * dx      * f      1.0000e+00e
201 * vol      * f      1.0000e+00e
202 * fa      * f      1.0000e+00e
203 * fric      * f      0.0000e+00e
204 * grav      * f      1.0000e+00e
205 * hd      * f      1.0000e+00e
206 * nff      *      1      -1e
207 * alp      * f      1.0000e+00e
208 * vl      * f      0.0000e+00e
209 * vv      * f      0.0000e+00e
210 * tl      * f      5.0000e+02e
211 * tv      * f      5.0000e+02e
212 * p      * f      1.0000e+06e
213 * pa      * f      0.0000e+00e
214 *
215 *****      type      num      id      ctitle
216 plenum      3      3 manifold plenum 3
217 *      npljn      iconc      juns1      juns2
218      2      0      1      1
219 *
220 * junj      *      3      4e
221 * dx      * f      1.0000e+00e
222 * vol      * f      4.0000e+00e
223 * elev      * f      2.0000e+00e
224 * alp      * f      1.0000e+00e
225 * tl      * f      5.0000e+02e
226 * tv      * f      5.0000e+02e
227 * p      * f      1.0000e+06e
228 * pa      * f      0.0000e+00e
229 *
230 *****      type      num      id      ctitle
231 pipe      4      4 pipe that replaces pipes 4, 5, 6 & 7
232 *      ncells      nodes      jun1      jun2      epsw
233      1      0      4      8      1.0000e-05
234 *      ichf      iconc      iacc      ipow
235      0      0      0      0
236 *      radin      th      hout1      houtv      tout1
237      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
238 *      toutv
239      5.0000e+02
240 *
241 * dx      *      1.0000e+00e
242 * vol      *      4.0000e+00e
243 * fa      *      4.0000e+00      2.0000e+00e
244 * fric      * f      0.0000e+00e
245 * grav      * f      1.0000e+00e
246 * hd      * f      1.0000e+00e

```

```

247 * nff      *          1          -1e
248 * alp      *      1.0000e+00e
249 * vl       * f      0.0000e+00e
250 * vv       * f      0.0000e+00e
251 * tl       *      5.0000e+02e
252 * tv       *      5.0000e+02e
253 * p        *      1.0000e+06e
254 * pa       *      0.0000e+00e
255 *
256 *****      type          num          id          ctitle
257 pipe          8          8 pipe that replaces vessels 8 & 9
258 *          ncells          nodes          jun1          jun2          epsw
259          3          0          8          12          1.0000e-05
260 *          ichf          iconc          iacc          ipow
261          0          0          0          0
262 *          radin          th          hout1          houtv          tout1
263          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
264 *          toutv
265          5.0000e+02
266 *
267 * dx      * f      1.0000e+00e
268 * vol     * f      2.0000e+00e
269 * fa      * f      2.0000e+00e
270 * fric    * f      0.0000e+00e
271 * grav    * f      1.0000e+00e
272 * hd      * f      1.0000e+00e
273 * nff     *          -1r03          1e
274 * alp     * f      1.0000e+00e
275 * vl      * f      0.0000e+00e
276 * vv      * f      0.0000e+00e
277 * tl      * f      5.0000e+02e
278 * tv      * f      5.0000e+02e
279 * p       * f      1.0000e+06e
280 * pa      * f      0.0000e+00e
281 *
282 *****      type          num          id          ctitle
283 pipe          10          10 pipe that replaces pipes 10 & 11
284 *          ncells          nodes          jun1          jun2          epsw
285          1          0          12          14          1.0000e-05
286 *          ichf          iconc          iacc          ipow
287          0          0          0          0
288 *          radin          th          hout1          houtv          tout1
289          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
290 *          toutv
291          5.0000e+02
292 *
293 * dx      *      1.0000e+00e
294 * vol     *      2.0000e+00e
295 * fa      *      2.0000e+00          1.0000e+00e
296 * fric    * f      0.0000e+00e
297 * grav    * f      1.0000e+00e
298 * hd      * f      1.0000e+00e
299 * nff     *          1          -1e
300 * alp     *      1.0000e+00e
301 * vl      * f      0.0000e+00e
302 * vv      * f      0.0000e+00e
303 * tl      *      5.0000e+02e
304 * tv      *      5.0000e+02e
305 * p       *      1.0000e+06e
306 * pa      *      0.0000e+00e
307 *
308 *****      type          num          id          ctitle

```

```

309 pipe                                     12 pipe that replaces vessel 12
310 *          ncells          nodes          jun1          jun2          epsw
311          3          0          14          16          1.0000e-05
312 *          ichf          iconc          iacc          ipow
313          0          0          0          0
314 *          radin          th          hout1          houtv          tout1
315          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
316 *          toutv
317          5.0000e+02
318 *
319 * dx          * f          1.0000e+00e
320 * vol          * f          1.0000e+00e
321 * fa          * f          1.0000e+00e
322 * fric          * f          0.0000e+00e
323 * grav          * f          1.0000e+00e
324 * hd          * f          1.0000e+00e
325 * nff          *          -1r03          1e
326 * alp          * f          1.0000e+00e
327 * vl          * f          0.0000e+00e
328 * vv          * f          0.0000e+00e
329 * tl          * f          5.0000e+02e
330 * tv          * f          5.0000e+02e
331 * p          * f          1.0000e+06e
332 * pa          * f          0.0000e+00e
333 *
334 *****          type          num          id          ctitle
335 pipe          13          13 outlet pipe for pipe 12
336 *          ncells          nodes          jun1          jun2          epsw
337          1          0          16          17          1.0000e-05
338 *          ichf          iconc          iacc          ipow
339          0          0          0          0
340 *          radin          th          hout1          houtv          tout1
341          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
342 *          toutv
343          5.0000e+02
344 *
345 * dx          *          1.0000e+00e
346 * vol          *          1.0000e+00e
347 * fa          * f          1.0000e+00e
348 * fric          * f          0.0000e+00e
349 * grav          * f          1.0000e+00e
350 * hd          * f          1.0000e+00e
351 * nff          * f          1e
352 * alp          *          1.0000e+00e
353 * vl          * f          0.0000e+00e
354 * vv          * f          0.0000e+00e
355 * tl          *          5.0000e+02e
356 * tv          *          5.0000e+02e
357 * p          *          1.0000e+06e
358 * pa          *          0.0000e+00e
359 *
360 *****          type          num          id          ctitle
361 pipe          14          14 inlet pipe for pipe 15
362 *          ncells          nodes          jun1          jun2          epsw
363          1          0          18          17          1.0000e-05
364 *          ichf          iconc          iacc          ipow
365          0          0          0          0
366 *          radin          th          hout1          houtv          tout1
367          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
368 *          toutv
369          5.0000e+02
370 *

```



```

371 * dx      *      1.0000e+00e
372 * vol     *      1.0000e+00e
373 * fa      * f     1.0000e+00e
374 * fric    * f     0.0000e+00e
375 * grav    * f    -1.0000e+00e
376 * hd      * f     1.0000e+00e
377 * nff     * f              1e
378 * alp     *      1.0000e+00e
379 * vl      * f     0.0000e+00e
380 * vv      * f     0.0000e+00e
381 * tl      *      5.0000e+02e
382 * tv      *      5.0000e+02e
383 * p       *      1.0000e+06e
384 * pa      *      0.0000e+00e
385 *
386 *****      type          num          id          ctitle
387 pipe                    15          15 pipe that replaces vessel 15
388 *          ncells        nodes        jun1        jun2        epsw
389 *          3              0            19           18        1.0000e-05
390 *          ichf          iconc        iacc         ipow
391 *          0              0            0            0
392 *          radin         th          hout1        houtv        tout1
393 *          5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    5.0000e+02
394 *          toutv
395 *          5.0000e+02
396 *
397 * dx      * f     1.0000e+00e
398 * vol     * f     1.0000e+00e
399 * fa      * f     1.0000e+00e
400 * fric    * f     0.0000e+00e
401 * grav    * f    -1.0000e+00e
402 * hd      * f     1.0000e+00e
403 * nff     *      -1r03          1e
404 * alp     * f     1.0000e+00e
405 * vl      * f     0.0000e+00e
406 * vv      * f     0.0000e+00e
407 * tl      * f     5.0000e+02e
408 * tv      * f     5.0000e+02e
409 * p       * f     1.0000e+06e
410 * pa      * f     0.0000e+00e
411 *
412 *****      type          num          id          ctitle
413 pipe                    16          16 pipe that replaces pipes 16 & 17
414 *          ncells        nodes        jun1        jun2        epsw
415 *          1              0            21           19        1.0000e-05
416 *          ichf          iconc        iacc         ipow
417 *          0              0            0            0
418 *          radin         th          hout1        houtv        tout1
419 *          5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    5.0000e+02
420 *          toutv
421 *          5.0000e+02
422 *
423 * dx      *      1.0000e+00e
424 * vol     *      2.0000e+00e
425 * fa      *      2.0000e+00    1.0000e+00e
426 * fric    * f     0.0000e+00e
427 * grav    * f    -1.0000e+00e
428 * hd      * f     1.0000e+00e
429 * nff     *          1          -1e
430 * alp     *      1.0000e+00e
431 * vl      * f     0.0000e+00e
432 * vv      * f     0.0000e+00e

```

```

433 * tl      *      5.0000e+02e
434 * tv      *      5.0000e+02e
435 * p       *      1.0000e+06e
436 * pa      *      0.0000e+00e
437 *
438 *****      type              num              id              ctitle
439 pipe              18              18 pipe that replaces vessels 18 & 19
440 *              ncells          nodes          jun1          jun2          epsw
441 *              3              0              23              21          1.0000e-05
442 *              ichf          iconc          iacc          ipow
443 *              0              0              0              0
444 *              radin          th          hout1          houtv          tout1
445 *              5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
446 *              toutv
447 *              5.0000e+02
448 *
449 * dx      * f      1.0000e+00e
450 * vol     * f      2.0000e+00e
451 * fa      * f      2.0000e+00e
452 * fric    * f      0.0000e+00e
453 * grav    * f      -1.0000e+00e
454 * hd      * f      1.0000e+00e
455 * nff     *          -1r03          1e
456 * alp     * f      1.0000e+00e
457 * vl      * f      0.0000e+00e
458 * vv      * f      0.0000e+00e
459 * tl      * f      5.0000e+02e
460 * tv      * f      5.0000e+02e
461 * p       * f      1.0000e+06e
462 * pa      * f      0.0000e+00e
463 *
464 *****      type              num              id              ctitle
465 pipe              20              20 pipe that replaces pipes 20,21,22&23
466 *              ncells          nodes          jun1          jun2          epsw
467 *              1              0              27              23          1.0000e-05
468 *              ichf          iconc          iacc          ipow
469 *              0              0              0              0
470 *              radin          th          hout1          houtv          tout1
471 *              5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
472 *              toutv
473 *              5.0000e+02
474 *
475 * dx      *          1.0000e+00e
476 * vol     *          4.0000e+00e
477 * fa      *          4.0000e+00      2.0000e+00e
478 * fric    * f      0.0000e+00e
479 * grav    * f      -1.0000e+00e
480 * hd      * f      1.0000e+00e
481 * nff     *          1          -1e
482 * alp     *          1.0000e+00e
483 * vl      * f      0.0000e+00e
484 * vv      * f      0.0000e+00e
485 * tl      *          5.0000e+02e
486 * tv      *          5.0000e+02e
487 * p       *          1.0000e+06e
488 * pa      *          0.0000e+00e
489 *
490 *****      type              num              id              ctitle
491 plenum              24              24 manifold plenum 24
492 *              npljn          iconc          juns1          juns2
493 *              2              0              1              1
494 *

```

```

495 * junj * 31
496 * dx * f 1.0000e+00e
497 * vol * f 4.0000e+00e
498 * elev * f 2.1000e+01e
499 * alp * f 1.0000e+00e
500 * tl * f 5.0000e+02e
501 * tv * f 5.0000e+02e
502 * p * f 1.0000e+06e
503 * pa * f 0.0000e+00e
504 *
505 ***** type num id ctitle
506 pipe 25 25 outlet pipe for plenum 24
507 * ncells nodes jun1 jun2 epsw
508 1 0 32 31 1.0000e-05
509 * ichf iconc iacc ipow
510 0 0 0 0
511 * radin th houtl houtv toutl
512 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
513 * toutv
514 5.0000e+02
515 *
516 * dx * f 1.0000e+00e
517 * vol * f 1.0000e+00e
518 * fa * f 1.0000e+00e
519 * fric * f 0.0000e+00e
520 * grav * f -1.0000e+00e
521 * hd * f 1.0000e+00e
522 * nff * 1
523 * alp * f 1.0000e+00e
524 * vl * f 0.0000e+00e
525 * vv * f 0.0000e+00e
526 * tl * f 5.0000e+02e
527 * tv * f 5.0000e+02e
528 * p * f 1.0000e+06e
529 * pa * f 0.0000e+00e
530 *
531 ***** type num id ctitle
532 break 26 26 pressure b.c. pipe 25 outlet
533 * jun1 ibty isat ioff
534 32 0 0 0
535 * dxin volin alpin tin pin
536 1.0000e+00 1.0000e+00 1.0000e+00 5.0000e+02 1.0000e+06
537 * pain concin rbmx poff belv
538 0.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00 2.3000e+01
539 *
540 end
541 *
542 *****
543 * time-step data *
544 *****
545 *
546 * dtmin dtmax tend rtwfp
547 1.0000e-03 1.0000e+00 1.0000e+01 1.0000e+00
548 * edint gfint dmpint sedint
549 1.0000e+01 1.0000e+00 1.1000e+01 1.0000e+01
550 *
551 * dtmin dtmax tend rtwfp
552 1.0000e-03 5.0000e+00 1.0000e+02 1.0000e+00
553 * edint gfint dmpint sedint
554 9.0000e+01 2.5000e+00 9.5000e+01 9.0000e+01
555 *
556 * dtmin dtmax tend rtwfp

```

27e

-1e

557	1.0000e-02	3.0000e+01	1.0000e+03	1.0000e+00
558 *	edint	gfint	dmpint	sedint
559	9.0000e+02	1.5000e+01	9.3000e+02	9.0000e+02
560 *				
561 *	dtmin	dtmax	tend	rtwfp
562	1.0000e-01	2.0000e+02	1.0000e+04	1.0000e+00
563 *	edint	gfint	dmpint	sedint
564	9.0000e+03	2.0000e+02	9.0000e+03	9.0000e+03
565 *				
566 *	endflag			
567	-1.0000e+00			

A-4.4 MSP2 Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              6              0              1              0              0
9 *--*--*TEST PROBLEM MSP2 , Time = 10000.0 s
10      mirrored flow channel with two-phase fluid
11      six 3-cell vessels replaced by six 3-cell pipes
12      twelve 1-cell pipes replaced by four 1-cell pipes
13      two plenums replaced by two 1-cell pipes
14      two pressure boundary conditions, t1 = tsat = tv = 455.0 k
15 *
16 *
17 *          nff      vl      vv      fa
18 *          (-) (m/s) (m/s) (m2)
19 *          #####
20 *          # break#
21 *          # 26 # p = 1.0000e+06 pa
22 *          #####
23 *          32          1 -6.3 -6.7 1.0
24 *          #####
25 *          # pipe #
26 *          # 25 #
27 *          #####
28 *          31          -1 -5.8 -5.8 1.0
29 *          #####
30 *          # pipe #
31 *          # 24 #
32 *          #####
33 *          27          1 -1.2 -1.4 4.0
34 *          #####
35 *          # pipe #
36 *          # 20 #
37 *          #####
38 *          23          -1 -2.4 -2.6 2.0
39 *          #####
40 *          # cell #
41 *          # 1 #
42 *          #-----#
43 *          # pipe #
44 *          # 18 #
45 *          #-----#
46 *          # cell #
47 *          # 3 #
48 *          #####
49 *          21          1 -2.7 -2.8 2.0
50 *          #####
51 *          # pipe #
52 *          # 16 #
53 *          #####
54 *          19          -1 -5.7 -5.9 1.0
55 *          #####
56 *          # cell #
57 *          # 1 #
58 *          #-----#
59 *          # pipe #
60 *          # 15 #
61 *          #-----#
62 *          # cell #

```

```

61 *          # 3 #
62 *          #####
63 *          18          1 -6.8 -7.0 1.0
64 *          #####
65 *          # pipe #
66 *          # 14 #
67 *          #####
68 *  -- mirror plane -- 17 -- mirror plane -- 1 7.1 7.3 1.0
69 *          #####
70 *          # pipe #
71 *          # 13 #
72 *          #####
73 *          16          1 7.4 7.5 1.0
74 *          #####
75 *          # cell #
76 *          # 3 #
77 *          #-----#
78 *          # pipe #
79 *          # 12 #
80 *          #-----#
81 *          # cell #
82 *          # 1 #
83 *          #####
84 *          14          -1 8.2 8.1 1.0
85 *          #####
86 *          # pipe #
87 *          # 10 #
88 *          #####
89 *          12          1 4.0 4.2 2.0
90 *          #####
91 *          # cell #
92 *          # 3 #
93 *          #-----#
94 *          # pipe #
95 *          # 8 #
96 *          #-----#
97 *          # cell #
98 *          # 1 #
99 *          #####
100 *          8          -1 4.3 4.4 2.0
101 *          #####
102 *          # pipe #
103 *          # 4 #
104 *          #####
105 *          4          1 2.1 2.3 4.0
106 *          #####
107 *          # pipe #
108 *          # 3 #
109 *          #####
110 *          3          -1 8.8 9.1 1.0
111 *          #####
112 *          # pipe #
113 *          # 2 #
114 *          #####
115 *          2          1 9.8 10.0 1.0
116 *          #####
117 *          # break# p = 1.1384e+06 pa
118 *          # 1 #
119 *          #####
120 *
121 *****
122 * namelist data *

```

```

123 *****
124 *
125 &inopts
126   iadded=10, ikfac=1, nifsh=1, ccif=1.0e+05,
127   idiag=4, nsdl=0, nsdu=5, nspl=0, nspl=5, cpuflg=1
128 &end
129 *
130 *           dstep           timet
131           0           0.0000e+00
132 *           stdyst           transi           ncomp           njun           ipak
133           0           1           16           15           0
134 *           epso           epss
135           1.0000e-04           1.0000e-04
136 *           oitmax           sitmax           isolut           ncontr           nccfl
137           10           10           0           0           0
138 *           ntsv           ntcb           ntcf           ntrp           ntcp
139           1           0           0           0           0
140 *
141 *****
142 * component-number data *
143 *****
144 *
145 * iorder *   1 s   * break           pressure b.c. for pipe 2 inlet
146 * iorder *   2 s   * pipe           inlet pipe for pipe 3
147 * iorder *   3 s   * pipe           pipe that replaces plenum 3
148 * iorder *   4 s   * pipe           pipe that replaces pipes 4, 5, 6 & 7
149 * iorder *   8 s   * pipe           pipe that replaces vessels 8 & 9
150 * iorder *  10 s   * pipe           pipe that replaces pipes 10 & 11
151 * iorder *  12 s   * pipe           pipe that replaces vessel 12
152 * iorder *  13 s   * pipe           outlet pipe for pipe 12
153 * iorder *  14 s   * pipe           inlet pipe for pipe 15
154 * iorder *  15 s   * pipe           pipe that replaces vessel 15
155 * iorder *  16 s   * pipe           pipe that replaces pipes 16 & 17
156 * iorder *  18 s   * pipe           pipe that replaces vessels 18 & 19
157 * iorder *  20 s   * pipe           pipe that replaces pipes 20, 21, 22 & 23
158 * iorder *  24 s   * pipe           pipe that replaces plenum 24
159 * iorder *  25 s   * pipe           outlet pipe for pipe 24
160 * iorder *  26 e   * break           pressure b.c. for pipe 25 outlet
161 *
162 *****
163 * control parameters *
164 *****
165 *
166 * signal variable
167 *
168 *           idsv           isvn           icln           icn1           icn2
169           1           0           0           0           0
170 *
171 *****
172 * component data *
173 *****
174 *
175 *****   type           num           id           ctitle
176 break           1           1           1 pressure b.c. for pipe 2 inlet
177 *           jun1           ibty           isat           ioff
178           2           1           0           0
179 *           ibtr           ibsv           nbtr           nbtr
180           0           1           2           0           0
181 *           dxin           volin           alpin           tin           pin
182           1.0000e+00           1.0000e+00           5.0000e-01           4.5500e+02           1.0000e+06
183 *           pain           concin           rbmx           poff           belv
184           0.0000e+00           0.0000e+00           1.3840e+05           0.0000e+00           0.0000e+00

```

```

185 *          pscl          tlscl          tvscl          pascl          conscl
186      1.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00
187 *
188 * ptb      *      0.0000e+00      1.0000e+06      1.0000e+00      1.1384e+06e
189 *
190 * type          num          id          ctitle
191 pipe          2          2 inlet pipe for pipe 3
192 *          ncells          nodes          jun1          jun2          epsw
193      1          0          2          3      1.0000e-05
194 *          ichf          iconc          iacc          ipow
195      0          0          0          0
196 *          radin          th          hout1          houtv          tout1
197      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
198 *          toutv
199      4.5500e+02
200 *
201 * dx      * f      1.0000e+00e
202 * vol      * f      1.0000e+00e
203 * fa      * f      1.0000e+00e
204 * fric      * f      0.0000e+00e
205 * grav      * f      1.0000e+00e
206 * hd      * f      1.0000e+00e
207 * nff      *      1          -1e
208 * alp      * f      5.0000e-01e
209 * vl      * f      0.0000e+00e
210 * vv      * f      0.0000e+00e
211 * tl      * f      4.5500e+02e
212 * tv      * f      4.5500e+02e
213 * p      * f      1.0000e+06e
214 * pa      * f      0.0000e+00e
215 *
216 * type          num          id          ctitle
217 pipe          3          3 pipe that replaces plenum 3
218 *          ncells          nodes          jun1          jun2          epsw
219      1          0          3          4      1.0000e-05
220 *          ichf          iconc          iacc          ipow
221      0          0          0          0
222 *          radin          th          hout1          houtv          tout1
223      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
224 *          toutv
225      4.5500e+02
226 *
227 * dx      * f      1.0000e+00e
228 * vol      * f      4.0000e+00e
229 * fa      *      1.0000e+00      4.0000e+00e
230 * fric      * f      0.0000e+00e
231 * grav      * f      1.0000e+00e
232 * hd      * f      1.0000e+00e
233 * nff      *      -1          1e
234 * alp      * f      5.0000e-01e
235 * vl      * f      0.0000e+00e
236 * vv      * f      0.0000e+00e
237 * tl      * f      4.5500e+02e
238 * tv      * f      4.5500e+02e
239 * p      * f      1.0000e+06e
240 * pa      * f      0.0000e+00e
241 *
242 * type          num          id          ctitle
243 pipe          4          4 pipe that replaces pipes 4, 5, 6 & 7
244 *          ncells          nodes          jun1          jun2          epsw
245      1          0          4          8      1.0000e-05
246 *          ichf          iconc          iacc          ipow

```



```

247          0          0          0          0
248 *      radin          th      houtl      houtv      toutl
249      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
250 *      toutv
251      4.5500e+02
252 *
253 * dx      *      1.0000e+00e
254 * vol      *      4.0000e+00e
255 * fa      *      4.0000e+00      2.0000e+00e
256 * fric      * f      0.0000e+00e
257 * grav      * f      1.0000e+00e
258 * hd      * f      1.0000e+00e
259 * nff      *      1      -1e
260 * alp      *      5.0000e-01e
261 * vl      * f      0.0000e+00e
262 * vv      * f      0.0000e+00e
263 * tl      *      4.5500e+02e
264 * tv      *      4.5500e+02e
265 * p      *      1.0000e+06e
266 * pa      *      0.0000e+00e
267 *
268 *****      type      num      id      ctitle
269 pipe      8      8 pipe that replaces vessels 8 & 9
270 *      ncells      nodes      jun1      jun2      epsw
271      3      0      8      12      1.0000e-05
272 *      ichf      iconc      iacc      ipow
273      0      0      0      0
274 *      radin      th      houtl      houtv      toutl
275      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
276 *      toutv
277      4.5500e+02
278 *
279 * dx      * f      1.0000e+00e
280 * vol      * f      2.0000e+00e
281 * fa      * f      2.0000e+00e
282 * fric      * f      0.0000e+00e
283 * grav      * f      1.0000e+00e
284 * hd      * f      1.0000e+00e
285 * nff      *      -1r03      1e
286 * alp      * f      5.0000e-01e
287 * vl      * f      0.0000e+00e
288 * vv      * f      0.0000e+00e
289 * tl      * f      4.5500e+02e
290 * tv      * f      4.5500e+02e
291 * p      * f      1.0000e+06e
292 * pa      * f      0.0000e+00e
293 *
294 *****      type      num      id      ctitle
295 pipe      10      10 pipe that replaces pipes 10 & 11
296 *      ncells      nodes      jun1      jun2      epsw
297      1      0      12      14      1.0000e-05
298 *      ichf      iconc      iacc      ipow
299      0      0      0      0
300 *      radin      th      houtl      houtv      toutl
301      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
302 *      toutv
303      4.5500e+02
304 *
305 * dx      *      1.0000e+00e
306 * vol      *      2.0000e+00e
307 * fa      *      2.0000e+00      1.0000e+00e
308 * fric      * f      0.0000e+00e

```

```

309 * grav * f 1.0000e+00e
310 * hd * f 1.0000e+00e
311 * nff * 1 -1e
312 * alp * 5.0000e-01e
313 * vl * f 0.0000e+00e
314 * vv * f 0.0000e+00e
315 * tl * 4.5500e+02e
316 * tv * 4.5500e+02e
317 * p * 1.0000e+06e
318 * pa * 0.0000e+00e
319 *
320 ***** type num id ctitle
321 pipe 12 12 pipe that replaces vessel 12
322 * ncells nodes jun1 jun2 epsw
323 3 0 14 16 1.0000e-05
324 * ichf iconc iacc ipow
325 0 0 0 0
326 * radin th houtl houtv toutl
327 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
328 * toutv
329 4.5500e+02
330 *
331 * dx * f 1.0000e+00e
332 * vol * f 1.0000e+00e
333 * fa * f 1.0000e+00e
334 * fric * f 0.0000e+00e
335 * grav * f 1.0000e+00e
336 * hd * f 1.0000e+00e
337 * nff * -1r03 1e
338 * alp * f 5.0000e-01e
339 * vl * f 0.0000e+00e
340 * vv * f 0.0000e+00e
341 * tl * f 4.5500e+02e
342 * tv * f 4.5500e+02e
343 * p * f 1.0000e+06e
344 * pa * f 0.0000e+00e
345 *
346 ***** type num id ctitle
347 pipe 13 13 outlet pipe for pipe 12
348 * ncells nodes jun1 jun2 epsw
349 1 0 16 17 1.0000e-05
350 * ichf iconc iacc ipow
351 0 0 0 0
352 * radin th houtl houtv toutl
353 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
354 * toutv
355 4.5500e+02
356 *
357 * dx * 1.0000e+00e
358 * vol * 1.0000e+00e
359 * fa * f 1.0000e+00e
360 * fric * f 0.0000e+00e
361 * grav * f 1.0000e+00e
362 * hd * f 1.0000e+00e
363 * nff * f 1e
364 * alp * 5.0000e-01e
365 * vl * f 0.0000e+00e
366 * vv * f 0.0000e+00e
367 * tl * 4.5500e+02e
368 * tv * 4.5500e+02e
369 * p * 1.0000e+06e
370 * pa * 0.0000e+00e

```

```

371 *
372 ***** type num id ctitle
373 pipe 14 14 inlet pipe for pipe 15
374 * ncells nodes jun1 jun2 epsw
375 * 1 0 18 17 1.0000e-05
376 * ichf iconc iacc ipow
377 * 0 0 0 0
378 * radin th houtl houtv toutl
379 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
380 * toutv
381 4.5500e+02
382 *
383 * dx * 1.0000e+00e
384 * vol * 1.0000e+00e
385 * fa * f 1.0000e+00e
386 * fric * f 0.0000e+00e
387 * grav * f -1.0000e+00e
388 * hd * f 1.0000e+00e
389 * nff * f 1e
390 * alp * 5.0000e-01e
391 * vl * f 0.0000e+00e
392 * vv * f 0.0000e+00e
393 * tl * 4.5500e+02e
394 * tv * 4.5500e+02e
395 * p * 1.0000e+06e
396 * pa * 0.0000e+00e
397 *
398 ***** type num id ctitle
399 pipe 15 15 pipe that replaces vessel 15
400 * ncells nodes jun1 jun2 epsw
401 * 3 0 19 18 1.0000e-05
402 * ichf iconc iacc ipow
403 * 0 0 0 0
404 * radin th houtl houtv toutl
405 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
406 * toutv
407 4.5500e+02
408 *
409 * dx * f 1.0000e+00e
410 * vol * f 1.0000e+00e
411 * fa * f 1.0000e+00e
412 * fric * f 0.0000e+00e
413 * grav * f -1.0000e+00e
414 * hd * f 1.0000e+00e
415 * nff * -1r03 1e
416 * alp * f 5.0000e-01e
417 * vl * f 0.0000e+00e
418 * vv * f 0.0000e+00e
419 * tl * f 4.5500e+02e
420 * tv * f 4.5500e+02e
421 * p * f 1.0000e+06e
422 * pa * f 0.0000e+00e
423 *
424 ***** type num id ctitle
425 pipe 16 16 pipe that replaces pipes 16 & 17
426 * ncells nodes jun1 jun2 epsw
427 * 1 0 21 19 1.0000e-05
428 * ichf iconc iacc ipow
429 * 0 0 0 0
430 * radin th houtl houtv toutl
431 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
432 * toutv

```

```

433      4.5500e+02
434 *
435 * dx      *      1.0000e+00e
436 * vol     *      2.0000e+00e
437 * fa      *      2.0000e+00      1.0000e+00e
438 * fric    * f      0.0000e+00e
439 * grav     * f     -1.0000e+00e
440 * hd      * f      1.0000e+00e
441 * nff      *          1          -1e
442 * alp      *      5.0000e-01e
443 * vl      * f      0.0000e+00e
444 * vv      * f      0.0000e+00e
445 * tl      *      4.5500e+02e
446 * tv      *      4.5500e+02e
447 * p       *      1.0000e+06e
448 * pa      *      0.0000e+00e
449 *
450 *****      type          num          id          ctitle
451 pipe          18          18 pipe that replaces vessels 18 & 19
452 *          ncells          nodes          jun1          jun2          epsw
453          3          0          23          21          1.0000e-05
454 *          ichf          iconc          iacc          ipow
455          0          0          0          0
456 *          radin          th          hout1          houtv          tout1
457      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
458 *          toutv
459      4.5500e+02
460 *
461 * dx      * f      1.0000e+00e
462 * vol     * f      2.0000e+00e
463 * fa      * f      2.0000e+00e
464 * fric    * f      0.0000e+00e
465 * grav     * f     -1.0000e+00e
466 * hd      * f      1.0000e+00e
467 * nff      *          -1r03          1e
468 * alp      * f      5.0000e-01e
469 * vl      * f      0.0000e+00e
470 * vv      * f      0.0000e+00e
471 * tl      * f      4.5500e+02e
472 * tv      * f      4.5500e+02e
473 * p       * f      1.0000e+06e
474 * pa      * f      0.0000e+00e
475 *
476 *****      type          num          id          ctitle
477 pipe          20          20 pipe that replaces pipes 20,21,22&23
478 *          ncells          nodes          jun1          jun2          epsw
479          1          0          27          23          1.0000e-05
480 *          ichf          iconc          iacc          ipow
481          0          0          0          0
482 *          radin          th          hout1          houtv          tout1
483      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
484 *          toutv
485      4.5500e+02
486 *
487 * dx      *      1.0000e+00e
488 * vol     *      4.0000e+00e
489 * fa      *      4.0000e+00      2.0000e+00e
490 * fric    * f      0.0000e+00e
491 * grav     * f     -1.0000e+00e
492 * hd      * f      1.0000e+00e
493 * nff      *          1          -1e
494 * alp      *      5.0000e-01e

```

```

495 * vl      * f    0.0000e+00e
496 * vv      * f    0.0000e+00e
497 * tl      *      4.5500e+02e
498 * tv      *      4.5500e+02e
499 * p       *      1.0000e+06e
500 * pa      *      0.0000e+00e
501 *
502 *****   type          num          id          ctitle
503 pipe                24          24 pipe that replaces plenum 24
504 *          ncells      nodes      jun1      jun2      epsw
505 *          1            0          31         27      1.0000e-05
506 *          ichf        iconc      iacc        ipow
507 *          0            0          0          0
508 *          radin        th        hout1      houtv      tout1
509 *          5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    4.5500e+02
510 *          toutv
511 *          4.5500e+02
512 *
513 * dx      * f    1.0000e+00e
514 * vol     * f    4.0000e+00e
515 * fa      *      1.0000e+00    4.0000e+00e
516 * fric    * f    0.0000e+00e
517 * grav     * f   -1.0000e+00e
518 * hd      * f    1.0000e+00e
519 * nff      *      -1          1e
520 * alp     * f    5.0000e-01e
521 * vl      * f    0.0000e+00e
522 * vv      * f    0.0000e+00e
523 * tl      * f    4.5500e+02e
524 * tv      * f    4.5500e+02e
525 * p       * f    1.0000e+06e
526 * pa      * f    0.0000e+00e
527 *
528 *****   type          num          id          ctitle
529 pipe                25          25 outlet pipe for pipe 24
530 *          ncells      nodes      jun1      jun2      epsw
531 *          1            0          32         31      1.0000e-05
532 *          ichf        iconc      iacc        ipow
533 *          0            0          0          0
534 *          radin        th        hout1      houtv      tout1
535 *          5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    4.5500e+02
536 *          toutv
537 *          4.5500e+02
538 *
539 * dx      * f    1.0000e+00e
540 * vol     * f    1.0000e+00e
541 * fa      * f    1.0000e+00e
542 * fric    * f    0.0000e+00e
543 * grav     * f   -1.0000e+00e
544 * hd      * f    1.0000e+00e
545 * nff      *      1          -1e
546 * alp     * f    5.0000e-01e
547 * vl      * f    0.0000e+00e
548 * vv      * f    0.0000e+00e
549 * tl      * f    4.5500e+02e
550 * tv      * f    4.5500e+02e
551 * p       * f    1.0000e+06e
552 * pa      * f    0.0000e+00e
553 *
554 *****   type          num          id          ctitle
555 break                26          26 pressure b.c. pipe 25 outlet
556 *          jun1        ibty      isat        ioff

```

```

557          32          0          0          0
558 *          dxin          volin          alpin          tin          pin
559          1.0000e+00          1.0000e+00          5.0000e-01          4.5500e+02          1.0000e+06
560 *          pain          concin          rbmx          poff          belv
561          0.0000e+00          0.0000e+00          0.0000e+00          0.0000e+00          2.3000e+01
562 *
563 end
564 *
565 *****
566 * time-step data *
567 *****
568 *
569 *          dtmin          dtmax          tend          rtwfp
570          1.0000e-03          1.0000e+00          1.0000e+01          1.0000e+00
571 *          edint          gfint          dmpint          sedint
572          1.0000e+01          1.0000e+00          1.1000e+01          1.0000e+01
573 *
574 *          dtmin          dtmax          tend          rtwfp
575          1.0000e-03          5.0000e+00          1.0000e+02          1.0000e+00
576 *          edint          gfint          dmpint          sedint
577          9.0000e+01          2.5000e+00          9.5000e+01          9.0000e+01
578 *
579 *          dtmin          dtmax          tend          rtwfp
580          1.0000e-02          3.0000e+01          1.0000e+03          1.0000e+00
581 *          edint          gfint          dmpint          sedint
582          9.0000e+02          1.5000e+01          9.3000e+02          9.0000e+02
583 *
584 *          dtmin          dtmax          tend          rtwfp
585          1.0000e-01          2.0000e+02          1.0000e+04          1.0000e+00
586 *          edint          gfint          dmpint          sedint
587          9.0000e+03          2.0000e+02          9.0000e+03          9.0000e+03
588 *
589 *          endflag
590          -1.0000e+00

```

A-4.5 MSPL Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              6              0              1              0              0
9 *--*--*TEST PROBLEM MSPL , Time = 10000.0 s
10      mirrored flow channel with single-phase liquid
11      six 3-cell vessels replaced by six 3-cell pipes
12      twelve 1-cell pipes replaced by four 1-cell pipes
13      two plenums replaced by two 1-cell pipes
14      two pressure boundary conditions, t1 = 300.0 k
15 *
16 *
17 *          nff          vl          fa
18 *          (-)          (m/s)          (m2)
19 *          # break# p = 1.0000e+06 pa
20 *          # 26 #
21 *          # 32 #
22 *          # 32 #
23 *          # pipe #
24 *          # 25 #
25 *          # 31 #
26 *          # 31 #
27 *          # 24 #
28 *          # 24 #
29 *          # 27 #
30 *          # 27 #
31 *          # pipe #
32 *          # 20 #
33 *          # 20 #
34 *          # 23 #
35 *          # 23 #
36 *          # cell #
37 *          # 1 #
38 *          # 18 #
39 *          # 18 #
40 *          # cell #
41 *          # 3 #
42 *          # 21 #
43 *          # 21 #
44 *          # pipe #
45 *          # 16 #
46 *          # 16 #
47 *          # 19 #
48 *          # 19 #
49 *          # cell #
50 *          # 1 #
51 *          # 15 #
52 *          # 15 #
53 *          # cell #
54 *          # 1 #
55 *          # 15 #
56 *          # 15 #
57 *          # cell #
58 *          # 1 #
59 *          # 15 #
60 *          # 15 #

```

```

61 *          # 3 #
62 *          #####
63 *          18          1  -10.0  1.0
64 *          #####
65 *          # pipe #
66 *          # 14 #
67 *          #####
68 *  -- mirror plane -- 17  -- mirror plane -- 1  10.0  1.0
69 *          #####
70 *          # pipe #
71 *          # 13 #
72 *          #####
73 *          16          1  10.0  1.0
74 *          #####
75 *          # cell #
76 *          # 3 #
77 *          #-----#          1  10.0  1.0
78 *          # pipe #
79 *          # 12 #
80 *          #-----#          1  10.0  1.0
81 *          # cell #
82 *          # 1 #
83 *          #####
84 *          14          -1  10.0  1.0
85 *          #####
86 *          # pipe #
87 *          # 10 #
88 *          #####
89 *          12          1  5.0  2.0
90 *          #####
91 *          # cell #
92 *          # 3 #
93 *          #-----#          1  5.0  2.0
94 *          # pipe #
95 *          # 8 #
96 *          #-----#          1  5.0  2.0
97 *          # cell #
98 *          # 1 #
99 *          #####
100 *          8          -1  5.0  2.0
101 *          #####
102 *          # pipe #
103 *          # 4 #
104 *          #####
105 *          4          1  2.5  4.0
106 *          #####
107 *          # pipe #
108 *          # 3 #
109 *          #####
110 *          3          -1  10.0  1.0
111 *          #####
112 *          # pipe #
113 *          # 2 #
114 *          #####
115 *          2          1  10.0  1.0
116 *          #####
117 *          # break# p = 1.4045e+06 pa
118 *          # 1 #
119 *          #####
120 *
121 * *****
122 * namelist data *

```



```

123 *****
124 *
125 &inopts
126 iadded=10, ikfac=1, cpuflg=1,
127 idiag=4, nsdl=0, nsdu=5, nspl=0, nspl=0, nspl=0, nspl=0
128 &end
129 *
130 *          dstep          timet
131          0          0.0000e+00
132 *          stdyst          transi          ncomp          njun          ipak
133          0          1          16          15          0
134 *          epso          epss
135          1.0000e-04          1.0000e-04
136 *          oitmax          sitmax          isolut          ncontr          nccfl
137          10          10          0          0          0
138 *          ntsv          ntcb          ntcf          ntrp          ntcp
139          1          0          0          0          0
140 *
141 *****
142 * component-number data *
143 *****
144 *
145 * iorder * 1 s * break          pressure b.c. for pipe 2 inlet
146 * iorder * 2 s * pipe          inlet pipe for pipe 3
147 * iorder * 3 s * pipe          pipe that replaces plenum 3
148 * iorder * 4 s * pipe          pipe that replaces pipes 4, 5, 6 & 7
149 * iorder * 8 s * pipe          pipe that replaces vessels 8 & 9
150 * iorder * 10 s * pipe          pipe that replaces pipes 10 & 11
151 * iorder * 12 s * pipe          pipe that replaces vessel 12
152 * iorder * 13 s * pipe          outlet pipe for pipe 12
153 * iorder * 14 s * pipe          inlet pipe for pipe 15
154 * iorder * 15 s * pipe          pipe that replaces vessel 15
155 * iorder * 16 s * pipe          pipe that replaces pipes 16 & 17
156 * iorder * 18 s * pipe          pipe that replaces vessels 18 & 19
157 * iorder * 20 s * pipe          pipe that replaces pipes 20, 21, 22 & 23
158 * iorder * 24 s * pipe          pipe that replaces plenum 24
159 * iorder * 25 s * pipe          outlet pipe for pipe 24
160 * iorder * 26 e * break          pressure b.c. for pipe 25 outlet
161 *
162 *****
163 * control parameters *
164 *****
165 *
166 * signal variable
167 *
168 *          idsv          isvn          icln          icn1          icn2
169          1          0          0          0          0
170 *
171 *****
172 * component data *
173 *****
174 *
175 *****          type          num          id          ctitle
176 break          1          1          1          pressure b.c. for pipe 2 inlet
177 *          jun1          ibty          isat          ioff
178          2          1          0          0
179 *          ibtr          ibsv          nbtr          nbtr          nbrf
180          0          1          2          0          0
181 *          dxin          volin          alpin          tin          pin
182          1.0000e+00          1.0000e+00          0.0000e+00          3.0000e+02          1.0000e+06
183 *          pain          concin          rbmx          poff          belv
184          0.0000e+00          0.0000e+00          4.0450e+05          0.0000e+00          0.0000e+00

```

```

185 *          pscl          tlscl          tvscl          pascl          conscl
186      1.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00
187 *
188 * ptb      *      0.0000e+00      1.0000e+06      1.0000e+00      1.4045e+06e
189 *
190 *****      type          num          id          ctitle
191 pipe          2          2 inlet pipe for pipe 3
192 *          ncells          nodes          jun1          jun2          epsw
193      1          0          2          3      1.0000e-05
194 *          ichf          iconc          iacc          ipow
195      0          0          0          0
196 *          radin          th          hout1          houtv          tout1
197      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
198 *          toutv
199      3.0000e+02
200 *
201 * dx      * f      1.0000e+00e
202 * vol      * f      1.0000e+00e
203 * fa      * f      1.0000e+00e
204 * fric      * f      0.0000e+00e
205 * grav      * f      1.0000e+00e
206 * hd      * f      1.0000e+00e
207 * nff      *      1          -1e
208 * alp      * f      0.0000e+00e
209 * vl      * f      0.0000e+00e
210 * vv      * f      0.0000e+00e
211 * tl      * f      3.0000e+02e
212 * tv      * f      3.0000e+02e
213 * p      * f      1.0000e+06e
214 * pa      * f      0.0000e+00e
215 *
216 *****      type          num          id          ctitle
217 pipe          3          3 pipe that replaces plenum 3
218 *          ncells          nodes          jun1          jun2          epsw
219      1          0          3          4      1.0000e-05
220 *          ichf          iconc          iacc          ipow
221      0          0          0          0
222 *          radin          th          hout1          houtv          tout1
223      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
224 *          toutv
225      3.0000e+02
226 *
227 * dx      * f      1.0000e+00e
228 * vol      * f      4.0000e+00e
229 * fa      *      1.0000e+00      4.0000e+00e
230 * fric      * f      0.0000e+00e
231 * grav      * f      1.0000e+00e
232 * hd      * f      1.0000e+00e
233 * nff      *      -1          1e
234 * alp      * f      0.0000e+00e
235 * vl      * f      0.0000e+00e
236 * vv      * f      0.0000e+00e
237 * tl      * f      3.0000e+02e
238 * tv      * f      3.0000e+02e
239 * p      * f      1.0000e+06e
240 * pa      * f      0.0000e+00e
241 *
242 *****      type          num          id          ctitle
243 pipe          4          4 pipe that replaces pipes 4, 5, 6 & 7
244 *          ncells          nodes          jun1          jun2          epsw
245      1          0          4          8      1.0000e-05
246 *          ichf          iconc          iacc          ipow

```

```

247          0          0          0          0
248 *      radin          th          houtl          houtv          toutl
249      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
250 *      toutv
251      3.0000e+02
252 *
253 * dx      *      1.0000e+00e
254 * vol      *      4.0000e+00e
255 * fa      *      4.0000e+00      2.0000e+00e
256 * fric      * f      0.0000e+00e
257 * grav      * f      1.0000e+00e
258 * hd      * f      1.0000e+00e
259 * nff      *      1          -1e
260 * alp      *      0.0000e+00e
261 * vl      * f      0.0000e+00e
262 * vv      * f      0.0000e+00e
263 * tl      *      3.0000e+02e
264 * tv      *      3.0000e+02e
265 * p      *      1.0000e+06e
266 * pa      *      0.0000e+00e
267 *
268 *****      type          num          id          ctitle
269 pipe          8          8 pipe that replaces vessels 8 & 9
270 *      ncells          nodes          jun1          jun2          epsw
271      3          0          8          12          1.0000e-05
272 *      ichf          iconc          iacc          ipow
273      0          0          0          0
274 *      radin          th          houtl          houtv          toutl
275      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
276 *      toutv
277      3.0000e+02
278 *
279 * dx      * f      1.0000e+00e
280 * vol      * f      2.0000e+00e
281 * fa      * f      2.0000e+00e
282 * fric      * f      0.0000e+00e
283 * grav      * f      1.0000e+00e
284 * hd      * f      1.0000e+00e
285 * nff      *      -1r03          1e
286 * alp      * f      0.0000e+00e
287 * vl      * f      0.0000e+00e
288 * vv      * f      0.0000e+00e
289 * tl      * f      3.0000e+02e
290 * tv      * f      3.0000e+02e
291 * p      * f      1.0000e+06e
292 * pa      * f      0.0000e+00e
293 *
294 *****      type          num          id          ctitle
295 pipe          10          10 pipe that replaces pipes 10 & 11
296 *      ncells          nodes          jun1          jun2          epsw
297      1          0          12          14          1.0000e-05
298 *      ichf          iconc          iacc          ipow
299      0          0          0          0
300 *      radin          th          houtl          houtv          toutl
301      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
302 *      toutv
303      3.0000e+02
304 *
305 * dx      *      1.0000e+00e
306 * vol      *      2.0000e+00e
307 * fa      *      2.0000e+00      1.0000e+00e
308 * fric      * f      0.0000e+00e

```

```

309 * grav * f 1.0000e+00e
310 * hd * f 1.0000e+00e
311 * nff * 1 -1e
312 * alp * 0.0000e+00e
313 * vl * f 0.0000e+00e
314 * vv * f 0.0000e+00e
315 * tl * 3.0000e+02e
316 * tv * 3.0000e+02e
317 * p * 1.0000e+06e
318 * pa * 0.0000e+00e
319 *
320 ***** type num id ctitle
321 pipe 12 12 pipe that replaces vessel 12
322 * ncells nodes jun1 jun2 epsw
323 3 0 14 16 1.0000e-05
324 * ichf iconc iacc ipow
325 0 0 0 0
326 * radin th houtl houtv toutl
327 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
328 * toutv
329 3.0000e+02
330 *
331 * dx * f 1.0000e+00e
332 * vol * f 1.0000e+00e
333 * fa * f 1.0000e+00e
334 * fric * f 0.0000e+00e
335 * grav * f 1.0000e+00e
336 * hd * f 1.0000e+00e
337 * nff * -1r03 1e
338 * alp * f 0.0000e+00e
339 * vl * f 0.0000e+00e
340 * vv * f 0.0000e+00e
341 * tl * f 3.0000e+02e
342 * tv * f 3.0000e+02e
343 * p * f 1.0000e+06e
344 * pa * f 0.0000e+00e
345 *
346 ***** type num id ctitle
347 pipe 13 13 outlet pipe for pipe 12
348 * ncells nodes jun1 jun2 epsw
349 1 0 16 17 1.0000e-05
350 * ichf iconc iacc ipow
351 0 0 0 0
352 * radin th houtl houtv toutl
353 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
354 * toutv
355 3.0000e+02
356 *
357 * dx * 1.0000e+00e
358 * vol * 1.0000e+00e
359 * fa * f 1.0000e+00e
360 * fric * f 0.0000e+00e
361 * grav * f 1.0000e+00e
362 * hd * f 1.0000e+00e
363 * nff * f 1e
364 * alp * 0.0000e+00e
365 * vl * f 0.0000e+00e
366 * vv * f 0.0000e+00e
367 * tl * 3.0000e+02e
368 * tv * 3.0000e+02e
369 * p * 1.0000e+06e
370 * pa * 0.0000e+00e

```

```

371 *
372 ***** type num id ctitle
373 pipe 14 14 inlet pipe for pipe 15
374 * ncells nodes jun1 jun2 epsw
375 1 0 18 17 1.0000e-05
376 * ichf iconc iacc ipow
377 0 0 0 0
378 * radin th hout1 houtv tout1
379 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
380 * toutv
381 3.0000e+02
382 *
383 * dx * 1.0000e+00e
384 * vol * 1.0000e+00e
385 * fa * f 1.0000e+00e
386 * fric * f 0.0000e+00e
387 * grav * f -1.0000e+00e
388 * hd * f 1.0000e+00e
389 * nff * f 1e
390 * alp * 0.0000e+00e
391 * vl * f 0.0000e+00e
392 * vv * f 0.0000e+00e
393 * tl * 3.0000e+02e
394 * tv * 3.0000e+02e
395 * p * 1.0000e+06e
396 * pa * 0.0000e+00e
397 *
398 ***** type num id ctitle
399 pipe 15 15 pipe that replaces vessel 15
400 * ncells nodes jun1 jun2 epsw
401 3 0 19 18 1.0000e-05
402 * ichf iconc iacc ipow
403 0 0 0 0
404 * radin th hout1 houtv tout1
405 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
406 * toutv
407 3.0000e+02
408 *
409 * dx * f 1.0000e+00e
410 * vol * f 1.0000e+00e
411 * fa * f 1.0000e+00e
412 * fric * f 0.0000e+00e
413 * grav * f -1.0000e+00e
414 * hd * f 1.0000e+00e
415 * nff * -1r03 1e
416 * alp * f 0.0000e+00e
417 * vl * f 0.0000e+00e
418 * vv * f 0.0000e+00e
419 * tl * f 3.0000e+02e
420 * tv * f 3.0000e+02e
421 * p * f 1.0000e+06e
422 * pa * f 0.0000e+00e
423 *
424 ***** type num id ctitle
425 pipe 16 16 pipe that replaces pipes 16 & 17
426 * ncells nodes jun1 jun2 epsw
427 1 0 21 19 1.0000e-05
428 * ichf iconc iacc ipow
429 0 0 0 0
430 * radin th hout1 houtv tout1
431 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
432 * toutv

```

```

433      3.0000e+02
434 *
435 * dx      *      1.0000e+00e
436 * vol     *      2.0000e+00e
437 * fa      *      2.0000e+00      1.0000e+00e
438 * fric    * f      0.0000e+00e
439 * grav    * f     -1.0000e+00e
440 * hd      * f      1.0000e+00e
441 * nff     *          1          -1e
442 * alp     *      0.0000e+00e
443 * vl      * f      0.0000e+00e
444 * vv      * f      0.0000e+00e
445 * tl      *      3.0000e+02e
446 * tv      *      3.0000e+02e
447 * p       *      1.0000e+06e
448 * pa      *      0.0000e+00e
449 *
450 *****      type          num          id          ctitle
451 pipe          18          18 pipe that replaces vessels 18 & 19
452 *          ncells      nodes      jun1      jun2      epsw
453          3          0          23          21      1.0000e-05
454 *          ichf      iconc      iacc      ipow
455          0          0          0          0
456 *          radin      th      hout1      houtv      tout1
457      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
458 *          toutv
459      3.0000e+02
460 *
461 * dx      * f      1.0000e+00e
462 * vol     * f      2.0000e+00e
463 * fa      * f      2.0000e+00e
464 * fric    * f      0.0000e+00e
465 * grav    * f     -1.0000e+00e
466 * hd      * f      1.0000e+00e
467 * nff     *          -1r03          1e
468 * alp     * f      0.0000e+00e
469 * vl      * f      0.0000e+00e
470 * vv      * f      0.0000e+00e
471 * tl      * f      3.0000e+02e
472 * tv      * f      3.0000e+02e
473 * p       * f      1.0000e+06e
474 * pa      * f      0.0000e+00e
475 *
476 *****      type          num          id          ctitle
477 pipe          20          20 pipe that replaces pipes 20,21,22&23
478 *          ncells      nodes      jun1      jun2      epsw
479          1          0          27          23      1.0000e-05
480 *          ichf      iconc      iacc      ipow
481          0          0          0          0
482 *          radin      th      hout1      houtv      tout1
483      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
484 *          toutv
485      3.0000e+02
486 *
487 * dx      *      1.0000e+00e
488 * vol     *      4.0000e+00e
489 * fa      *      4.0000e+00      2.0000e+00e
490 * fric    * f      0.0000e+00e
491 * grav    * f     -1.0000e+00e
492 * hd      * f      1.0000e+00e
493 * nff     *          1          -1e
494 * alp     *      0.0000e+00e

```

```

495 * vl      * f    0.0000e+00e
496 * vv      * f    0.0000e+00e
497 * tl      *      3.0000e+02e
498 * tv      *      3.0000e+02e
499 * p       *      1.0000e+06e
500 * pa      *      0.0000e+00e
501 *
502 *****   type          num          id          ctitle
503 pipe                24          24 pipe that replaces plenum 24
504 *          ncells      nodes      jun1      jun2      epsw
505 *          1            0          31          27      1.0000e-05
506 *          ichf        iconc      iacc          ipow
507 *          0            0          0            0
508 *          radin      th          hout1      houtv      tout1
509 *          5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  3.0000e+02
510 *          toutv
511 *          3.0000e+02
512 *
513 * dx      * f    1.0000e+00e
514 * vol     * f    4.0000e+00e
515 * fa      *      1.0000e+00      4.0000e+00e
516 * fric   * f    0.0000e+00e
517 * grav   * f   -1.0000e+00e
518 * hd      * f    1.0000e+00e
519 * nff     *      -1            1e
520 * alp     * f    0.0000e+00e
521 * vl      * f    0.0000e+00e
522 * vv      * f    0.0000e+00e
523 * tl      * f    3.0000e+02e
524 * tv      * f    3.0000e+02e
525 * p       * f    1.0000e+06e
526 * pa      * f    0.0000e+00e
527 *
528 *****   type          num          id          ctitle
529 pipe                25          25 outlet pipe for pipe 24
530 *          ncells      nodes      jun1      jun2      epsw
531 *          1            0          32          31      1.0000e-05
532 *          ichf        iconc      iacc          ipow
533 *          0            0          0            0
534 *          radin      th          hout1      houtv      tout1
535 *          5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  3.0000e+02
536 *          toutv
537 *          3.0000e+02
538 *
539 * dx      * f    1.0000e+00e
540 * vol     * f    1.0000e+00e
541 * fa      * f    1.0000e+00e
542 * fric   * f    0.0000e+00e
543 * grav   * f   -1.0000e+00e
544 * hd      * f    1.0000e+00e
545 * nff     *      1            -1e
546 * alp     * f    0.0000e+00e
547 * vl      * f    0.0000e+00e
548 * vv      * f    0.0000e+00e
549 * tl      * f    3.0000e+02e
550 * tv      * f    3.0000e+02e
551 * p       * f    1.0000e+06e
552 * pa      * f    0.0000e+00e
553 *
554 *****   type          num          id          ctitle
555 break                26          26 pressure b.c. pipe 25 outlet
556 *          jun1      ibty      isat          ioff

```

```

557          32          0          0          0
558 *          dxin          volin          alpin          tin          pin
559          1.0000e+00          1.0000e+00          0.0000e+00          3.0000e+02          1.0000e+06
560 *          pain          concin          rbmx          poff          belv
561          0.0000e+00          0.0000e+00          0.0000e+00          0.0000e+00          2.3000e+01
562 *
563 end
564 *
565 *****
566 * time-step data *
567 *****
568 *
569 *          dtmin          dtmax          tend          rtwfp
570          1.0000e-03          1.0000e+00          1.0000e+01          1.0000e+00
571 *          edint          gfint          dmpint          sedint
572          1.0000e+01          1.0000e+00          1.1000e+01          1.0000e+01
573 *
574 *          dtmin          dtmax          tend          rtwfp
575          1.0000e-03          5.0000e+00          1.0000e+02          1.0000e+00
576 *          edint          gfint          dmpint          sedint
577          9.0000e+01          2.5000e+00          9.5000e+01          9.0000e+01
578 *
579 *          dtmin          dtmax          tend          rtwfp
580          1.0000e-02          3.0000e+01          1.0000e+03          1.0000e+00
581 *          edint          gfint          dmpint          sedint
582          9.0000e+02          1.5000e+01          9.3000e+02          9.0000e+02
583 *
584 *          dtmin          dtmax          tend          rtwfp
585          1.0000e-01          2.0000e+02          1.0000e+04          1.0000e+00
586 *          edint          gfint          dmpint          sedint
587          9.0000e+03          2.0000e+02          9.0000e+03          9.0000e+03
588 *
589 *          endflag
590          -1.0000e+00

```


A-4.6 MSPV Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              6              0              1              0              0
9 *--**TEST PROBLEM MSPV , Time = 10000.0 s
10      mirrored flow channel with single-phase vapor
11      six 3-cell vessels replaced by six 3-cell pipes
12      twelve 1-cell pipes replaced by four 1-cell pipes
13      two plenums replaced by two 1-cell pipes
14      two pressure boundary conditions, tv = 500.0 k
15 *
16 *
17 *          nff          vv          fa
18 *          (-)          (m/s)          (m2)
19 *          # break#
20 *          # 26 # p = 1.0000e+06 pa
21 *          # 32 #
22 *          # 32 #
23 *          # pipe #
24 *          # 25 #
25 *          # 31 #
26 *          # 31 #
27 *          # 24 #
28 *          # 24 #
29 *          # 27 #
30 *          # 27 #
31 *          # 20 #
32 *          # 20 #
33 *          # 23 #
34 *          # 23 #
35 *          # 18 #
36 *          # 18 #
37 *          # 3 #
38 *          # 3 #
39 *          # 21 #
40 *          # 21 #
41 *          # 16 #
42 *          # 16 #
43 *          # 19 #
44 *          # 19 #
45 *          # 1 #
46 *          # 1 #
47 *          # 15 #
48 *          # 15 #
49 *          # 1 #
50 *          # 1 #
51 *          # 1 #
52 *          # 1 #
53 *          # 1 #
54 *          # 1 #
55 *          # 1 #
56 *          # 1 #
57 *          # 1 #
58 *          # 1 #
59 *          # 1 #
60 *          # 1 #

```

[illegible]

```

123 *****
124 *
125 &inopts
126   iadded=10, ikfac=1, cpuflg=1,
127   idiag=4, nsdl=0, nsdu=5, nspl=0, nspl=5
128 &end
129 *
130 *           dstep           timet
131           0           0.0000e+00
132 *           stdyst           transi           ncomp           njun           ipak
133           0           1           16           15           0
134 *           epso           epss
135           1.0000e-04           1.0000e-04
136 *           oitmax           sitmax           isolut           ncontr           nccfl
137           10           10           0           0           0
138 *           ntsv           ntcb           ntcf           ntrp           ntcp
139           1           0           0           0           0
140 *
141 *****
142 * component-number data *
143 *****
144 *
145 * iorder * 1 s * break           pressure b.c. for pipe 2 inlet
146 * iorder * 2 s * pipe           inlet pipe for pipe 3
147 * iorder * 3 s * pipe           pipe that replaces plenum 3
148 * iorder * 4 s * pipe           pipe that replaces pipes 4, 5, 6 & 7
149 * iorder * 8 s * pipe           pipe that replaces vessels 8 & 9
150 * iorder * 10 s * pipe          pipe that replaces pipes 10 & 11
151 * iorder * 12 s * pipe          pipe that replaces vessel 12
152 * iorder * 13 s * pipe          outlet pipe for pipe 12
153 * iorder * 14 s * pipe          inlet pipe for pipe 15
154 * iorder * 15 s * pipe          pipe that replaces vessel 15
155 * iorder * 16 s * pipe          pipe that replaces pipes 16 & 17
156 * iorder * 18 s * pipe          pipe that replaces vessels 18 & 19
157 * iorder * 20 s * pipe          pipe that replaces pipes 20, 21, 22 & 23
158 * iorder * 24 s * pipe          pipe that replaces plenum 24
159 * iorder * 25 s * pipe          outlet pipe for pipe 24
160 * iorder * 26 e * break          pressure b.c. for pipe 25 outlet
161 *
162 *****
163 * control parameters *
164 *****
165 *
166 * signal variable
167 *
168 *           idsv           isvn           icln           icn1           icn2
169           1           0           0           0           0
170 *
171 *****
172 * component data *
173 *****
174 *
175 * type           num           id           ctitle
176 break           1           1           pressure b.c. for pipe 2 inlet
177 *           jun1           ibty           isat           ioff
178           2           1           0           0
179 *           ibtr           ibsv           nbtb           nbsv           nbrf
180           0           1           2           0           0
181 *           dxin           volin           alpin           tin           pin
182           1.0000e+00           1.0000e+00           1.0000e+00           5.0000e+02           1.0000e+06
183 *           pain           concin           rbmx           poff           belv
184           0.0000e+00           0.0000e+00           1.7585e+03           0.0000e+00           0.0000e+00

```

```

185 *          pscl          tlscl          tvscl          pascl          conscl
186      1.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00
187 *
188 * ptb      *      0.0000e+00      1.0000e+06      1.0000e+00      1001758.50e
189 *
190 *****      type          num          id          ctitle
191 pipe          2          2 inlet pipe for pipe 3
192 *          ncells          nodes          jun1          jun2          epsw
193      1          0          2          3      1.0000e-05
194 *          ichf          iconc          iacc          ipow
195      0          0          0          0
196 *          radin          th          hout1          houtv          tout1
197      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
198 *          toutv
199      5.0000e+02
200 *
201 * dx      * f      1.0000e+00e
202 * vol      * f      1.0000e+00e
203 * fa      * f      1.0000e+00e
204 * fric      * f      0.0000e+00e
205 * grav      * f      1.0000e+00e
206 * hd      * f      1.0000e+00e
207 * nff      *      1          -1e
208 * alp      * f      1.0000e+00e
209 * vl      * f      0.0000e+00e
210 * vv      * f      0.0000e+00e
211 * tl      * f      5.0000e+02e
212 * tv      * f      5.0000e+02e
213 * p      * f      1.0000e+06e
214 * pa      * f      0.0000e+00e
215 *
216 *****      type          num          id          ctitle
217 pipe          3          3 pipe that replaces plenum 3
218 *          ncells          nodes          jun1          jun2          epsw
219      1          0          3          4      1.0000e-05
220 *          ichf          iconc          iacc          ipow
221      0          0          0          0
222 *          radin          th          hout1          houtv          tout1
223      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
224 *          toutv
225      5.0000e+02
226 *
227 * dx      * f      1.0000e+00e
228 * vol      * f      4.0000e+00e
229 * fa      *      1.0000e+00      4.0000e+00e
230 * fric      * f      0.0000e+00e
231 * grav      * f      1.0000e+00e
232 * hd      * f      1.0000e+00e
233 * nff      *      -1          1e
234 * alp      * f      1.0000e+00e
235 * vl      * f      0.0000e+00e
236 * vv      * f      0.0000e+00e
237 * tl      * f      5.0000e+02e
238 * tv      * f      5.0000e+02e
239 * p      * f      1.0000e+06e
240 * pa      * f      0.0000e+00e
241 *
242 *****      type          num          id          ctitle
243 pipe          4          4 pipe that replaces pipes 4, 5, 6 & 7
244 *          ncells          nodes          jun1          jun2          epsw
245      1          0          4          8      1.0000e-05
246 *          ichf          iconc          iacc          ipow

```

```

247      0      0      0      0
248 *      radin      th      hout1      houtv      tout1
249      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
250 *      toutv
251      5.0000e+02
252 *
253 * dx      *      1.0000e+00e
254 * vol      *      4.0000e+00e
255 * fa      *      4.0000e+00      2.0000e+00e
256 * fric      * f      0.0000e+00e
257 * grav      * f      1.0000e+00e
258 * hd      * f      1.0000e+00e
259 * nff      *      1      -1e
260 * alp      *      1.0000e+00e
261 * vl      * f      0.0000e+00e
262 * vv      * f      0.0000e+00e
263 * tl      *      5.0000e+02e
264 * tv      *      5.0000e+02e
265 * p      *      1.0000e+06e
266 * pa      *      0.0000e+00e
267 *
268 *****      type      num      id      ctitle
269 pipe      8      8 pipe that replaces vessels 8 & 9
270 *      ncells      nodes      jun1      jun2      epsw
271      3      0      8      12      1.0000e-05
272 *      ichf      iconc      iacc      ipow
273      0      0      0      0
274 *      radin      th      hout1      houtv      tout1
275      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
276 *      toutv
277      5.0000e+02
278 *
279 * dx      * f      1.0000e+00e
280 * vol      * f      2.0000e+00e
281 * fa      * f      2.0000e+00e
282 * fric      * f      0.0000e+00e
283 * grav      * f      1.0000e+00e
284 * hd      * f      1.0000e+00e
285 * nff      *      -1r03      1e
286 * alp      * f      1.0000e+00e
287 * vl      * f      0.0000e+00e
288 * vv      * f      0.0000e+00e
289 * tl      * f      5.0000e+02e
290 * tv      * f      5.0000e+02e
291 * p      * f      1.0000e+06e
292 * pa      * f      0.0000e+00e
293 *
294 *****      type      num      id      ctitle
295 pipe      10      10 pipe that replaces pipes 10 & 11
296 *      ncells      nodes      jun1      jun2      epsw
297      1      0      12      14      1.0000e-05
298 *      ichf      iconc      iacc      ipow
299      0      0      0      0
300 *      radin      th      hout1      houtv      tout1
301      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
302 *      toutv
303      5.0000e+02
304 *
305 * dx      *      1.0000e+00e
306 * vol      *      2.0000e+00e
307 * fa      *      2.0000e+00      1.0000e+00e
308 * fric      * f      0.0000e+00e

```

```

309 * grav * f 1.0000e+00e
310 * hd * f 1.0000e+00e
311 * nff * 1 -1e
312 * alp * 1.0000e+00e
313 * vl * f 0.0000e+00e
314 * vv * f 0.0000e+00e
315 * tl * 5.0000e+02e
316 * tv * 5.0000e+02e
317 * p * 1.0000e+06e
318 * pa * 0.0000e+00e
319 *
320 ***** type num id ctitle
321 pipe 12 12 pipe that replaces vessel 12
322 * ncells nodes jun1 jun2 epsw
323 3 0 14 16 1.0000e-05
324 * ichf iconc iacc ipow
325 0 0 0 0
326 * radin th houtl houtv toutl
327 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
328 * toutv
329 5.0000e+02
330 *
331 * dx * f 1.0000e+00e
332 * vol * f 1.0000e+00e
333 * fa * f 1.0000e+00e
334 * fric * f 0.0000e+00e
335 * grav * f 1.0000e+00e
336 * hd * f 1.0000e+00e
337 * nff * -1r03 1e
338 * alp * f 1.0000e+00e
339 * vl * f 0.0000e+00e
340 * vv * f 0.0000e+00e
341 * tl * f 5.0000e+02e
342 * tv * f 5.0000e+02e
343 * p * f 1.0000e+06e
344 * pa * f 0.0000e+00e
345 *
346 ***** type num id ctitle
347 pipe 13 13 outlet pipe for pipe 12
348 * ncells nodes jun1 jun2 epsw
349 1 0 16 17 1.0000e-05
350 * ichf iconc iacc ipow
351 0 0 0 0
352 * radin th houtl houtv toutl
353 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
354 * toutv
355 5.0000e+02
356 *
357 * dx * 1.0000e+00e
358 * vol * 1.0000e+00e
359 * fa * f 1.0000e+00e
360 * fric * f 0.0000e+00e
361 * grav * f 1.0000e+00e
362 * hd * f 1.0000e+00e
363 * nff * f 1e
364 * alp * 1.0000e+00e
365 * vl * f 0.0000e+00e
366 * vv * f 0.0000e+00e
367 * tl * 5.0000e+02e
368 * tv * 5.0000e+02e
369 * p * 1.0000e+06e
370 * pa * 0.0000e+00e

```

```

371 *
372 ***** type num id ctitle
373 pipe 14 14 inlet pipe for pipe 15
374 * ncells nodes jun1 jun2 epsw
375 * 1 0 18 17 1.0000e-05
376 * ichf iconc iacc ipow
377 * 0 0 0 0
378 * radin th houtl houtv toutl
379 * 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
380 * toutv
381 * 5.0000e+02
382 *
383 * dx * 1.0000e+00e
384 * vol * 1.0000e+00e
385 * fa * f 1.0000e+00e
386 * fric * f 0.0000e+00e
387 * grav * f -1.0000e+00e
388 * hd * f 1.0000e+00e
389 * nff * f 1e
390 * alp * 1.0000e+00e
391 * vl * f 0.0000e+00e
392 * vv * f 0.0000e+00e
393 * tl * 5.0000e+02e
394 * tv * 5.0000e+02e
395 * p * 1.0000e+06e
396 * pa * 0.0000e+00e
397 *
398 ***** type num id ctitle
399 pipe 15 15 pipe that replaces vessel 15
400 * ncells nodes jun1 jun2 epsw
401 * 3 0 19 18 1.0000e-05
402 * ichf iconc iacc ipow
403 * 0 0 0 0
404 * radin th houtl houtv toutl
405 * 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
406 * toutv
407 * 5.0000e+02
408 *
409 * dx * f 1.0000e+00e
410 * vol * f 1.0000e+00e
411 * fa * f 1.0000e+00e
412 * fric * f 0.0000e+00e
413 * grav * f -1.0000e+00e
414 * hd * f 1.0000e+00e
415 * nff * -1r03 1e
416 * alp * f 1.0000e+00e
417 * vl * f 0.0000e+00e
418 * vv * f 0.0000e+00e
419 * tl * f 5.0000e+02e
420 * tv * f 5.0000e+02e
421 * p * f 1.0000e+06e
422 * pa * f 0.0000e+00e
423 *
424 ***** type num id ctitle
425 pipe 16 16 pipe that replaces pipes 16 & 17
426 * ncells nodes jun1 jun2 epsw
427 * 1 0 21 19 1.0000e-05
428 * ichf iconc iacc ipow
429 * 0 0 0 0
430 * radin th houtl houtv toutl
431 * 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
432 * toutv

```

```

433      5.0000e+02
434 *
435 * dx      *      1.0000e+00e
436 * vol     *      2.0000e+00e
437 * fa      *      2.0000e+00      1.0000e+00e
438 * fric    * f      0.0000e+00e
439 * grav     * f     -1.0000e+00e
440 * hd       * f      1.0000e+00e
441 * nff      *          1          -1e
442 * alp      *      1.0000e+00e
443 * vl       * f      0.0000e+00e
444 * vv       * f      0.0000e+00e
445 * tl       *      5.0000e+02e
446 * tv       *      5.0000e+02e
447 * p        *      1.0000e+06e
448 * pa       *      0.0000e+00e
449 *
450 *****      type          num          id          ctitle
451 pipe          18          18 pipe that replaces vessels 18 & 19
452 *          ncells      nodes      jun1      jun2      epsw
453          3          0          23          21      1.0000e-05
454 *          ichf      iconc      iacc      ipow
455          0          0          0          0
456 *          radin      th      hout1      houtv      tout1
457      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
458 *          toutv
459      5.0000e+02
460 *
461 * dx      * f      1.0000e+00e
462 * vol     * f      2.0000e+00e
463 * fa      * f      2.0000e+00e
464 * fric    * f      0.0000e+00e
465 * grav     * f     -1.0000e+00e
466 * hd       * f      1.0000e+00e
467 * nff      *          -1r03          1e
468 * alp      * f      1.0000e+00e
469 * vl       * f      0.0000e+00e
470 * vv       * f      0.0000e+00e
471 * tl       * f      5.0000e+02e
472 * tv       * f      5.0000e+02e
473 * p        * f      1.0000e+06e
474 * pa       * f      0.0000e+00e
475 *
476 *****      type          num          id          ctitle
477 pipe          20          20 pipe that replaces pipes 20,21,22&23
478 *          ncells      nodes      jun1      jun2      epsw
479          1          0          27          23      1.0000e-05
480 *          ichf      iconc      iacc      ipow
481          0          0          0          0
482 *          radin      th      hout1      houtv      tout1
483      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
484 *          toutv
485      5.0000e+02
486 *
487 * dx      *      1.0000e+00e
488 * vol     *      4.0000e+00e
489 * fa      *      4.0000e+00      2.0000e+00e
490 * fric    * f      0.0000e+00e
491 * grav     * f     -1.0000e+00e
492 * hd       * f      1.0000e+00e
493 * nff      *          1          -1e
494 * alp      *      1.0000e+00e

```



```

495 * vl      * f    0.0000e+00e
496 * vv      * f    0.0000e+00e
497 * tl      *      5.0000e+02e
498 * tv      *      5.0000e+02e
499 * p       *      1.0000e+06e
500 * pa      *      0.0000e+00e
501 *
502 *****   type          num          id          ctitle
503 pipe                24          24 pipe that replaces plenum 24
504 *      ncells        nodes        jun1          jun2          epsw
505 *          1          0          31          27          1.0000e-05
506 *      ichf          iconc          iacc          ipow
507 *          0          0          0          0
508 *      radin          th          houtl          houtv          toutl
509 *      5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    5.0000e+02
510 *      toutv
511 *      5.0000e+02
512 *
513 * dx      * f    1.0000e+00e
514 * vol     * f    4.0000e+00e
515 * fa      *      1.0000e+00    4.0000e+00e
516 * fric    * f    0.0000e+00e
517 * grav    * f   -1.0000e+00e
518 * hd      * f    1.0000e+00e
519 * nff     *      -1          1e
520 * alp     * f    1.0000e+00e
521 * vl      * f    0.0000e+00e
522 * vv      * f    0.0000e+00e
523 * tl      * f    5.0000e+02e
524 * tv      * f    5.0000e+02e
525 * p       * f    1.0000e+06e
526 * pa      * f    0.0000e+00e
527 *
528 *****   type          num          id          ctitle
529 pipe                25          25 outlet pipe for pipe 24
530 *      ncells        nodes        jun1          jun2          epsw
531 *          1          0          32          31          1.0000e-05
532 *      ichf          iconc          iacc          ipow
533 *          0          0          0          0
534 *      radin          th          houtl          houtv          toutl
535 *      5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    5.0000e+02
536 *      toutv
537 *      5.0000e+02
538 *
539 * dx      * f    1.0000e+00e
540 * vol     * f    1.0000e+00e
541 * fa      * f    1.0000e+00e
542 * fric    * f    0.0000e+00e
543 * grav    * f   -1.0000e+00e
544 * hd      * f    1.0000e+00e
545 * nff     *          1          -1e
546 * alp     * f    1.0000e+00e
547 * vl      * f    0.0000e+00e
548 * vv      * f    0.0000e+00e
549 * tl      * f    5.0000e+02e
550 * tv      * f    5.0000e+02e
551 * p       * f    1.0000e+06e
552 * pa      * f    0.0000e+00e
553 *
554 *****   type          num          id          ctitle
555 break                26          26 pressure b.c. pipe 25 outlet
556 *      jun1          ibty          isat          ioff

```

```

557          32          0          0          0
558 *          dxin          volin          alpin          tin          pin
559          1.0000e+00          1.0000e+00          1.0000e+00          5.0000e+02          1.0000e+06
560 *          pain          concin          rbmx          poff          belv
561          0.0000e+00          0.0000e+00          0.0000e+00          0.0000e+00          2.3000e+01
562 *
563 end
564 *
565 *****
566 * time-step data *
567 *****
568 *
569 *          dtmin          dtmax          tend          rtwfp
570          1.0000e-03          1.0000e+00          1.0000e+01          1.0000e+00
571 *          edint          gfint          dmpint          sedint
572          1.0000e+01          1.0000e+00          1.1000e+01          1.0000e+01
573 *
574 *          dtmin          dtmax          tend          rtwfp
575          1.0000e-03          5.0000e+00          1.0000e+02          1.0000e+00
576 *          edint          gfint          dmpint          sedint
577          9.0000e+01          2.5000e+00          9.5000e+01          9.0000e+01
578 *
579 *          dtmin          dtmax          tend          rtwfp
580          1.0000e-02          3.0000e+01          1.0000e+03          1.0000e+00
581 *          edint          gfint          dmpint          sedint
582          9.0000e+02          1.5000e+01          9.3000e+02          9.0000e+02
583 *
584 *          dtmin          dtmax          tend          rtwfp
585          1.0000e-01          2.0000e+02          1.0000e+04          1.0000e+00
586 *          edint          gfint          dmpint          sedint
587          9.0000e+03          2.0000e+02          9.0000e+03          9.0000e+03
588 *
589 *          endflag
590          -1.0000e+00

```

A-4.7 MSR2 Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              4              0              1              0              0
9 *--*TEST PROBLEM MSR2 , Time = 10000.0 s
10 mirrored parallel-flow channel with two-phase fluid
11 vessels 8 and 18 have their cell numbering reversed
12 two pressure boundary conditions, t1 = tsat = tv = 455.0 k
13 *
14 *
15 *                                     nff    vl    vv    fa
16 *                                     (-) (m/s) (m/s) (m2)
17 *          #####
18 *          # break#
19 *          # 26 #   p = 1.0000e+06 pa
20 *          #####
21 *          32
22 *          #####
23 *          # pipe #
24 *          # 25 #
25 *          #####
26 *          31
27 *          #####
28 *          # plenum #
29 *          # 24 #
30 *          #####
31 *          27      28      29      30      1  -1.2  -1.4  1.0x4
32 *          #####
33 *          # pipe # # pipe # # pipe # # pipe #
34 *          # 20 # # 21 # # 22 # # 23 #
35 *          #####
36 *          23      24      25      26      -1  -2.4  -2.6  0.5x4
37 *          #####
38 *          # cell # # cell #
39 *          # 3 # # 1 #
40 *          #-----# #-----#
41 *          #vessel# #vessel#
42 *          # 18 # # 19 #
43 *          #-----# #-----#
44 *          # cell # # cell #
45 *          # 1 # # 3 #
46 *          #####
47 *          21      22      1  -2.7  -2.8  1.0x2
48 *          #####
49 *          # pipe # # pipe #
50 *          # 16 # # 17 #
51 *          #####
52 *          19      20      -1  -5.7  -5.9  0.5x2
53 *          #####
54 *          # cell #
55 *          # 1 #
56 *          #-----#
57 *          #vessel#
58 *          # 15 #
59 *          #-----#
60 *          # cell #
61 *          # 3 #
62 *          #####

```

```

61 *          18          1 -6.8 -7.0 1.0
62 *          #####
63 *          # pipe #
64 *          # 14 #
65 *          #####
66 * -- mirror plane -- 17 -- mirror plane -- 1 7.1 7.3 1.0
67 *          #####
68 *          # pipe #
69 *          # 13 #
70 *          #####
71 *          16          1 7.4 7.5 1.0
72 *          #####
73 *          # cell #
74 *          # 3 #
75 *          #-----#
76 *          #vessel#
77 *          # 12 #
78 *          #-----#
79 *          # cell #
80 *          # 1 #
81 *          #####
82 *          14 15      -1 8.2 8.1 0.5x2
83 *          #####
84 *          # pipe # # pipe #
85 *          # 10 # # 11 #
86 *          #####
87 *          12 13      1 4.0 4.2 1.0x2
88 *          #####
89 *          # cell # # cell #
90 *          # 1 # # 3 #
91 *          #-----#
92 *          #vessel# #vessel#
93 *          # 8 # # 9 #
94 *          #-----#
95 *          # cell # # cell #
96 *          # 3 # # 1 #
97 *          #####
98 *          8 9 10 11  -1 4.3 4.4 0.5x4
99 *          #####
100 *          # pipe # # pipe # # pipe # # pipe #
101 *          # 4 # # 5 # # 6 # # 7 #
102 *          #####
103 *          4 5 6 7      1 2.1 2.3 1.0x4
104 *          #####
105 *          # plenum #
106 *          # 3 #
107 *          #####
108 *          3      -1 8.8 9.1 1.0
109 *          #####
110 *          # pipe #
111 *          # 2 #
112 *          #####
113 *          2      1 9.8 10.0 1.0
114 *          #####
115 *          # break# p = 1.1384e+06 pa
116 *          # 1 #
117 *          #####
118 *
119 * *****
120 * namelist data *
121 * *****
122 *

```

```

123 &inopts
124 iadded=10, ikfac=1, nifsh=1, ccif=1.0e+05, cpuflg=1,
125 idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5, nvgrav=1
126 &end
127 *
128 *          dstep          timet
129          0          0.0000e+00
130 *          stdyst          transi          ncomp          njun          ipak
131          0          1          26          31          0
132 *          epso          epss
133          1.0000e-04          1.0000e-04
134 *          oitmax          sitmax          isolut          ncontr          nccfl
135          10          10          0          0          0
136 *          ntsv          ntcb          ntcf          ntrp          ntcp
137          1          0          0          0          0
138 *
139 *****
140 * component-number data *
141 *****
142 *
143 * iorder * 1 s * break          pressure b.c. for pipe 2 inlet
144 * iorder * 2 s * pipe          inlet pipe for plenum 3
145 * iorder * 3 s * plenum        manifold for parallel-channel pipes
146 * iorder * 4 s * pipe          1st inlet pipe for vessel 8
147 * iorder * 5 s * pipe          2nd inlet pipe for vessel 8
148 * iorder * 6 s * pipe          1st inlet pipe for vessel 9
149 * iorder * 7 s * pipe          2nd inlet pipe for vessel 9
150 * iorder * 8 s * vessel        first vessel component
151 * iorder * 9 s * vessel        second vessel component
152 * iorder * 10 s * pipe         outlet pipe for vessel 8
153 * iorder * 11 s * pipe         outlet pipe for vessel 9
154 * iorder * 12 s * vessel        third vessel component
155 * iorder * 13 s * pipe         outlet pipe for vessel 12
156 * iorder * 14 s * pipe         inlet pipe for vessel 15
157 * iorder * 15 s * vessel        fourth vessel component
158 * iorder * 16 s * pipe         inlet pipe for vessel 18
159 * iorder * 17 s * pipe         inlet pipe for vessel 19
160 * iorder * 18 s * vessel        fifth vessel component
161 * iorder * 19 s * vessel        sixth vessel component
162 * iorder * 20 s * pipe         1st outlet pipe for vessel 18
163 * iorder * 21 s * pipe         2nd outlet pipe for vessel 18
164 * iorder * 22 s * pipe         1st outlet pipe for vessel 19
165 * iorder * 23 s * pipe         2nd outlet pipe for vessel 19
166 * iorder * 24 s * plenum        manifold for parallel-channel pipes
167 * iorder * 25 s * pipe         outlet pipe for plenum 24
168 * iorder * 26 e * break        pressure b.c. for pipe 25 outlet
169 *
170 *****
171 * control parameters *
172 *****
173 *
174 * signal variable
175 *
176 *          idsv          isvn          icln          icn1          icn2
177          1          0          0          0          0
178 *
179 *****
180 * component data *
181 *****
182 *
183 *****          type          num          id          ctitle
184 break          1          1          pressure b.c. for pipe 2 inlet

```

```

185 *      jun1      ibty      isat      ioff
186      2          1          0          0
187 *      ibtr      ibsv      nbtr      nbv      nbrf
188      0          1          2          0          0
189 *      dxin      volin      alpin      tin      pin
190      1.0000e+00    1.0000e+00    5.0000e-01    4.5500e+02    1.0000e+06
191 *      pain      concin      rbmx      poff      belv
192      0.0000e+00    0.0000e+00    1.3840e+05    0.0000e+00    0.0000e+00
193 *      pscl      tlsc1      tvsc1      pascl      conscl
194      1.0000e+00    0.0000e+00    0.0000e+00    0.0000e+00    0.0000e+00
195 *
196 * ptb *      0.0000e+00    1.0000e+06    1.0000e+00    1.1384e+06e
197 *
198 * type      num      id      ctitle
199 pipe      2      2      inlet pipe for plenum 3
200 *      ncells      nodes      jun1      jun2      epsw
201      1          0          2          3      1.0000e-05
202 *      ichf      iconc      iacc      ipow
203      0          0          0          0
204 *      radin      th      hout1      houtv      tout1
205      5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    4.5500e+02
206 *      toutv
207      4.5500e+02
208 *
209 * dx * f      1.0000e+00e
210 * vol * f      1.0000e+00e
211 * fa * f      1.0000e+00e
212 * fric * f      0.0000e+00e
213 * grav * f      1.0000e+00e
214 * hd * f      1.0000e+00e
215 * nff *      1      -1e
216 * alp * f      5.0000e-01e
217 * vl * f      0.0000e+00e
218 * vv * f      0.0000e+00e
219 * tl * f      4.5500e+02e
220 * tv * f      4.5500e+02e
221 * p * f      1.0000e+06e
222 * pa * f      0.0000e+00e
223 *
224 * type      num      id      ctitle
225 plenum      3      3      manifold plenum 3
226 *      npljn      iconc      juns1      juns2
227      5          0          1          4
228 *
229 * junj *      3s
230 * junj *      4      5      6      7e
231 * dx * f      1.0000e+00e
232 * vol * f      4.0000e+00e
233 * elev * f      2.0000e+00e
234 * alp * f      5.0000e-01e
235 * tl * f      4.5500e+02e
236 * tv * f      4.5500e+02e
237 * p * f      1.0000e+06e
238 * pa * f      0.0000e+00e
239 *
240 * type      num      id      ctitle
241 pipe      4      4      1st inlet pipe for vessel 8
242 *      ncells      nodes      jun1      jun2      epsw
243      1          0          4          8      1.0000e-05
244 *      ichf      iconc      iacc      ipow
245      0          0          0          0
246 *      radin      th      hout1      houtv      tout1

```

```

247      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
248 *      toutv
249      4.5500e+02
250 *
251 * dx      * f      1.0000e+00e
252 * vol      * f      1.0000e+00e
253 * fa      *      1.0000e+00      5.0000e-01e
254 * fric      * f      0.0000e+00e
255 * grav      * f      1.0000e+00e
256 * hd      * f      1.0000e+00e
257 * nff      *      1      -1e
258 * alp      * f      5.0000e-01e
259 * vl      * f      0.0000e+00e
260 * vv      * f      0.0000e+00e
261 * tl      * f      4.5500e+02e
262 * tv      * f      4.5500e+02e
263 * p      * f      1.0000e+06e
264 * pa      * f      0.0000e+00e
265 *
266 *****      type      num      id      ctitle
267 pipe      5      5 2nd inlet pipe for vessel 8
268 *      ncells      nodes      jun1      jun2      epsw
269      1      0      5      9      1.0000e-05
270 *      ichf      iconc      iacc      ipow
271      0      0      0      0
272 *      radin      th      hout1      houtv      tout1
273      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
274 *      toutv
275      4.5500e+02
276 *
277 * dx      * f      1.0000e+00e
278 * vol      * f      1.0000e+00e
279 * fa      *      1.0000e+00      5.0000e-01e
280 * fric      * f      0.0000e+00e
281 * grav      * f      1.0000e+00e
282 * hd      * f      1.0000e+00e
283 * nff      *      1      -1e
284 * alp      * f      5.0000e-01e
285 * vl      * f      0.0000e+00e
286 * vv      * f      0.0000e+00e
287 * tl      * f      4.5500e+02e
288 * tv      * f      4.5500e+02e
289 * p      * f      1.0000e+06e
290 * pa      * f      0.0000e+00e
291 *
292 *****      type      num      id      ctitle
293 pipe      6      6 1st inlet pipe for vessel 9
294 *      ncells      nodes      jun1      jun2      epsw
295      1      0      6      10      1.0000e-05
296 *      ichf      iconc      iacc      ipow
297      0      0      0      0
298 *      radin      th      hout1      houtv      tout1
299      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
300 *      toutv
301      4.5500e+02
302 *
303 * dx      * f      1.0000e+00e
304 * vol      * f      1.0000e+00e
305 * fa      *      1.0000e+00      5.0000e-01e
306 * fric      * f      0.0000e+00e
307 * grav      * f      1.0000e+00e
308 * hd      * f      1.0000e+00e

```

```

309 * nff      *      1      -1e
310 * alp      * f    5.0000e-01e
311 * vl       * f    0.0000e+00e
312 * vv       * f    0.0000e+00e
313 * tl       * f    4.5500e+02e
314 * tv       * f    4.5500e+02e
315 * p        * f    1.0000e+06e
316 * pa       * f    0.0000e+00e
317 *
318 *****      type          num          id          ctitle
319 pipe                7          7 2nd inlet pipe for vessel 9
320 *      ncells      nodes      jun1      jun2      epsw
321      1              0          7          11      1.0000e-05
322 *      ichf        iconc      iacc      ipow
323      0              0          0          0
324 *      radin      th          hout1      houtv      tout1
325      5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    4.5500e+02
326 *      toutv
327      4.5500e+02
328 *
329 * dx      * f    1.0000e+00e
330 * vol     * f    1.0000e+00e
331 * fa      *      1.0000e+00    5.0000e-01e
332 * fric    * f    0.0000e+00e
333 * grav    * f    1.0000e+00e
334 * hd      * f    1.0000e+00e
335 * nff     *      1      -1e
336 * alp     * f    5.0000e-01e
337 * vl      * f    0.0000e+00e
338 * vv      * f    0.0000e+00e
339 * tl      * f    4.5500e+02e
340 * tv      * f    4.5500e+02e
341 * p       * f    1.0000e+06e
342 * pa      * f    0.0000e+00e
343 *
344 *****      type          num          id          ctitle
345 vessel                8          8 first vessel component
346 *      nasx      nrsv      ntsx      ncsr      ivssbf
347      3              1          1          3          0
348 *      idcu      idcl      idcr      icru      icrl
349      0              0          0          0          0
350 *      icrr      ilcsp      iucsp      iuhp      iconc
351      0              0          0          0          0
352 *      igeom      nvent      nvvtb
353      1              0          0
354 *      shelv      epsw
355      6.5000e+00    1.0000e-05
356 *
357 * z      *      1.0000e+00    2.0000e+00    3.0000e+00e
358 * rad    *      1.0000e+00e
359 * th     *      1.0000e+00e
360 *
361 *      gc      gytc      gxrc      gzc
362      9.8066e+00    0.0000e+00    0.0000e+00    1.0000e+00
363 *
364 *      lisrl      lisrc      lisrf      ljuns
365      3              1          2          8
366      3              1          2          9
367      1              1          -2         12
368 *
369 * level  1
370 *

```



```

371 * cfzl-t*      0.0000e+00e
372 * cfzl-z*      0.0000e+00e
373 * cfzl-r*      0.0000e+00e
374 * cfzv-t*      0.0000e+00e
375 * cfzv-z*      0.0000e+00e
376 * cfzv-r*      0.0000e+00e
377 * vol      *      1.0000e+00e
378 * fa-t      *      0.0000e+00e
379 * fa-z      *      1.0000e+00e
380 * fa-r      *      0.0000e+00e
381 * hd-t      *      0.0000e+00e
382 * hd-z      *      1.0000e+00e
383 * hd-r      *      0.0000e+00e
384 * alpn      *      5.0000e-01e
385 * vvn-t      *      0.0000e+00e
386 * vvn-z      *      0.0000e+00e
387 * vvn-r      *      0.0000e+00e
388 * vln-t      *      0.0000e+00e
389 * vln-z      *      0.0000e+00e
390 * vln-r      *      0.0000e+00e
391 * tvn      *      4.5500e+02e
392 * tln      *      4.5500e+02e
393 * pn      *      1.0000e+06e
394 * pan      *      0.0000e+00e
395 *
396 * level      2
397 *
398 * cfzl-t*      0.0000e+00e
399 * cfzl-z*      0.0000e+00e
400 * cfzl-r*      0.0000e+00e
401 * cfzv-t*      0.0000e+00e
402 * cfzv-z*      0.0000e+00e
403 * cfzv-r*      0.0000e+00e
404 * vol      *      1.0000e+00e
405 * fa-t      *      0.0000e+00e
406 * fa-z      *      1.0000e+00e
407 * fa-r      *      0.0000e+00e
408 * hd-t      *      0.0000e+00e
409 * hd-z      *      1.0000e+00e
410 * hd-r      *      0.0000e+00e
411 * alpn      *      5.0000e-01e
412 * vvn-t      *      0.0000e+00e
413 * vvn-z      *      0.0000e+00e
414 * vvn-r      *      0.0000e+00e
415 * vln-t      *      0.0000e+00e
416 * vln-z      *      0.0000e+00e
417 * vln-r      *      0.0000e+00e
418 * tvn      *      4.5500e+02e
419 * tln      *      4.5500e+02e
420 * pn      *      1.0000e+06e
421 * pan      *      0.0000e+00e
422 *
423 * level      3
424 *
425 * cfzl-t*      0.0000e+00e
426 * cfzl-z*      0.0000e+00e
427 * cfzl-r*      0.0000e+00e
428 * cfzv-t*      0.0000e+00e
429 * cfzv-z*      0.0000e+00e
430 * cfzv-r*      0.0000e+00e
431 * vol      *      1.0000e+00e
432 * fa-t      *      0.0000e+00e

```

```

433 * fa-z *      1.0000e+00e
434 * fa-r *      0.0000e+00e
435 * hd-t *      0.0000e+00e
436 * hd-z *      1.0000e+00e
437 * hd-r *      0.0000e+00e
438 * alpn *      5.0000e-01e
439 * vvn-t *      0.0000e+00e
440 * vvn-z *      0.0000e+00e
441 * vvn-r *      0.0000e+00e
442 * vln-t *      0.0000e+00e
443 * vln-z *      0.0000e+00e
444 * vln-r *      0.0000e+00e
445 * tvn *        4.5500e+02e
446 * tln *        4.5500e+02e
447 * pn *         1.0000e+06e
448 * pan *        0.0000e+00e
449 *
450 *****      type          num          id          ctitle
451 vessel          9          9 second vessel component
452 *              nasx          nrsx          ntsx          ncsr          ivssbf
453 *              3              1              1              3              0
454 *              idcu          idcl          idcr          icru          icrl
455 *              0              0              0              0              0
456 *              icrr          ilcsp          iucsp          iuhp          iconc
457 *              0              0              0              0              0
458 *              igeom          nvent          nvvtb
459 *              1              0              0
460 *              shelv          epsw
461 *              3.5000e+00      1.0000e-05
462 *
463 * z *           1.0000e+00      2.0000e+00      3.0000e+00e
464 * rad *          1.0000e+00e
465 * th *           1.0000e+00e
466 *
467 *              gc          gytc          gxrc          gzc
468 *              9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
469 *
470 *              lisrl          lisrc          lisrf          ljuns
471 *              1              1              -2              10
472 *              1              1              -2              11
473 *              3              1              2              13
474 *
475 * level 1
476 *
477 * cfzl-t*      0.0000e+00e
478 * cfzl-z*      0.0000e+00e
479 * cfzl-r*      0.0000e+00e
480 * cfzv-t*      0.0000e+00e
481 * cfzv-z*      0.0000e+00e
482 * cfzv-r*      0.0000e+00e
483 * vol *        1.0000e+00e
484 * fa-t *        0.0000e+00e
485 * fa-z *        1.0000e+00e
486 * fa-r *        0.0000e+00e
487 * hd-t *        0.0000e+00e
488 * hd-z *        1.0000e+00e
489 * hd-r *        0.0000e+00e
490 * alpn *        5.0000e-01e
491 * vvn-t *        0.0000e+00e
492 * vvn-z *        0.0000e+00e
493 * vvn-r *        0.0000e+00e
494 * vln-t *        0.0000e+00e

```

```

495 * vln-z *      0.0000e+00e
496 * vln-r *      0.0000e+00e
497 * tvn  *      4.5500e+02e
498 * tln  *      4.5500e+02e
499 * pn   *      1.0000e+06e
500 * pan  *      0.0000e+00e
501 *
502 * level  2
503 *
504 * cfzl-t*      0.0000e+00e
505 * cfzl-z*      0.0000e+00e
506 * cfzl-r*      0.0000e+00e
507 * cfzv-t*      0.0000e+00e
508 * cfzv-z*      0.0000e+00e
509 * cfzv-r*      0.0000e+00e
510 * vol   *      1.0000e+00e
511 * fa-t  *      0.0000e+00e
512 * fa-z  *      1.0000e+00e
513 * fa-r  *      0.0000e+00e
514 * hd-t  *      0.0000e+00e
515 * hd-z  *      1.0000e+00e
516 * hd-r  *      0.0000e+00e
517 * alpn  *      5.0000e-01e
518 * vvn-t *      0.0000e+00e
519 * vvn-z *      0.0000e+00e
520 * vvn-r *      0.0000e+00e
521 * vln-t *      0.0000e+00e
522 * vln-z *      0.0000e+00e
523 * vln-r *      0.0000e+00e
524 * tvn   *      4.5500e+02e
525 * tln   *      4.5500e+02e
526 * pn    *      1.0000e+06e
527 * pan   *      0.0000e+00e
528 *
529 * level  3
530 *
531 * cfzl-t*      0.0000e+00e
532 * cfzl-z*      0.0000e+00e
533 * cfzl-r*      0.0000e+00e
534 * cfzv-t*      0.0000e+00e
535 * cfzv-z*      0.0000e+00e
536 * cfzv-r*      0.0000e+00e
537 * vol   *      1.0000e+00e
538 * fa-t  *      0.0000e+00e
539 * fa-z  *      1.0000e+00e
540 * fa-r  *      0.0000e+00e
541 * hd-t  *      0.0000e+00e
542 * hd-z  *      1.0000e+00e
543 * hd-r  *      0.0000e+00e
544 * alpn  *      5.0000e-01e
545 * vvn-t *      0.0000e+00e
546 * vvn-z *      0.0000e+00e
547 * vvn-r *      0.0000e+00e
548 * vln-t *      0.0000e+00e
549 * vln-z *      0.0000e+00e
550 * vln-r *      0.0000e+00e
551 * tvn   *      4.5500e+02e
552 * tln   *      4.5500e+02e
553 * pn    *      1.0000e+06e
554 * pan   *      0.0000e+00e
555 *
556 *****      type      num      id      ctitle

```

```

557 pipe                10                10 outlet pipe for vessel 8
558 *      ncells      nodes      jun1      jun2      epsw
559      1                0                12      14      1.0000e-05
560 *      ichf      iconc      iacc      ipow
561      0                0                0      0
562 *      radin      th      hout1      houtv      tout1
563      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
564 *      toutv
565      4.5500e+02
566 *
567 * dx      * f      1.0000e+00e
568 * vol      * f      1.0000e+00e
569 * fa      *      1.0000e+00      5.0000e-01e
570 * fric      * f      0.0000e+00e
571 * grav      * f      1.0000e+00e
572 * hd      * f      1.0000e+00e
573 * nff      *      1      -1e
574 * alp      * f      5.0000e-01e
575 * vl      * f      0.0000e+00e
576 * vv      * f      0.0000e+00e
577 * tl      * f      4.5500e+02e
578 * tv      * f      4.5500e+02e
579 * p      * f      1.0000e+06e
580 * pa      * f      0.0000e+00e
581 *
582 *****      type      num      id      ctitle
583 pipe                11      11 outlet pipe for vessel 9
584 *      ncells      nodes      jun1      jun2      epsw
585      1                0                13      15      1.0000e-05
586 *      ichf      iconc      iacc      ipow
587      0                0                0      0
588 *      radin      th      hout1      houtv      tout1
589      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
590 *      toutv
591      4.5500e+02
592 *
593 * dx      * f      1.0000e+00e
594 * vol      * f      1.0000e+00e
595 * fa      *      1.0000e+00      5.0000e-01e
596 * fric      * f      0.0000e+00e
597 * grav      * f      1.0000e+00e
598 * hd      * f      1.0000e+00e
599 * nff      *      1      -1e
600 * alp      * f      5.0000e-01e
601 * vl      * f      0.0000e+00e
602 * vv      * f      0.0000e+00e
603 * tl      * f      4.5500e+02e
604 * tv      * f      4.5500e+02e
605 * p      * f      1.0000e+06e
606 * pa      * f      0.0000e+00e
607 *
608 *****      type      num      id      ctitle
609 vessel      12      12 third vessel component
610 *      nasx      nrsx      ntsx      ncsr      ivssbf
611      3                1      1      3      0
612 *      idcu      idcl      idcr      icru      icrl
613      0                0      0      0      0
614 *      icrr      ilcsp      iucsp      iuhp      iconc
615      0                0      0      0      0
616 *      igeom      nvent      nvvtb
617      1                0      0
618 *      shelv      epsw

```

```

619      7.5000e+00      1.0000e-05
620 *
621 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
622 * rad    *      1.0000e+00e
623 * th     *      1.0000e+00e
624 *
625 *          gc          gytc          gxrc          gzc
626      9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
627 *
628 *          lisrl          lisrc          lisrf          ljuns
629          1          1          -2          14
630          1          1          -2          15
631          3          1          2          16
632 *
633 * level    1
634 *
635 * cfzl-t*      0.0000e+00e
636 * cfzl-z*      0.0000e+00e
637 * cfzl-r*      0.0000e+00e
638 * cfzv-t*      0.0000e+00e
639 * cfzv-z*      0.0000e+00e
640 * cfzv-r*      0.0000e+00e
641 * vol      *      1.0000e+00e
642 * fa-t      *      0.0000e+00e
643 * fa-z      *      1.0000e+00e
644 * fa-r      *      0.0000e+00e
645 * hd-t      *      0.0000e+00e
646 * hd-z      *      1.0000e+00e
647 * hd-r      *      0.0000e+00e
648 * alpn      *      5.0000e-01e
649 * vvn-t      *      0.0000e+00e
650 * vvn-z      *      0.0000e+00e
651 * vvn-r      *      0.0000e+00e
652 * vln-t      *      0.0000e+00e
653 * vln-z      *      0.0000e+00e
654 * vln-r      *      0.0000e+00e
655 * tvn      *      4.5500e+02e
656 * tln      *      4.5500e+02e
657 * pn      *      1.0000e+06e
658 * pan      *      0.0000e+00e
659 *
660 * level    2
661 *
662 * cfzl-t*      0.0000e+00e
663 * cfzl-z*      0.0000e+00e
664 * cfzl-r*      0.0000e+00e
665 * cfzv-t*      0.0000e+00e
666 * cfzv-z*      0.0000e+00e
667 * cfzv-r*      0.0000e+00e
668 * vol      *      1.0000e+00e
669 * fa-t      *      0.0000e+00e
670 * fa-z      *      1.0000e+00e
671 * fa-r      *      0.0000e+00e
672 * hd-t      *      0.0000e+00e
673 * hd-z      *      1.0000e+00e
674 * hd-r      *      0.0000e+00e
675 * alpn      *      5.0000e-01e
676 * vvn-t      *      0.0000e+00e
677 * vvn-z      *      0.0000e+00e
678 * vvn-r      *      0.0000e+00e
679 * vln-t      *      0.0000e+00e
680 * vln-z      *      0.0000e+00e

```

```

681 * vln-r *      0.0000e+00e
682 * tvn  *      4.5500e+02e
683 * tln  *      4.5500e+02e
684 * pn   *      1.0000e+06e
685 * pan  *      0.0000e+00e
686 *
687 * level  3
688 *
689 * cfzl-t*      0.0000e+00e
690 * cfzl-z*      0.0000e+00e
691 * cfzl-r*      0.0000e+00e
692 * cfzv-t*      0.0000e+00e
693 * cfzv-z*      0.0000e+00e
694 * cfzv-r*      0.0000e+00e
695 * vol   *      1.0000e+00e
696 * fa-t  *      0.0000e+00e
697 * fa-z  *      1.0000e+00e
698 * fa-r  *      0.0000e+00e
699 * hd-t  *      0.0000e+00e
700 * hd-z  *      1.0000e+00e
701 * hd-r  *      0.0000e+00e
702 * alpn  *      5.0000e-01e
703 * vvn-t *      0.0000e+00e
704 * vvn-z *      0.0000e+00e
705 * vvn-r *      0.0000e+00e
706 * vln-t *      0.0000e+00e
707 * vln-z *      0.0000e+00e
708 * vln-r *      0.0000e+00e
709 * tvn   *      4.5500e+02e
710 * tln   *      4.5500e+02e
711 * pn    *      1.0000e+06e
712 * pan   *      0.0000e+00e
713 *

```

```

714 *****      type          num          id          ctitle
715 pipe                  13          13 outlet pipe for vessel 12
716 *      ncells          nodes      jun1          jun2          epsw
717          1              0          16          17          1.0000e-05
718 *      ichf            iconc      iacc          ipow
719          0              0              0              0
720 *      radin            th          houtl          houtv          toutl
721          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
722 *      toutv
723          4.5500e+02
724 *

```

```

725 * dx      * f      1.0000e+00e
726 * vol     * f      1.0000e+00e
727 * fa      * f      1.0000e+00e
728 * fric    * f      0.0000e+00e
729 * grav    * f      1.0000e+00e
730 * hd      * f      1.0000e+00e
731 * nff     * f              1e
732 * alp     * f      5.0000e-01e
733 * vl      * f      0.0000e+00e
734 * vv      * f      0.0000e+00e
735 * tl      * f      4.5500e+02e
736 * tv      * f      4.5500e+02e
737 * p       * f      1.0000e+06e
738 * pa      * f      0.0000e+00e
739 *

```

```

740 *****      type          num          id          ctitle
741 pipe                  14          14 inlet pipe for vessel 15
742 *      ncells          nodes      jun1          jun2          epsw

```

```

743          1          0          18          17      1.0000e-05
744 *      ichf      iconc      iacc      ipow
745          0          0          0          0
746 *      radin      th      houtl      houtv      toutl
747      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
748 *      toutv
749      4.5500e+02
750 *
751 * dx      * f      1.0000e+00e
752 * vol      * f      1.0000e+00e
753 * fa      * f      1.0000e+00e
754 * fric      * f      0.0000e+00e
755 * grav      * f      -1.0000e+00e
756 * hd      * f      1.0000e+00e
757 * nff      * f      1e
758 * alp      * f      5.0000e-01e
759 * vl      * f      0.0000e+00e
760 * vv      * f      0.0000e+00e
761 * tl      * f      4.5500e+02e
762 * tv      * f      4.5500e+02e
763 * p      * f      1.0000e+06e
764 * pa      * f      0.0000e+00e
765 *
766 *****      type      num      id      ctitle
767 vessel      15      15 fourth vessel component
768 *      nasx      nrsx      ntsx      ncsr      ivssbf
769          3          1          1          3          0
770 *      idcu      idcl      idcr      icru      icrl
771          0          0          0          0          0
772 *      icrr      ilcsp      iucsp      iuhp      iconc
773          0          0          0          0          0
774 *      igeom      nvent      nvvtb
775          1          0          0
776 *      shelv      epsw
777      1.5500e+01      1.0000e-05
778 *
779 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
780 * rad      *      1.0000e+00e
781 * th      *      1.0000e+00e
782 *
783 *      gc      gytc      gxrc      gzc
784      9.8066e+00      0.0000e+00      0.0000e+00      1.0000e+00
785 *
786 *      lisrl      lisrc      lisrf      ljuns
787          1          1          -2          19
788          1          1          -2          20
789          3          1          2          18
790 *
791 * level      1
792 *
793 * cfzl-t*      0.0000e+00e
794 * cfzl-z*      0.0000e+00e
795 * cfzl-r*      0.0000e+00e
796 * cfzv-t*      0.0000e+00e
797 * cfzv-z*      0.0000e+00e
798 * cfzv-r*      0.0000e+00e
799 * vol      *      1.0000e+00e
800 * fa-t      *      0.0000e+00e
801 * fa-z      *      1.0000e+00e
802 * fa-r      *      0.0000e+00e
803 * hd-t      *      0.0000e+00e
804 * hd-z      *      1.0000e+00e

```

805	*	hd-r	*	0.0000e+00e
806	*	alpn	*	5.0000e-01e
807	*	vvv-t	*	0.0000e+00e
808	*	vvv-z	*	0.0000e+00e
809	*	vvv-r	*	0.0000e+00e
810	*	vln-t	*	0.0000e+00e
811	*	vln-z	*	0.0000e+00e
812	*	vln-r	*	0.0000e+00e
813	*	tvn	*	4.5500e+02e
814	*	tlv	*	4.5500e+02e
815	*	pn	*	1.0000e+06e
816	*	pan	*	0.0000e+00e
817	*			
818	*	level	2	
819	*			
820	*	cfzl-t*		0.0000e+00e
821	*	cfzl-z*		0.0000e+00e
822	*	cfzl-r*		0.0000e+00e
823	*	cfzv-t*		0.0000e+00e
824	*	cfzv-z*		0.0000e+00e
825	*	cfzv-r*		0.0000e+00e
826	*	vol	*	1.0000e+00e
827	*	fa-t	*	0.0000e+00e
828	*	fa-z	*	1.0000e+00e
829	*	fa-r	*	0.0000e+00e
830	*	hd-t	*	0.0000e+00e
831	*	hd-z	*	1.0000e+00e
832	*	hd-r	*	0.0000e+00e
833	*	alpn	*	5.0000e-01e
834	*	vvv-t	*	0.0000e+00e
835	*	vvv-z	*	0.0000e+00e
836	*	vvv-r	*	0.0000e+00e
837	*	vln-t	*	0.0000e+00e
838	*	vln-z	*	0.0000e+00e
839	*	vln-r	*	0.0000e+00e
840	*	tvn	*	4.5500e+02e
841	*	tlv	*	4.5500e+02e
842	*	pn	*	1.0000e+06e
843	*	pan	*	0.0000e+00e
844	*			
845	*	level	3	
846	*			
847	*	cfzl-t*		0.0000e+00e
848	*	cfzl-z*		0.0000e+00e
849	*	cfzl-r*		0.0000e+00e
850	*	cfzv-t*		0.0000e+00e
851	*	cfzv-z*		0.0000e+00e
852	*	cfzv-r*		0.0000e+00e
853	*	vol	*	1.0000e+00e
854	*	fa-t	*	0.0000e+00e
855	*	fa-z	*	1.0000e+00e
856	*	fa-r	*	0.0000e+00e
857	*	hd-t	*	0.0000e+00e
858	*	hd-z	*	1.0000e+00e
859	*	hd-r	*	0.0000e+00e
860	*	alpn	*	5.0000e-01e
861	*	vvv-t	*	0.0000e+00e
862	*	vvv-z	*	0.0000e+00e
863	*	vvv-r	*	0.0000e+00e
864	*	vln-t	*	0.0000e+00e
865	*	vln-z	*	0.0000e+00e
866	*	vln-r	*	0.0000e+00e


```

867 * tvn      *      4.5500e+02e
868 * tln      *      4.5500e+02e
869 * pn       *      1.0000e+06e
870 * pan      *      0.0000e+00e
871 *
872 *****      type              num              id              ctitle
873 pipe              16              16 inlet pipe for vessel 18
874 *              ncells          nodes          jun1              jun2              epsw
875 *              1              0              21              19              1.0000e-05
876 *              ichf            iconc          iacc              ipow
877 *              0              0              0              0
878 *              radin            th              hout1            houtv              tout1
879 *              5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
880 *              toutv
881 *              4.5500e+02
882 *
883 * dx        * f      1.0000e+00e
884 * vol       * f      1.0000e+00e
885 * fa        *      1.0000e+00      5.0000e-01e
886 * fric      * f      0.0000e+00e
887 * grav      * f      -1.0000e+00e
888 * hd        * f      1.0000e+00e
889 * nff       *      1              -1e
890 * alp       * f      5.0000e-01e
891 * vl        * f      0.0000e+00e
892 * vv        * f      0.0000e+00e
893 * tl        * f      4.5500e+02e
894 * tv        * f      4.5500e+02e
895 * p         * f      1.0000e+06e
896 * pa        * f      0.0000e+00e
897 *
898 *****      type              num              id              ctitle
899 pipe              17              17 inlet pipe for vessel 19
900 *              ncells          nodes          jun1              jun2              epsw
901 *              1              0              22              20              1.0000e-05
902 *              ichf            iconc          iacc              ipow
903 *              0              0              0              0
904 *              radin            th              hout1            houtv              tout1
905 *              5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
906 *              toutv
907 *              4.5500e+02
908 *
909 * dx        * f      1.0000e+00e
910 * vol       * f      1.0000e+00e
911 * fa        *      1.0000e+00      5.0000e-01e
912 * fric      * f      0.0000e+00e
913 * grav      * f      -1.0000e+00e
914 * hd        * f      1.0000e+00e
915 * nff       *      1              -1e
916 * alp       * f      5.0000e-01e
917 * vl        * f      0.0000e+00e
918 * vv        * f      0.0000e+00e
919 * tl        * f      4.5500e+02e
920 * tv        * f      4.5500e+02e
921 * p         * f      1.0000e+06e
922 * pa        * f      0.0000e+00e
923 *
924 *****      type              num              id              ctitle
925 vessel          18              18 fifth vessel component
926 *              nasx            nrxx            ntsx              ncsr              ivssbf
927 *              3              1              1              3              0
928 *              idcu            idcl            idcr              icru              icrl

```

929		0	0	0	0	0
930 *	icrr		ilcsp	iucsp	iuhp	iconc
931		0	0	0	0	0
932 *	igeom		nvent	nvvtb		
933		1	0	0		
934 *	shelv		epsw			
935	1.6500e+01		1.0000e-05			
936 *						
937 * z *		1.0000e+00	2.0000e+00	3.0000e+00e		
938 * rad *		1.0000e+00e				
939 * th *		1.0000e+00e				
940 *						
941 *	gc		gytc	gxrc	gzc	
942	9.8066e+00		0.0000e+00	0.0000e+00	-1.0000e+00	
943 *						
944 *	lisrl		lisrc	lisrf	ljuns	
945	3		1	2	23	
946	3		1	2	24	
947	1		1	-2	21	
948 *						
949 * level	1					
950 *						
951 * cfzl-t*		0.0000e+00e				
952 * cfzl-z*		0.0000e+00e				
953 * cfzl-r*		0.0000e+00e				
954 * cfzv-t*		0.0000e+00e				
955 * cfzv-z*		0.0000e+00e				
956 * cfzv-r*		0.0000e+00e				
957 * vol *		1.0000e+00e				
958 * fa-t *		0.0000e+00e				
959 * fa-z *		1.0000e+00e				
960 * fa-r *		0.0000e+00e				
961 * hd-t *		0.0000e+00e				
962 * hd-z *		1.0000e+00e				
963 * hd-r *		0.0000e+00e				
964 * alp		5.0000e-01e				
965 * vvn-t *		0.0000e+00e				
966 * vvn-z *		0.0000e+00e				
967 * vvn-r *		0.0000e+00e				
968 * vln-t *		0.0000e+00e				
969 * vln-z *		0.0000e+00e				
970 * vln-r *		0.0000e+00e				
971 * tvn *		4.5500e+02e				
972 * tln *		4.5500e+02e				
973 * pn *		1.0000e+06e				
974 * pan *		0.0000e+00e				
975 *						
976 * level	2					
977 *						
978 * cfzl-t*		0.0000e+00e				
979 * cfzl-z*		0.0000e+00e				
980 * cfzl-r*		0.0000e+00e				
981 * cfzv-t*		0.0000e+00e				
982 * cfzv-z*		0.0000e+00e				
983 * cfzv-r*		0.0000e+00e				
984 * vol *		1.0000e+00e				
985 * fa-t *		0.0000e+00e				
986 * fa-z *		1.0000e+00e				
987 * fa-r *		0.0000e+00e				
988 * hd-t *		0.0000e+00e				
989 * hd-z *		1.0000e+00e				
990 * hd-r *		0.0000e+00e				

```

991 * alpn *      5.0000e-01e
992 * vvn-t *      0.0000e+00e
993 * vvn-z *      0.0000e+00e
994 * vvn-r *      0.0000e+00e
995 * vln-t *      0.0000e+00e
996 * vln-z *      0.0000e+00e
997 * vln-r *      0.0000e+00e
998 * tvn *        4.5500e+02e
999 * tln *        4.5500e+02e
1000 * pn *        1.0000e+06e
1001 * pan *       0.0000e+00e
1002 *
1003 * level 3
1004 *
1005 * cfzl-t*      0.0000e+00e
1006 * cfzl-z*      0.0000e+00e
1007 * cfzl-r*      0.0000e+00e
1008 * cfzv-t*      0.0000e+00e
1009 * cfzv-z*      0.0000e+00e
1010 * cfzv-r*      0.0000e+00e
1011 * vol *       1.0000e+00e
1012 * fa-t *       0.0000e+00e
1013 * fa-z *       1.0000e+00e
1014 * fa-r *       0.0000e+00e
1015 * hd-t *       0.0000e+00e
1016 * hd-z *       1.0000e+00e
1017 * hd-r *       0.0000e+00e
1018 * alpn *      5.0000e-01e
1019 * vvn-t *      0.0000e+00e
1020 * vvn-z *      0.0000e+00e
1021 * vvn-r *      0.0000e+00e
1022 * vln-t *      0.0000e+00e
1023 * vln-z *      0.0000e+00e
1024 * vln-r *      0.0000e+00e
1025 * tvn *        4.5500e+02e
1026 * tln *        4.5500e+02e
1027 * pn *        1.0000e+06e
1028 * pan *       0.0000e+00e
1029 *

```

```

1030 *****      type          num          id          ctitle
1031 vessel          19          19 sixth vessel component
1032 *              nasx          nr sx          ntsx          ncsr          ivssbf
1033                3              1              1              3              0
1034 *              idcu          idcl          idcr          icru          icrl
1035                0              0              0              0              0
1036 *              icrr          ilcsp          iucsp          iuhp          iconc
1037                0              0              0              0              0
1038 *              igeom          nvent          nvvtb
1039                1              0              0
1040 *              shelv          epsw
1041      1.9500e+01      1.0000e-05
1042 *
1043 * z *              1.0000e+00      2.0000e+00      3.0000e+00e
1044 * rad *           1.0000e+00e
1045 * th *            1.0000e+00e
1046 *
1047 *              gc          gycr          gxrc          gzc
1048      9.8066e+00      0.0000e+00      0.0000e+00      1.0000e+00
1049 *
1050 *              lisrl          lisrc          lisrf          ljuns
1051                1              1              -2              25
1052                1              1              -2              26

```

1053		3	1	2	22
1054	*				
1055	* level	1			
1056	*				
1057	* cfzl-t*	0.0000e+00e			
1058	* cfzl-z*	0.0000e+00e			
1059	* cfzl-r*	0.0000e+00e			
1060	* cfzv-t*	0.0000e+00e			
1061	* cfzv-z*	0.0000e+00e			
1062	* cfzv-r*	0.0000e+00e			
1063	* vol *	1.0000e+00e			
1064	* fa-t *	0.0000e+00e			
1065	* fa-z *	1.0000e+00e			
1066	* fa-r *	0.0000e+00e			
1067	* hd-t *	0.0000e+00e			
1068	* hd-z *	1.0000e+00e			
1069	* hd-r *	0.0000e+00e			
1070	* alpn *	5.0000e-01e			
1071	* vvn-t *	0.0000e+00e			
1072	* vvn-z *	0.0000e+00e			
1073	* vvn-r *	0.0000e+00e			
1074	* vln-t *	0.0000e+00e			
1075	* vln-z *	0.0000e+00e			
1076	* vln-r *	0.0000e+00e			
1077	* tvn *	4.5500e+02e			
1078	* tln *	4.5500e+02e			
1079	* pn *	1.0000e+06e			
1080	* pan *	0.0000e+00e			
1081	*				
1082	* level	2			
1083	*				
1084	* cfzl-t*	0.0000e+00e			
1085	* cfzl-z*	0.0000e+00e			
1086	* cfzl-r*	0.0000e+00e			
1087	* cfzv-t*	0.0000e+00e			
1088	* cfzv-z*	0.0000e+00e			
1089	* cfzv-r*	0.0000e+00e			
1090	* vol *	1.0000e+00e			
1091	* fa-t *	0.0000e+00e			
1092	* fa-z *	1.0000e+00e			
1093	* fa-r *	0.0000e+00e			
1094	* hd-t *	0.0000e+00e			
1095	* hd-z *	1.0000e+00e			
1096	* hd-r *	0.0000e+00e			
1097	* alpn *	5.0000e-01e			
1098	* vvn-t *	0.0000e+00e			
1099	* vvn-z *	0.0000e+00e			
1100	* vvn-r *	0.0000e+00e			
1101	* vln-t *	0.0000e+00e			
1102	* vln-z *	0.0000e+00e			
1103	* vln-r *	0.0000e+00e			
1104	* tvn *	4.5500e+02e			
1105	* tln *	4.5500e+02e			
1106	* pn *	1.0000e+06e			
1107	* pan *	0.0000e+00e			
1108	*				
1109	* level	3			
1110	*				
1111	* cfzl-t*	0.0000e+00e			
1112	* cfzl-z*	0.0000e+00e			
1113	* cfzl-r*	0.0000e+00e			
1114	* cfzv-t*	0.0000e+00e			

```

1115 * cfzv-z*      0.0000e+00e
1116 * cfzv-r*      0.0000e+00e
1117 * vol    *      1.0000e+00e
1118 * fa-t    *      0.0000e+00e
1119 * fa-z    *      1.0000e+00e
1120 * fa-r    *      0.0000e+00e
1121 * hd-t    *      0.0000e+00e
1122 * hd-z    *      1.0000e+00e
1123 * hd-r    *      0.0000e+00e
1124 * alpn    *      5.0000e-01e
1125 * vvn-t    *      0.0000e+00e
1126 * vvn-z    *      0.0000e+00e
1127 * vvn-r    *      0.0000e+00e
1128 * vln-t    *      0.0000e+00e
1129 * vln-z    *      0.0000e+00e
1130 * vln-r    *      0.0000e+00e
1131 * tvn     *      4.5500e+02e
1132 * tln     *      4.5500e+02e
1133 * pn      *      1.0000e+06e
1134 * pan     *      0.0000e+00e
1135 *
1136 *****      type          num          id          ctitle
1137 pipe                20          20 1st outlet pipe from vessel 18
1138 *          ncells      nodes      jun1      jun2      epsw
1139          1              0          27          23      1.0000e-05
1140 *          ichf      iconc      iacc      ipow
1141          0              0          0          0
1142 *          radin      th      houtl      houtv      toutl
1143          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
1144 *          toutv
1145          4.5500e+02
1146 *
1147 * dx      * f      1.0000e+00e
1148 * vol      * f      1.0000e+00e
1149 * fa      *      1.0000e+00      5.0000e-01e
1150 * fric      * f      0.0000e+00e
1151 * grav      * f      -1.0000e+00e
1152 * hd      * f      1.0000e+00e
1153 * nff      *      1      -1e
1154 * alp      * f      5.0000e-01e
1155 * vl      * f      0.0000e+00e
1156 * vv      * f      0.0000e+00e
1157 * tl      * f      4.5500e+02e
1158 * tv      * f      4.5500e+02e
1159 * p      * f      1.0000e+06e
1160 * pa      * f      0.0000e+00e
1161 *
1162 *****      type          num          id          ctitle
1163 pipe                21          21 2nd outlet pipe from vessel 18
1164 *          ncells      nodes      jun1      jun2      epsw
1165          1              0          28          24      1.0000e-05
1166 *          ichf      iconc      iacc      ipow
1167          0              0          0          0
1168 *          radin      th      houtl      houtv      toutl
1169          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
1170 *          toutv
1171          4.5500e+02
1172 *
1173 * dx      * f      1.0000e+00e
1174 * vol      * f      1.0000e+00e
1175 * fa      *      1.0000e+00      5.0000e-01e
1176 * fric      * f      0.0000e+00e

```

```

1177 * grav * f -1.0000e+00e
1178 * hd * f 1.0000e+00e
1179 * nff * 1 -1e
1180 * alp * f 5.0000e-01e
1181 * vl * f 0.0000e+00e
1182 * vv * f 0.0000e+00e
1183 * tl * f 4.5500e+02e
1184 * tv * f 4.5500e+02e
1185 * p * f 1.0000e+06e
1186 * pa * f 0.0000e+00e
1187 *
1188 ***** type num id ctitle
1189 pipe 22 22 1st outlet pipe from vessel 19
1190 * ncells nodes jun1 jun2 epsw
1191 1 0 29 25 1.0000e-05
1192 * ichf iconc iacc ipow
1193 0 0 0 0
1194 * radin th houtl houtv toutl
1195 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
1196 * toutv
1197 4.5500e+02
1198 *
1199 * dx * f 1.0000e+00e
1200 * vol * f 1.0000e+00e
1201 * fa * 1.0000e+00 5.0000e-01e
1202 * fric * f 0.0000e+00e
1203 * grav * f -1.0000e+00e
1204 * hd * f 1.0000e+00e
1205 * nff * 1 -1e
1206 * alp * f 5.0000e-01e
1207 * vl * f 0.0000e+00e
1208 * vv * f 0.0000e+00e
1209 * tl * f 4.5500e+02e
1210 * tv * f 4.5500e+02e
1211 * p * f 1.0000e+06e
1212 * pa * f 0.0000e+00e
1213 *
1214 ***** type num id ctitle
1215 pipe 23 23 2nd outlet pipe from vessel 19
1216 * ncells nodes jun1 jun2 epsw
1217 1 0 30 26 1.0000e-05
1218 * ichf iconc iacc ipow
1219 0 0 0 0
1220 * radin th houtl houtv toutl
1221 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
1222 * toutv
1223 4.5500e+02
1224 *
1225 * dx * f 1.0000e+00e
1226 * vol * f 1.0000e+00e
1227 * fa * 1.0000e+00 5.0000e-01e
1228 * fric * f 0.0000e+00e
1229 * grav * f -1.0000e+00e
1230 * hd * f 1.0000e+00e
1231 * nff * 1 -1e
1232 * alp * f 5.0000e-01e
1233 * vl * f 0.0000e+00e
1234 * vv * f 0.0000e+00e
1235 * tl * f 4.5500e+02e
1236 * tv * f 4.5500e+02e
1237 * p * f 1.0000e+06e
1238 * pa * f 0.0000e+00e

```

```

1239 *
1240 ***** type num id ctitle
1241 plenum 24 24 manifold plenum 24
1242 * npljn iconc juns1 juns2
1243 5 0 1 4
1244 *
1245 * junj * 31s
1246 * junj * 27 28 29 30e
1247 * dx * f 1.0000e+00e
1248 * vol * f 4.0000e+00e
1249 * elev * f 2.1000e+01e
1250 * alp * f 5.0000e-01e
1251 * tl * f 4.5500e+02e
1252 * tv * f 4.5500e+02e
1253 * p * f 1.0000e+06e
1254 * pa * f 0.0000e+00e
1255 *
1256 ***** type num id ctitle
1257 pipe 25 25 outlet pipe from plenum 24
1258 * ncells nodes jun1 jun2 epsw
1259 1 0 32 31 1.0000e-05
1260 * ichf iconc iacc ipow
1261 0 0 0 0
1262 * radin th houtl houtv toutl
1263 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
1264 * toutv
1265 4.5500e+02
1266 *
1267 * dx * f 1.0000e+00e
1268 * vol * f 1.0000e+00e
1269 * fa * f 1.0000e+00e
1270 * fric * f 0.0000e+00e
1271 * grav * f -1.0000e+00e
1272 * hd * f 1.0000e+00e
1273 * nff * 1 -1e
1274 * alp * f 5.0000e-01e
1275 * vl * f 0.0000e+00e
1276 * vv * f 0.0000e+00e
1277 * tl * f 4.5500e+02e
1278 * tv * f 4.5500e+02e
1279 * p * f 1.0000e+06e
1280 * pa * f 0.0000e+00e
1281 *
1282 ***** type num id ctitle
1283 break 26 26 pressure b.c. for pipe 25 outlet
1284 * jun1 ibty isat ioff
1285 32 0 0 0
1286 * dxin volin alpin tin pin
1287 1.0000e+00 1.0000e+00 5.0000e-01 4.5500e+02 1.0000e+06
1288 * pain concin rbmx poff belv
1289 0.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00 2.3000e+01
1290 *
1291 end
1292 *
1293 *****
1294 * time-step data *
1295 *****
1296 *
1297 * dtmin dtmax tend rtwfp
1298 1.0000e-03 1.0000e+00 1.0000e+01 1.0000e+00
1299 * edint gfint dmpint sedint
1300 1.0000e+01 1.0000e+00 1.1000e+01 1.0000e+01

```

1301 *				
1302 *	dtmin	dtmax	tend	rtwfp
1303	1.0000e-03	5.0000e+00	1.0000e+02	1.0000e+00
1304 *	edint	gfint	dmpint	sedint
1305	9.0000e+01	2.5000e+00	9.5000e+01	9.0000e+01
1306 *				
1307 *	dtmin	dtmax	tend	rtwfp
1308	1.0000e-02	3.0000e+01	1.0000e+03	1.0000e+00
1309 *	edint	gfint	dmpint	sedint
1310	9.0000e+02	1.5000e+01	9.3000e+02	9.0000e+02
1311 *				
1312 *	dtmin	dtmax	tend	rtwfp
1313	1.0000e-01	2.0000e+02	1.0000e+04	1.0000e+00
1314 *	edint	gfint	dmpint	sedint
1315	9.0000e+03	2.0000e+02	9.0000e+03	9.0000e+03
1316 *				
1317 *	endflag			
1318	-1.0000e+00			

A-4.8 MSRL Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              4              0              1              0              0
9 *--*--*TEST PROBLEM MSRL , Time = 10000.0
10 mirrored parallel-flow channel with single-phase liquid
11 vessels 8 and 18 have their cell numbering reversed
12 two pressure boundary conditions, t1 = 300.0 k
13 *
14 *
15 *          nff          vl          fa
16 *          (-)        (m/s)        (m2)
17 *          #####
18 *          # break#
19 *          # 26 # p = 1.0000e+06 pa
20 *          #####
21 *          32          1          -10.0          1.0
22 *          #####
23 *          # pipe #
24 *          # 25 #
25 *          #####
26 *          31          -1          -10.0          1.0
27 *          #####
28 *          #          plenum          #
29 *          #          24          #
30 *          #####
31 *          27          28          29          30          1          -2.5          1.0x4
32 *          #####
33 *          # pipe # # pipe # # pipe # # pipe #
34 *          # 20 # # 21 # # 22 # # 23 #
35 *          #####
36 *          23          24          25          26          -1          -5.0          0.5x4
37 *          #####
38 *          # cell #          # cell #
39 *          # 3 #          # 1 #
40 *          #-----#          #-----#
41 *          #vessel#          #vessel#
42 *          # 18 #          # 19 #
43 *          #-----#          #-----#
44 *          # cell #          # cell #
45 *          # 1 #          # 3 #
46 *          #####
47 *          21          22          1          -5.0          1.0x2
48 *          #####
49 *          # pipe # # pipe #
50 *          # 16 # # 17 #
51 *          #####
52 *          19          20          -1          -10.0          0.5x2
53 *          #####
54 *          # cell #
55 *          # 1 #
56 *          #-----#
57 *          #vessel#
58 *          # 15 #
59 *          #-----#
60 *          # cell #
61 *          # 3 #
62 *          #####

```

```

61 *                18                1  -10.0    1.0
62 *                #####
63 *                # pipe #
64 *                # 14 #
65 *                #####
66 * -- mirror plane -- 17 -- mirror plane -- 1  10.0    1.0
67 *                #####
68 *                # pipe #
69 *                # 13 #
70 *                #####
71 *                16                1  10.0    1.0
72 *                #####
73 *                # cell #
74 *                # 3 #
75 *                #-----#
76 *                #vessel#
77 *                # 12 #
78 *                #-----#
79 *                # cell #
80 *                # 1 #
81 *                #####
82 *                14 15                -1  10.0    0.5x2
83 *                #####
84 *                # pipe # # pipe #
85 *                # 10 # # 11 #
86 *                #####
87 *                12 13                1  5.0    1.0x2
88 *                #####
89 *                # cell # # cell #
90 *                # 1 # # 3 #
91 *                #-----#
92 *                #vessel# #vessel#
93 *                # 8 # # 9 #
94 *                #-----#
95 *                # cell # # cell #
96 *                # 3 # # 1 #
97 *                #####
98 *                8 9 10 11                -1  5.0    0.5x4
99 *                #####
100 *                # pipe # # pipe # # pipe # # pipe #
101 *                # 4 # # 5 # # 6 # # 7 #
102 *                #####
103 *                4 5 6 7                1  2.5    1.0x4
104 *                #####
105 *                # plenum #
106 *                # 3 #
107 *                #####
108 *                3                -1  10.0    1.0
109 *                #####
110 *                # pipe #
111 *                # 2 #
112 *                #####
113 *                2                1  10.0    1.0
114 *                #####
115 *                # break# p = 1.4045e+06 pa
116 *                # 1 #
117 *                #####
118 *
119 *****
120 * namelist data *
121 *****
122 *

```

```

123 &inopts
124   iadded=10, ikfac=1, nvgrav=1, cpuflg=1,
125   idiag=4, nsdl=0, nsdu=5, nspl=0, nspl=5
126 &end
127 *
128 *           dstep           timet
129           0           0.0000e+00
130 *           stdyst           transi           ncomp           njun           ipak
131           0           1           26           31           0
132 *           epso           epss
133           1.0000e-04           1.0000e-04
134 *           oitmax           sitmax           isolut           ncontr           nccfl
135           10           10           0           0           0
136 *           ntsv           ntcb           ntcf           ntrp           ntcp
137           1           0           0           0           0
138 *
139 *****
140 * component-number data *
141 *****
142 *
143 * iorder * 1 s * break           pressure b.c. for pipe 2 inlet
144 * iorder * 2 s * pipe           inlet pipe for plenum 3
145 * iorder * 3 s * plenum         manifold for parallel-channel pipes
146 * iorder * 4 s * pipe           1st inlet pipe for vessel 8
147 * iorder * 5 s * pipe           2nd inlet pipe for vessel 8
148 * iorder * 6 s * pipe           1st inlet pipe for vessel 9
149 * iorder * 7 s * pipe           2nd inlet pipe for vessel 9
150 * iorder * 8 s * vessel         first vessel component
151 * iorder * 9 s * vessel         second vessel component
152 * iorder * 10 s * pipe          outlet pipe for vessel 8
153 * iorder * 11 s * pipe          outlet pipe for vessel 9
154 * iorder * 12 s * vessel        third vessel component
155 * iorder * 13 s * pipe          outlet pipe for vessel 12
156 * iorder * 14 s * pipe          inlet pipe for vessel 15
157 * iorder * 15 s * vessel        fourth vessel component
158 * iorder * 16 s * pipe          inlet pipe for vessel 18
159 * iorder * 17 s * pipe          inlet pipe for vessel 19
160 * iorder * 18 s * vessel        fifth vessel component
161 * iorder * 19 s * vessel        sixth vessel component
162 * iorder * 20 s * pipe          1st outlet pipe for vessel 18
163 * iorder * 21 s * pipe          2nd outlet pipe for vessel 18
164 * iorder * 22 s * pipe          1st outlet pipe for vessel 19
165 * iorder * 23 s * pipe          2nd outlet pipe for vessel 19
166 * iorder * 24 s * plenum        manifold for parallel-channel pipes
167 * iorder * 25 s * pipe          outlet pipe for plenum 24
168 * iorder * 26 e * break         pressure b.c. for pipe 25 outlet
169 *
170 *****
171 * control parameters *
172 *****
173 *
174 * signal variable
175 *
176 *           idsv           isvn           icln           icn1           icn2
177           1           0           0           0           0
178 *
179 *****
180 * component data *
181 *****
182 *
183 *****   type           num           id           ctitle
184 break           1           1           pressure b.c. for pipe 2 inlet

```

```

185 *      jun1      ibty      isat      ioff
186 *      2          1          0          0
187 *      ibtr      ibsv      nbtb      nbsv      nbrf
188 *      0          1          2          0          0
189 *      dxin      volin      alpin      tin      pin
190 *      1.0000e+00  1.0000e+00  0.0000e+00  3.0000e+02  1.0000e+06
191 *      pain      concin     rbmx      poff      belv
192 *      0.0000e+00  0.0000e+00  4.0450e+05  0.0000e+00  0.0000e+00
193 *      pscl      tlscl      tvscl      pascl      conscl
194 *      1.0000e+00  0.0000e+00  0.0000e+00  0.0000e+00  0.0000e+00
195 *
196 * ptb *      0.0000e+00  1.0000e+06  1.0000e+00  1.4045e+06e
197 *
198 * type      num      id      ctitle
199 pipe      2          2 inlet pipe for plenum 3
200 * ncells      nodes      jun1      jun2      epsw
201 *      1          0          2          3      1.0000e-05
202 *      ichf      iconc      iacc      ipow
203 *      0          0          0          0
204 *      radin      th      houtl      houtv      toutl
205 *      5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  3.0000e+02
206 *      toutv
207 *      3.0000e+02
208 *
209 * dx * f 1.0000e+00e
210 * vol * f 1.0000e+00e
211 * fa * f 1.0000e+00e
212 * fric * f 0.0000e+00e
213 * grav * f 1.0000e+00e
214 * hd * f 1.0000e+00e
215 * nff * 1 -1e
216 * alp * f 0.0000e+00e
217 * vl * f 0.0000e+00e
218 * vv * f 0.0000e+00e
219 * tl * f 3.0000e+02e
220 * tv * f 3.0000e+02e
221 * p * f 1.0000e+06e
222 * pa * f 0.0000e+00e
223 *
224 * type      num      id      ctitle
225 plenum      3          3 manifold plenum 3
226 * npljn      iconc      juns1      juns2
227 *      5          0          1          4
228 *
229 * junj * 3s
230 * junj * 4 5 6 7e
231 * dx * f 1.0000e+00e
232 * vol * f 4.0000e+00e
233 * elev * f 2.0000e+00e
234 * alp * f 0.0000e+00e
235 * tl * f 3.0000e+02e
236 * tv * f 3.0000e+02e
237 * p * f 1.0000e+06e
238 * pa * f 0.0000e+00e
239 *
240 * type      num      id      ctitle
241 pipe      4          4 1st inlet pipe for vessel 8
242 * ncells      nodes      jun1      jun2      epsw
243 *      1          0          4          8      1.0000e-05
244 *      ichf      iconc      iacc      ipow
245 *      0          0          0          0
246 *      radin      th      houtl      houtv      toutl

```

```

247      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
248 *      toutv
249      3.0000e+02
250 *
251 * dx      * f      1.0000e+00e
252 * vol      * f      1.0000e+00e
253 * fa      *      1.0000e+00      5.0000e-01e
254 * fric      * f      0.0000e+00e
255 * grav      * f      1.0000e+00e
256 * hd      * f      1.0000e+00e
257 * nff      *      1      -1e
258 * alp      * f      0.0000e+00e
259 * vl      * f      0.0000e+00e
260 * vv      * f      0.0000e+00e
261 * tl      * f      3.0000e+02e
262 * tv      * f      3.0000e+02e
263 * p      * f      1.0000e+06e
264 * pa      * f      0.0000e+00e
265 *
266 *****      type      num      id      ctitle
267 pipe      5      5 2nd inlet pipe for vessel 8
268 *      ncells      nodes      jun1      jun2      epsw
269      1      0      5      9      1.0000e-05
270 *      ichf      iconc      iacc      ipow
271      0      0      0      0
272 *      radin      th      hout1      houtv      tout1
273      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
274 *      toutv
275      3.0000e+02
276 *
277 * dx      * f      1.0000e+00e
278 * vol      * f      1.0000e+00e
279 * fa      *      1.0000e+00      5.0000e-01e
280 * fric      * f      0.0000e+00e
281 * grav      * f      1.0000e+00e
282 * hd      * f      1.0000e+00e
283 * nff      *      1      -1e
284 * alp      * f      0.0000e+00e
285 * vl      * f      0.0000e+00e
286 * vv      * f      0.0000e+00e
287 * tl      * f      3.0000e+02e
288 * tv      * f      3.0000e+02e
289 * p      * f      1.0000e+06e
290 * pa      * f      0.0000e+00e
291 *
292 *****      type      num      id      ctitle
293 pipe      6      6 1st inlet pipe for vessel 9
294 *      ncells      nodes      jun1      jun2      epsw
295      1      0      6      10      1.0000e-05
296 *      ichf      iconc      iacc      ipow
297      0      0      0      0
298 *      radin      th      hout1      houtv      tout1
299      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
300 *      toutv
301      3.0000e+02
302 *
303 * dx      * f      1.0000e+00e
304 * vol      * f      1.0000e+00e
305 * fa      *      1.0000e+00      5.0000e-01e
306 * fric      * f      0.0000e+00e
307 * grav      * f      1.0000e+00e
308 * hd      * f      1.0000e+00e

```

```

309 * nff      *      1      -1e
310 * alp      * f    0.0000e+00e
311 * vl       * f    0.0000e+00e
312 * vv       * f    0.0000e+00e
313 * tl       * f    3.0000e+02e
314 * tv       * f    3.0000e+02e
315 * p        * f    1.0000e+06e
316 * pa       * f    0.0000e+00e
317 *
318 *****   type          num          id          ctitle
319 pipe              7              7 2nd inlet pipe for vessel 9
320 *      ncells      nodes      jun1      jun2      epsw
321      1              0              7      11      1.0000e-05
322 *      ichf        iconc      iacc      ipow
323      0              0              0      0
324 *      radin       th        houtl      houtv      toutl
325      5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    3.0000e+02
326 *      toutv
327      3.0000e+02
328 *
329 * dx      * f    1.0000e+00e
330 * vol     * f    1.0000e+00e
331 * fa      *      1.0000e+00    5.0000e-01e
332 * fric    * f    0.0000e+00e
333 * grav    * f    1.0000e+00e
334 * hd      * f    1.0000e+00e
335 * nff      *      1      -1e
336 * alp      * f    0.0000e+00e
337 * vl       * f    0.0000e+00e
338 * vv       * f    0.0000e+00e
339 * tl       * f    3.0000e+02e
340 * tv       * f    3.0000e+02e
341 * p        * f    1.0000e+06e
342 * pa       * f    0.0000e+00e
343 *
344 *****   type          num          id          ctitle
345 vessel              8              8 first vessel component
346 *      nasx      nrxx      ntsx      ncsr      ivssbf
347      3              1              1      3      0
348 *      idcu      idcl      idcr      icru      icrl
349      0              0              0      0      0
350 *      icrr      ilcsp      iucsp      iuhp      iconc
351      0              0              0      0      0
352 *      igeom      nvent      nvvtb
353      1              0              0
354 *      shelv      epsw
355      6.5000e+00    1.0000e-05
356 *
357 * z      *      1.0000e+00    2.0000e+00    3.0000e+00e
358 * rad    *      1.0000e+00e
359 * th     *      1.0000e+00e
360 *
361 *      gc      gytc      gxrc      gzc
362      9.8066e+00    0.0000e+00    0.0000e+00    1.0000e+00
363 *
364 *      lisrl      lisrc      lisrf      ljuns
365      3              1              2      8
366      3              1              2      9
367      1              1              -2      12
368 *
369 * level    1
370 *

```

371	*	cfzl-t*	0.0000e+00e
372	*	cfzl-z*	0.0000e+00e
373	*	cfzl-r*	0.0000e+00e
374	*	cfzv-t*	0.0000e+00e
375	*	cfzv-z*	0.0000e+00e
376	*	cfzv-r*	0.0000e+00e
377	*	vol *	1.0000e+00e
378	*	fa-t *	0.0000e+00e
379	*	fa-z *	1.0000e+00e
380	*	fa-r *	0.0000e+00e
381	*	hd-t *	0.0000e+00e
382	*	hd-z *	1.0000e+00e
383	*	hd-r *	0.0000e+00e
384	*	alpn *	0.0000e+00e
385	*	vvv-t *	0.0000e+00e
386	*	vvv-z *	0.0000e+00e
387	*	vvv-r *	0.0000e+00e
388	*	vln-t *	0.0000e+00e
389	*	vln-z *	0.0000e+00e
390	*	vln-r *	0.0000e+00e
391	*	tvn *	3.0000e+02e
392	*	tlv *	3.0000e+02e
393	*	pn *	1.0000e+06e
394	*	pan *	0.0000e+00e
395	*		
396	*	level 2	
397	*		
398	*	cfzl-t*	0.0000e+00e
399	*	cfzl-z*	0.0000e+00e
400	*	cfzl-r*	0.0000e+00e
401	*	cfzv-t*	0.0000e+00e
402	*	cfzv-z*	0.0000e+00e
403	*	cfzv-r*	0.0000e+00e
404	*	vol *	1.0000e+00e
405	*	fa-t *	0.0000e+00e
406	*	fa-z *	1.0000e+00e
407	*	fa-r *	0.0000e+00e
408	*	hd-t *	0.0000e+00e
409	*	hd-z *	1.0000e+00e
410	*	hd-r *	0.0000e+00e
411	*	alpn *	0.0000e+00e
412	*	vvv-t *	0.0000e+00e
413	*	vvv-z *	0.0000e+00e
414	*	vvv-r *	0.0000e+00e
415	*	vln-t *	0.0000e+00e
416	*	vln-z *	0.0000e+00e
417	*	vln-r *	0.0000e+00e
418	*	tvn *	3.0000e+02e
419	*	tlv *	3.0000e+02e
420	*	pn *	1.0000e+06e
421	*	pan *	0.0000e+00e
422	*		
423	*	level 3	
424	*		
425	*	cfzl-t*	0.0000e+00e
426	*	cfzl-z*	0.0000e+00e
427	*	cfzl-r*	0.0000e+00e
428	*	cfzv-t*	0.0000e+00e
429	*	cfzv-z*	0.0000e+00e
430	*	cfzv-r*	0.0000e+00e
431	*	vol *	1.0000e+00e
432	*	fa-t *	0.0000e+00e

```

433 * fa-z *      1.0000e+00e
434 * fa-r *      0.0000e+00e
435 * hd-t *      0.0000e+00e
436 * hd-z *      1.0000e+00e
437 * hd-r *      0.0000e+00e
438 * alpn *      0.0000e+00e
439 * vvn-t *      0.0000e+00e
440 * vvn-z *      0.0000e+00e
441 * vvn-r *      0.0000e+00e
442 * vln-t *      0.0000e+00e
443 * vln-z *      0.0000e+00e
444 * vln-r *      0.0000e+00e
445 * tvn *        3.0000e+02e
446 * tln *        3.0000e+02e
447 * pn *         1.0000e+06e
448 * pan *        0.0000e+00e
449 *

```

```

450 *****      type          num          id          ctitle
451 vessel          9          9 second vessel component
452 *              nasx          nrsx          ntsx          ncsr          ivssbf
453 *              3              1              1              3              0
454 *              idcu          idcl          idcr          icru          icrl
455 *              0              0              0              0              0
456 *              icrr          ilcsp          iucsp          iuhp          iconc
457 *              0              0              0              0              0
458 *              igeom          nvent          nvvtb
459 *              1              0              0
460 *              shelv          epsw
461          3.5000e+00      1.0000e-05
462 *
463 * z *          1.0000e+00      2.0000e+00      3.0000e+00e
464 * rad *        1.0000e+00e
465 * th *         1.0000e+00e
466 *
467 *              gc          gytc          gxrc          gzc
468          9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
469 *
470 *              lisrl          lisrc          lisrf          ljuns
471 *              1              1              -2              10
472 *              1              1              -2              11
473 *              3              1              2              13
474 *
475 * level 1
476 *
477 * cfzl-t*      0.0000e+00e
478 * cfzl-z*      0.0000e+00e
479 * cfzl-r*      0.0000e+00e
480 * cfzv-t*      0.0000e+00e
481 * cfzv-z*      0.0000e+00e
482 * cfzv-r*      0.0000e+00e
483 * vol *        1.0000e+00e
484 * fa-t *        0.0000e+00e
485 * fa-z *        1.0000e+00e
486 * fa-r *        0.0000e+00e
487 * hd-t *        0.0000e+00e
488 * hd-z *        1.0000e+00e
489 * hd-r *        0.0000e+00e
490 * alpn *        0.0000e+00e
491 * vvn-t *        0.0000e+00e
492 * vvn-z *        0.0000e+00e
493 * vvn-r *        0.0000e+00e
494 * vln-t *        0.0000e+00e

```



```

495 * vln-z *      0.0000e+00e
496 * vln-r *      0.0000e+00e
497 * tvn  *      3.0000e+02e
498 * tln  *      3.0000e+02e
499 * pn   *      1.0000e+06e
500 * pan  *      0.0000e+00e
501 *
502 * level  2
503 *
504 * cfzl-t*      0.0000e+00e
505 * cfzl-z*      0.0000e+00e
506 * cfzl-r*      0.0000e+00e
507 * cfzv-t*      0.0000e+00e
508 * cfzv-z*      0.0000e+00e
509 * cfzv-r*      0.0000e+00e
510 * vol   *      1.0000e+00e
511 * fa-t  *      0.0000e+00e
512 * fa-z  *      1.0000e+00e
513 * fa-r  *      0.0000e+00e
514 * hd-t  *      0.0000e+00e
515 * hd-z  *      1.0000e+00e
516 * hd-r  *      0.0000e+00e
517 * alpn  *      0.0000e+00e
518 * vvn-t *      0.0000e+00e
519 * vvn-z *      0.0000e+00e
520 * vvn-r *      0.0000e+00e
521 * vln-t *      0.0000e+00e
522 * vln-z *      0.0000e+00e
523 * vln-r *      0.0000e+00e
524 * tvn  *      3.0000e+02e
525 * tln  *      3.0000e+02e
526 * pn   *      1.0000e+06e
527 * pan  *      0.0000e+00e
528 *
529 * level  3
530 *
531 * cfzl-t*      0.0000e+00e
532 * cfzl-z*      0.0000e+00e
533 * cfzl-r*      0.0000e+00e
534 * cfzv-t*      0.0000e+00e
535 * cfzv-z*      0.0000e+00e
536 * cfzv-r*      0.0000e+00e
537 * vol   *      1.0000e+00e
538 * fa-t  *      0.0000e+00e
539 * fa-z  *      1.0000e+00e
540 * fa-r  *      0.0000e+00e
541 * hd-t  *      0.0000e+00e
542 * hd-z  *      1.0000e+00e
543 * hd-r  *      0.0000e+00e
544 * alpn  *      0.0000e+00e
545 * vvn-t *      0.0000e+00e
546 * vvn-z *      0.0000e+00e
547 * vvn-r *      0.0000e+00e
548 * vln-t *      0.0000e+00e
549 * vln-z *      0.0000e+00e
550 * vln-r *      0.0000e+00e
551 * tvn  *      3.0000e+02e
552 * tln  *      3.0000e+02e
553 * pn   *      1.0000e+06e
554 * pan  *      0.0000e+00e
555 *
556 * *****  type          num          id          ctitle

```

```

557 pipe                                10                                10 outlet pipe for vessel 8
558 *          ncells          nodes          jun1          jun2          epsw
559          1          0          12          14          1.0000e-05
560 *          ichf          iconc          iacc          ipow
561          0          0          0          0
562 *          radin          th          hout1          houtv          tout1
563          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          3.0000e+02
564 *          toutv
565          3.0000e+02
566 *
567 * dx      * f      1.0000e+00e
568 * vol      * f      1.0000e+00e
569 * fa      *      1.0000e+00          5.0000e-01e
570 * fric      * f      0.0000e+00e
571 * grav      * f      1.0000e+00e
572 * hd      * f      1.0000e+00e
573 * nff      *          1          -1e
574 * alp      * f      0.0000e+00e
575 * vl      * f      0.0000e+00e
576 * vv      * f      0.0000e+00e
577 * tl      * f      3.0000e+02e
578 * tv      * f      3.0000e+02e
579 * p      * f      1.0000e+06e
580 * pa      * f      0.0000e+00e
581 *
582 *****      type          num          id          ctitle
583 pipe          11          11 outlet pipe for vessel 9
584 *          ncells          nodes          jun1          jun2          epsw
585          1          0          13          15          1.0000e-05
586 *          ichf          iconc          iacc          ipow
587          0          0          0          0
588 *          radin          th          hout1          houtv          tout1
589          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          3.0000e+02
590 *          toutv
591          3.0000e+02
592 *
593 * dx      * f      1.0000e+00e
594 * vol      * f      1.0000e+00e
595 * fa      *      1.0000e+00          5.0000e-01e
596 * fric      * f      0.0000e+00e
597 * grav      * f      1.0000e+00e
598 * hd      * f      1.0000e+00e
599 * nff      *          1          -1e
600 * alp      * f      0.0000e+00e
601 * vl      * f      0.0000e+00e
602 * vv      * f      0.0000e+00e
603 * tl      * f      3.0000e+02e
604 * tv      * f      3.0000e+02e
605 * p      * f      1.0000e+06e
606 * pa      * f      0.0000e+00e
607 *
608 *****      type          num          id          ctitle
609 vessel          12          12 third vessel component
610 *          nasx          nrsx          ntsx          ncsr          ivssbf
611          3          1          1          3          0
612 *          idcu          idcl          idcr          icru          icrl
613          0          0          0          0          0
614 *          icrr          ilcsp          iucsp          iuhp          iconc
615          0          0          0          0          0
616 *          igeom          nvent          nvvtb
617          1          0          0
618 *          shelv          epsw

```

```

619      7.5000e+00      1.0000e-05
620 *
621 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
622 * rad    *      1.0000e+00e
623 * th     *      1.0000e+00e
624 *
625 *      gc      gytc      gxrc      gzc
626      9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
627 *
628 *      lisrl      lisrc      lisrf      ljuns
629      1      1      -2      14
630      1      1      -2      15
631      3      1      2      16
632 *
633 * level  1
634 *
635 * cfzl-t*      0.0000e+00e
636 * cfzl-z*      0.0000e+00e
637 * cfzl-r*      0.0000e+00e
638 * cfzv-t*      0.0000e+00e
639 * cfzv-z*      0.0000e+00e
640 * cfzv-r*      0.0000e+00e
641 * vol      *      1.0000e+00e
642 * fa-t      *      0.0000e+00e
643 * fa-z      *      1.0000e+00e
644 * fa-r      *      0.0000e+00e
645 * hd-t      *      0.0000e+00e
646 * hd-z      *      1.0000e+00e
647 * hd-r      *      0.0000e+00e
648 * alpn      *      0.0000e+00e
649 * vvn-t      *      0.0000e+00e
650 * vvn-z      *      0.0000e+00e
651 * vvn-r      *      0.0000e+00e
652 * vln-t      *      0.0000e+00e
653 * vln-z      *      0.0000e+00e
654 * vln-r      *      0.0000e+00e
655 * tvn      *      3.0000e+02e
656 * tln      *      3.0000e+02e
657 * pn      *      1.0000e+06e
658 * pan      *      0.0000e+00e
659 *
660 * level  2
661 *
662 * cfzl-t*      0.0000e+00e
663 * cfzl-z*      0.0000e+00e
664 * cfzl-r*      0.0000e+00e
665 * cfzv-t*      0.0000e+00e
666 * cfzv-z*      0.0000e+00e
667 * cfzv-r*      0.0000e+00e
668 * vol      *      1.0000e+00e
669 * fa-t      *      0.0000e+00e
670 * fa-z      *      1.0000e+00e
671 * fa-r      *      0.0000e+00e
672 * hd-t      *      0.0000e+00e
673 * hd-z      *      1.0000e+00e
674 * hd-r      *      0.0000e+00e
675 * alpn      *      0.0000e+00e
676 * vvn-t      *      0.0000e+00e
677 * vvn-z      *      0.0000e+00e
678 * vvn-r      *      0.0000e+00e
679 * vln-t      *      0.0000e+00e
680 * vln-z      *      0.0000e+00e

```

```

681 * vln-r *      0.0000e+00e
682 * tvn   *      3.0000e+02e
683 * tln   *      3.0000e+02e
684 * pn     *      1.0000e+06e
685 * pan    *      0.0000e+00e
686 *
687 * level   3
688 *
689 * cfzl-t*      0.0000e+00e
690 * cfzl-z*      0.0000e+00e
691 * cfzl-r*      0.0000e+00e
692 * cfzv-t*      0.0000e+00e
693 * cfzv-z*      0.0000e+00e
694 * cfzv-r*      0.0000e+00e
695 * vol     *      1.0000e+00e
696 * fa-t    *      0.0000e+00e
697 * fa-z    *      1.0000e+00e
698 * fa-r    *      0.0000e+00e
699 * hd-t    *      0.0000e+00e
700 * hd-z    *      1.0000e+00e
701 * hd-r    *      0.0000e+00e
702 * alpn    *      0.0000e+00e
703 * vvn-t   *      0.0000e+00e
704 * vvn-z   *      0.0000e+00e
705 * vvn-r   *      0.0000e+00e
706 * vln-t   *      0.0000e+00e
707 * vln-z   *      0.0000e+00e
708 * vln-r   *      0.0000e+00e
709 * tvn     *      3.0000e+02e
710 * tln     *      3.0000e+02e
711 * pn      *      1.0000e+06e
712 * pan     *      0.0000e+00e
713 *

```

```

714 *****      type          num          id          ctitle
715 pipe                  13          13 outlet pipe for vessel 12
716 *      ncells          nodes      jun1          jun2          epsw
717          1              0          16          17          1.0000e-05
718 *      ichf            iconc      iacc          ipow
719          0              0          0              0
720 *      radin            th      houtl          houtv          toutl
721          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
722 *      toutv
723          3.0000e+02
724 *

```

```

725 * dx      * f      1.0000e+00e
726 * vol     * f      1.0000e+00e
727 * fa      * f      1.0000e+00e
728 * fric    * f      0.0000e+00e
729 * grav    * f      1.0000e+00e
730 * hd      * f      1.0000e+00e
731 * nff     * f          1e
732 * alp     * f      0.0000e+00e
733 * vl      * f      0.0000e+00e
734 * vv      * f      0.0000e+00e
735 * tl      * f      3.0000e+02e
736 * tv      * f      3.0000e+02e
737 * p       * f      1.0000e+06e
738 * pa      * f      0.0000e+00e
739 *

```

```

740 *****      type          num          id          ctitle
741 pipe                  14          14 inlet pipe for vessel 15
742 *      ncells          nodes      jun1          jun2          epsw

```

```

743          1          0          18          17          1.0000e-05
744 *      ichf      iconc      iacc      ipow
745          0          0          0          0
746 *      radin      th      houtl      houtv      toutl
747      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
748 *      toutv
749      3.0000e+02
750 *
751 * dx      * f      1.0000e+00e
752 * vol      * f      1.0000e+00e
753 * fa      * f      1.0000e+00e
754 * fric      * f      0.0000e+00e
755 * grav      * f      -1.0000e+00e
756 * hd      * f      1.0000e+00e
757 * nff      * f      1e
758 * alp      * f      0.0000e+00e
759 * vl      * f      0.0000e+00e
760 * vv      * f      0.0000e+00e
761 * tl      * f      3.0000e+02e
762 * tv      * f      3.0000e+02e
763 * p      * f      1.0000e+06e
764 * pa      * f      0.0000e+00e
765 *
766 * type      num      id      ctitle
767 vessel      15      15 fourth vessel component
768 *      nasx      nrsx      ntsx      ncsr      ivssbf
769          3          1          1          3          0
770 *      idcu      idcl      idcr      icru      icrl
771          0          0          0          0          0
772 *      icrr      ilcsp      iucsp      iuhp      iconc
773          0          0          0          0          0
774 *      igeom      nvent      nvvtb
775          1          0          0
776 *      shelv      epsw
777      1.5500e+01      1.0000e-05
778 *
779 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
780 * rad      *      1.0000e+00e
781 * th      *      1.0000e+00e
782 *
783 *      gc      gytc      gxrc      gzc
784      9.8066e+00      0.0000e+00      0.0000e+00      1.0000e+00
785 *
786 *      lisrl      lisrc      lisrf      ljuns
787          1          1          -2          19
788          1          1          -2          20
789          3          1          2          18
790 *
791 * level      1
792 *
793 * cfzl-t*      0.0000e+00e
794 * cfzl-z*      0.0000e+00e
795 * cfzl-r*      0.0000e+00e
796 * cfzv-t*      0.0000e+00e
797 * cfzv-z*      0.0000e+00e
798 * cfzv-r*      0.0000e+00e
799 * vol      *      1.0000e+00e
800 * fa-t      *      0.0000e+00e
801 * fa-z      *      1.0000e+00e
802 * fa-r      *      0.0000e+00e
803 * hd-t      *      0.0000e+00e
804 * hd-z      *      1.0000e+00e

```

805	*	hd-r	*	0.0000e+00e
806	*	alpn	*	0.0000e+00e
807	*	vvv-t	*	0.0000e+00e
808	*	vvv-z	*	0.0000e+00e
809	*	vvv-r	*	0.0000e+00e
810	*	vln-t	*	0.0000e+00e
811	*	vln-z	*	0.0000e+00e
812	*	vln-r	*	0.0000e+00e
813	*	tvn	*	3.0000e+02e
814	*	tlv	*	3.0000e+02e
815	*	pn	*	1.0000e+06e
816	*	pan	*	0.0000e+00e
817	*			
818	*	level	2	
819	*			
820	*	cfzl-t*		0.0000e+00e
821	*	cfzl-z*		0.0000e+00e
822	*	cfzl-r*		0.0000e+00e
823	*	cfzv-t*		0.0000e+00e
824	*	cfzv-z*		0.0000e+00e
825	*	cfzv-r*		0.0000e+00e
826	*	vol	*	1.0000e+00e
827	*	fa-t	*	0.0000e+00e
828	*	fa-z	*	1.0000e+00e
829	*	fa-r	*	0.0000e+00e
830	*	hd-t	*	0.0000e+00e
831	*	hd-z	*	1.0000e+00e
832	*	hd-r	*	0.0000e+00e
833	*	alpn	*	0.0000e+00e
834	*	vvv-t	*	0.0000e+00e
835	*	vvv-z	*	0.0000e+00e
836	*	vvv-r	*	0.0000e+00e
837	*	vln-t	*	0.0000e+00e
838	*	vln-z	*	0.0000e+00e
839	*	vln-r	*	0.0000e+00e
840	*	tvn	*	3.0000e+02e
841	*	tlv	*	3.0000e+02e
842	*	pn	*	1.0000e+06e
843	*	pan	*	0.0000e+00e
844	*			
845	*	level	3	
846	*			
847	*	cfzl-t*		0.0000e+00e
848	*	cfzl-z*		0.0000e+00e
849	*	cfzl-r*		0.0000e+00e
850	*	cfzv-t*		0.0000e+00e
851	*	cfzv-z*		0.0000e+00e
852	*	cfzv-r*		0.0000e+00e
853	*	vol	*	1.0000e+00e
854	*	fa-t	*	0.0000e+00e
855	*	fa-z	*	1.0000e+00e
856	*	fa-r	*	0.0000e+00e
857	*	hd-t	*	0.0000e+00e
858	*	hd-z	*	1.0000e+00e
859	*	hd-r	*	0.0000e+00e
860	*	alpn	*	0.0000e+00e
861	*	vvv-t	*	0.0000e+00e
862	*	vvv-z	*	0.0000e+00e
863	*	vvv-r	*	0.0000e+00e
864	*	vln-t	*	0.0000e+00e
865	*	vln-z	*	0.0000e+00e
866	*	vln-r	*	0.0000e+00e

```

867 * tvn      *      3.0000e+02e
868 * tln      *      3.0000e+02e
869 * pn       *      1.0000e+06e
870 * pan      *      0.0000e+00e
871 *
872 *****      type              num              id              ctitle
873 pipe              16              16 inlet pipe for vessel 18
874 *              ncells          nodes          jun1          jun2          epsw
875 *              1              0              21              19          1.0000e-05
876 *              ichf            iconc          iacc          ipow
877 *              0              0              0              0
878 *              radin            th          houtl          houtv          toutl
879 *              5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
880 *              toutv
881 *              3.0000e+02
882 *
883 * dx      * f      1.0000e+00e
884 * vol     * f      1.0000e+00e
885 * fa      *      1.0000e+00      5.0000e-01e
886 * fric    * f      0.0000e+00e
887 * grav    * f      -1.0000e+00e
888 * hd      * f      1.0000e+00e
889 * nff     *      1              -1e
890 * alp     * f      0.0000e+00e
891 * vl      * f      0.0000e+00e
892 * vv      * f      0.0000e+00e
893 * tl      * f      3.0000e+02e
894 * tv      * f      3.0000e+02e
895 * p       * f      1.0000e+06e
896 * pa      * f      0.0000e+00e
897 *
898 *****      type              num              id              ctitle
899 pipe              17              17 inlet pipe for vessel 19
900 *              ncells          nodes          jun1          jun2          epsw
901 *              1              0              22              20          1.0000e-05
902 *              ichf            iconc          iacc          ipow
903 *              0              0              0              0
904 *              radin            th          houtl          houtv          toutl
905 *              5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
906 *              toutv
907 *              3.0000e+02
908 *
909 * dx      * f      1.0000e+00e
910 * vol     * f      1.0000e+00e
911 * fa      *      1.0000e+00      5.0000e-01e
912 * fric    * f      0.0000e+00e
913 * grav    * f      -1.0000e+00e
914 * hd      * f      1.0000e+00e
915 * nff     *      1              -1e
916 * alp     * f      0.0000e+00e
917 * vl      * f      0.0000e+00e
918 * vv      * f      0.0000e+00e
919 * tl      * f      3.0000e+02e
920 * tv      * f      3.0000e+02e
921 * p       * f      1.0000e+06e
922 * pa      * f      0.0000e+00e
923 *
924 *****      type              num              id              ctitle
925 vessel          18              18 fifth vessel component
926 *              nasx            nrxx          ntsx          ncsr          ivssbf
927 *              3              1              1              3              0
928 *              idcu            idcl          idcr          icru          icrl

```

```

929          0          0          0          0          0
930 *        icrr        ilcsp        iucsp        iuhp        iconc
931          0          0          0          0          0
932 *        igeom        nvent        nvvtb
933          1          0          0
934 *        shelv        epsw
935      1.6500e+01      1.0000e-05
936 *
937 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
938 * rad    *      1.0000e+00e
939 * th     *      1.0000e+00e
940 *
941 *          gc          gyc          gxrc          gzc
942      9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
943 *
944 *        lisrl        lisrc        lisrf        ljuns
945          3          1          2          23
946          3          1          2          24
947          1          1          -2          21
948 *
949 * level    1
950 *
951 * cfzl-t*      0.0000e+00e
952 * cfzl-z*      0.0000e+00e
953 * cfzl-r*      0.0000e+00e
954 * cfzv-t*      0.0000e+00e
955 * cfzv-z*      0.0000e+00e
956 * cfzv-r*      0.0000e+00e
957 * vol      *      1.0000e+00e
958 * fa-t      *      0.0000e+00e
959 * fa-z      *      1.0000e+00e
960 * fa-r      *      0.0000e+00e
961 * hd-t      *      0.0000e+00e
962 * hd-z      *      1.0000e+00e
963 * hd-r      *      0.0000e+00e
964 * alpn      *      0.0000e+00e
965 * vvn-t      *      0.0000e+00e
966 * vvn-z      *      0.0000e+00e
967 * vvn-r      *      0.0000e+00e
968 * vln-t      *      0.0000e+00e
969 * vln-z      *      0.0000e+00e
970 * vln-r      *      0.0000e+00e
971 * tvn      *      3.0000e+02e
972 * tln      *      3.0000e+02e
973 * pn      *      1.0000e+06e
974 * pan      *      0.0000e+00e
975 *
976 * level    2
977 *
978 * cfzl-t*      0.0000e+00e
979 * cfzl-z*      0.0000e+00e
980 * cfzl-r*      0.0000e+00e
981 * cfzv-t*      0.0000e+00e
982 * cfzv-z*      0.0000e+00e
983 * cfzv-r*      0.0000e+00e
984 * vol      *      1.0000e+00e
985 * fa-t      *      0.0000e+00e
986 * fa-z      *      1.0000e+00e
987 * fa-r      *      0.0000e+00e
988 * hd-t      *      0.0000e+00e
989 * hd-z      *      1.0000e+00e
990 * hd-r      *      0.0000e+00e

```



```

991 * alpn *      0.0000e+00e
992 * vvn-t *      0.0000e+00e
993 * vvn-z *      0.0000e+00e
994 * vvn-r *      0.0000e+00e
995 * vln-t *      0.0000e+00e
996 * vln-z *      0.0000e+00e
997 * vln-r *      0.0000e+00e
998 * tvn *        3.0000e+02e
999 * tln *        3.0000e+02e
1000 * pn *        1.0000e+06e
1001 * pan *       0.0000e+00e

```

```

1002 *
1003 * level      3
1004 *

```

```

1005 * cfzl-t*      0.0000e+00e
1006 * cfzl-z*      0.0000e+00e
1007 * cfzl-r*      0.0000e+00e
1008 * cfzv-t*      0.0000e+00e
1009 * cfzv-z*      0.0000e+00e
1010 * cfzv-r*      0.0000e+00e
1011 * vol *        1.0000e+00e
1012 * fa-t *        0.0000e+00e
1013 * fa-z *        1.0000e+00e
1014 * fa-r *        0.0000e+00e
1015 * hd-t *        0.0000e+00e
1016 * hd-z *        1.0000e+00e
1017 * hd-r *        0.0000e+00e
1018 * alpn *        0.0000e+00e
1019 * vvn-t *        0.0000e+00e
1020 * vvn-z *        0.0000e+00e
1021 * vvn-r *        0.0000e+00e
1022 * vln-t *        0.0000e+00e
1023 * vln-z *        0.0000e+00e
1024 * vln-r *        0.0000e+00e
1025 * tvn *        3.0000e+02e
1026 * tln *        3.0000e+02e
1027 * pn *        1.0000e+06e
1028 * pan *       0.0000e+00e

```

```

1029 *
1030 *****      type              num              id              ctitle
1031 vessel              19              19 sixth vessel component
1032 *              nasx              nrsx              ntsx              ncsr              ivssbf
1033 *              3              1              1              3              0
1034 *              idcu              idcl              idcr              icru              icrl
1035 *              0              0              0              0              0
1036 *              icrr              ilcsp              iucsp              iuhp              iconc
1037 *              0              0              0              0              0
1038 *              igeom              nvent              nvvtb
1039 *              1              0              0
1040 *              shelv              epsw
1041 *              1.9500e+01      1.0000e-05
1042 *
1043 * z *              1.0000e+00      2.0000e+00      3.0000e+00e
1044 * rad *              1.0000e+00e
1045 * th *              1.0000e+00e
1046 *
1047 *              gc              gyc              gxrc              gzc
1048 *              9.8066e+00      0.0000e+00      0.0000e+00      1.0000e+00
1049 *
1050 *              lisrl              lisrc              lisrf              ljuns
1051 *              1              1              -2              25
1052 *              1              1              -2              26

```

1053		3	1	2	22
1054	*				
1055	* level	1			
1056	*				
1057	* cfzl-t*	0.0000e+00e			
1058	* cfzl-z*	0.0000e+00e			
1059	* cfzl-r*	0.0000e+00e			
1060	* cfzv-t*	0.0000e+00e			
1061	* cfzv-z*	0.0000e+00e			
1062	* cfzv-r*	0.0000e+00e			
1063	* vol *	1.0000e+00e			
1064	* fa-t *	0.0000e+00e			
1065	* fa-z *	1.0000e+00e			
1066	* fa-r *	0.0000e+00e			
1067	* hd-t *	0.0000e+00e			
1068	* hd-z *	1.0000e+00e			
1069	* hd-r *	0.0000e+00e			
1070	* alpn *	0.0000e+00e			
1071	* vvn-t *	0.0000e+00e			
1072	* vvn-z *	0.0000e+00e			
1073	* vvn-r *	0.0000e+00e			
1074	* vln-t *	0.0000e+00e			
1075	* vln-z *	0.0000e+00e			
1076	* vln-r *	0.0000e+00e			
1077	* tvn *	3.0000e+02e			
1078	* tln *	3.0000e+02e			
1079	* pn *	1.0000e+06e			
1080	* pan *	0.0000e+00e			
1081	*				
1082	* level	2			
1083	*				
1084	* cfzl-t*	0.0000e+00e			
1085	* cfzl-z*	0.0000e+00e			
1086	* cfzl-r*	0.0000e+00e			
1087	* cfzv-t*	0.0000e+00e			
1088	* cfzv-z*	0.0000e+00e			
1089	* cfzv-r*	0.0000e+00e			
1090	* vol *	1.0000e+00e			
1091	* fa-t *	0.0000e+00e			
1092	* fa-z *	1.0000e+00e			
1093	* fa-r *	0.0000e+00e			
1094	* hd-t *	0.0000e+00e			
1095	* hd-z *	1.0000e+00e			
1096	* hd-r *	0.0000e+00e			
1097	* alpn *	0.0000e+00e			
1098	* vvn-t *	0.0000e+00e			
1099	* vvn-z *	0.0000e+00e			
1100	* vvn-r *	0.0000e+00e			
1101	* vln-t *	0.0000e+00e			
1102	* vln-z *	0.0000e+00e			
1103	* vln-r *	0.0000e+00e			
1104	* tvn *	3.0000e+02e			
1105	* tln *	3.0000e+02e			
1106	* pn *	1.0000e+06e			
1107	* pan *	0.0000e+00e			
1108	*				
1109	* level	3			
1110	*				
1111	* cfzl-t*	0.0000e+00e			
1112	* cfzl-z*	0.0000e+00e			
1113	* cfzl-r*	0.0000e+00e			
1114	* cfzv-t*	0.0000e+00e			

```

1115 * cfzv-z*      0.0000e+00e
1116 * cfzv-r*      0.0000e+00e
1117 * vol   *      1.0000e+00e
1118 * fa-t   *      0.0000e+00e
1119 * fa-z   *      1.0000e+00e
1120 * fa-r   *      0.0000e+00e
1121 * hd-t   *      0.0000e+00e
1122 * hd-z   *      1.0000e+00e
1123 * hd-r   *      0.0000e+00e
1124 * alpn   *      0.0000e+00e
1125 * vvn-t   *      0.0000e+00e
1126 * vvn-z   *      0.0000e+00e
1127 * vvn-r   *      0.0000e+00e
1128 * vln-t   *      0.0000e+00e
1129 * vln-z   *      0.0000e+00e
1130 * vln-r   *      0.0000e+00e
1131 * tvn     *      3.0000e+02e
1132 * tln     *      3.0000e+02e
1133 * pn      *      1.0000e+06e
1134 * pan     *      0.0000e+00e
1135 *
1136 *****      type          num          id          ctitle
1137 pipe                20          20 1st outlet pipe from vessel 18
1138 *          ncells      nodes          jun1          jun2          epsw
1139          1              0          27          23      1.0000e-05
1140 *          ichf      iconc          iacc          ipow
1141          0              0              0              0
1142 *          radin          th          houtl          houtv          toutl
1143      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
1144 *          toutv
1145      3.0000e+02
1146 *
1147 * dx      * f      1.0000e+00e
1148 * vol     * f      1.0000e+00e
1149 * fa      *      1.0000e+00      5.0000e-01e
1150 * fric   * f      0.0000e+00e
1151 * grav   * f      -1.0000e+00e
1152 * hd     * f      1.0000e+00e
1153 * nff    *      1          -1e
1154 * alp    * f      0.0000e+00e
1155 * vl     * f      0.0000e+00e
1156 * vv     * f      0.0000e+00e
1157 * tl     * f      3.0000e+02e
1158 * tv     * f      3.0000e+02e
1159 * p      * f      1.0000e+06e
1160 * pa     * f      0.0000e+00e
1161 *
1162 *****      type          num          id          ctitle
1163 pipe                21          21 2nd outlet pipe from vessel 18
1164 *          ncells      nodes          jun1          jun2          epsw
1165          1              0          28          24      1.0000e-05
1166 *          ichf      iconc          iacc          ipow
1167          0              0              0              0
1168 *          radin          th          houtl          houtv          toutl
1169      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
1170 *          toutv
1171      3.0000e+02
1172 *
1173 * dx      * f      1.0000e+00e
1174 * vol     * f      1.0000e+00e
1175 * fa      *      1.0000e+00      5.0000e-01e
1176 * fric   * f      0.0000e+00e

```

```

1177 * grav * f -1.0000e+00e
1178 * hd * f 1.0000e+00e
1179 * nff * 1 -1e
1180 * alp * f 0.0000e+00e
1181 * vl * f 0.0000e+00e
1182 * vv * f 0.0000e+00e
1183 * tl * f 3.0000e+02e
1184 * tv * f 3.0000e+02e
1185 * p * f 1.0000e+06e
1186 * pa * f 0.0000e+00e
1187 *
1188 ***** type num id ctitle
1189 pipe 22 22 1st outlet pipe from vessel 19
1190 * ncells nodes jun1 jun2 epsw
1191 1 0 29 25 1.0000e-05
1192 * ichf iconc iacc ipow
1193 0 0 0 0
1194 * radin th houtl houtv toutl
1195 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
1196 * toutv
1197 3.0000e+02
1198 *
1199 * dx * f 1.0000e+00e
1200 * vol * f 1.0000e+00e
1201 * fa * 1.0000e+00 5.0000e-01e
1202 * fric * f 0.0000e+00e
1203 * grav * f -1.0000e+00e
1204 * hd * f 1.0000e+00e
1205 * nff * 1 -1e
1206 * alp * f 0.0000e+00e
1207 * vl * f 0.0000e+00e
1208 * vv * f 0.0000e+00e
1209 * tl * f 3.0000e+02e
1210 * tv * f 3.0000e+02e
1211 * p * f 1.0000e+06e
1212 * pa * f 0.0000e+00e
1213 *
1214 ***** type num id ctitle
1215 pipe 23 23 2nd outlet pipe from vessel 19
1216 * ncells nodes jun1 jun2 epsw
1217 1 0 30 26 1.0000e-05
1218 * ichf iconc iacc ipow
1219 0 0 0 0
1220 * radin th houtl houtv toutl
1221 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
1222 * toutv
1223 3.0000e+02
1224 *
1225 * dx * f 1.0000e+00e
1226 * vol * f 1.0000e+00e
1227 * fa * 1.0000e+00 5.0000e-01e
1228 * fric * f 0.0000e+00e
1229 * grav * f -1.0000e+00e
1230 * hd * f 1.0000e+00e
1231 * nff * 1 -1e
1232 * alp * f 0.0000e+00e
1233 * vl * f 0.0000e+00e
1234 * vv * f 0.0000e+00e
1235 * tl * f 3.0000e+02e
1236 * tv * f 3.0000e+02e
1237 * p * f 1.0000e+06e
1238 * pa * f 0.0000e+00e

```

```

1239 *
1240 ***** type num id ctitle
1241 plenum 24 24 manifold plenum 24
1242 * npljn iconc juns1 juns2
1243 5 0 1 4
1244 *
1245 * junj * 31s
1246 * junj * 27 28 29 30e
1247 * dx * f 1.0000e+00e
1248 * vol * f 4.0000e+00e
1249 * elev * f 2.1000e+01e
1250 * alp * f 0.0000e+00e
1251 * tl * f 3.0000e+02e
1252 * tv * f 3.0000e+02e
1253 * p * f 1.0000e+06e
1254 * pa * f 0.0000e+00e
1255 *
1256 ***** type num id ctitle
1257 pipe 25 25 outlet pipe from plenum 24
1258 * ncells nodes jun1 jun2 epsw
1259 1 0 32 31 1.0000e-05
1260 * ichf iconc iacc ipow
1261 0 0 0 0
1262 * radin th houtl houtv toutl
1263 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
1264 * toutv
1265 3.0000e+02
1266 *
1267 * dx * f 1.0000e+00e
1268 * vol * f 1.0000e+00e
1269 * fa * f 1.0000e+00e
1270 * fric * f 0.0000e+00e
1271 * grav * f -1.0000e+00e
1272 * hd * f 1.0000e+00e
1273 * nff * 1 -1e
1274 * alp * f 0.0000e+00e
1275 * vl * f 0.0000e+00e
1276 * vv * f 0.0000e+00e
1277 * tl * f 3.0000e+02e
1278 * tv * f 3.0000e+02e
1279 * p * f 1.0000e+06e
1280 * pa * f 0.0000e+00e
1281 *
1282 ***** type num id ctitle
1283 break 26 26 pressure b.c. for pipe 25 outlet
1284 * jun1 ibty isat ioff
1285 32 0 0 0
1286 * dxin volin alpin tin pin
1287 1.0000e+00 1.0000e+00 0.0000e+00 3.0000e+02 1.0000e+06
1288 * pain concin rbmx poff belv
1289 0.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00 2.3000e+01
1290 *
1291 end
1292 *
1293 *****
1294 * time-step data *
1295 *****
1296 *
1297 * dtmin dtmax tend rtwfp
1298 1.0000e-03 1.0000e+00 1.0000e+01 1.0000e+00
1299 * edint gfint dmpint sedint
1300 1.0000e+01 1.0000e+00 1.1000e+01 1.0000e+01

```

1301 *				
1302 *	dtmin	dtmax	tend	rtwfp
1303	1.0000e-03	5.0000e+00	1.0000e+02	1.0000e+00
1304 *	edint	gfint	dmpint	sedint
1305	9.0000e+01	2.5000e+00	9.5000e+01	9.0000e+01
1306 *				
1307 *	dtmin	dtmax	tend	rtwfp
1308	1.0000e-02	3.0000e+01	1.0000e+03	1.0000e+00
1309 *	edint	gfint	dmpint	sedint
1310	9.0000e+02	1.5000e+01	9.3000e+02	9.0000e+02
1311 *				
1312 *	dtmin	dtmax	tend	rtwfp
1313	1.0000e-01	2.0000e+02	1.0000e+04	1.0000e+00
1314 *	edint	gfint	dmpint	sedint
1315	9.0000e+03	2.0000e+02	9.0000e+03	9.0000e+03
1316 *				
1317 *	endflag			
1318	-1.0000e+00			

A-4.9 MSRV Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              4              0              1              0              0
9 *--*--*TEST PROBLEM MSRV , Time = 10000.0 s
10 mirrored parallel-flow channel with single-phase vapor
11 vessels 8 and 18 have their cell numbering reversed
12 two pressure boundary conditions, tv = 500.0 k
13 *
14 *
15 *                                     nff          vv          fa
16 *                                     (-)         (m/s)        (m2)
17 *
18 *          #####
19 *          # break#
20 *          # 26 #   p = 1.0000e+06 pa
21 *          #####
22 *          32
23 *          #####
24 *          # pipe #
25 *          # 25 #
26 *          #####
27 *          31
28 *          #####
29 *          # plenum #
30 *          # 24 #
31 *          #####
32 *          27          28          29          30          1          -2.5          1.0x4
33 *          #####
34 *          # pipe # # pipe # # pipe # # pipe #
35 *          # 20 # # 21 # # 22 # # 23 #
36 *          #####
37 *          23          24          25          26          -1          -5.0          0.5x4
38 *          #####
39 *          # cell #
40 *          # 3 #
41 *          #-----#
42 *          #vessel#
43 *          # 18 #
44 *          #-----#
45 *          # cell #
46 *          # 1 #
47 *          #-----#
48 *          #vessel#
49 *          # 15 #
50 *          #-----#
51 *          # cell #
52 *          # 3 #
53 *          #####
54 *          19          20          -1          -10.0          0.5x2
55 *          #####
56 *          # cell #
57 *          # 1 #
58 *          #-----#
59 *          #vessel#
60 *          # 15 #
61 *          #-----#
62 *          # cell #
63 *          # 3 #
64 *          #####

```

```

61 *          18          1 -10.0  1.0
62 *          #####
63 *          # pipe #
64 *          # 14 #
65 *          #####
66 * -- mirror plane -- 17 -- mirror plane -- 1 10.0  1.0
67 *          #####
68 *          # pipe #
69 *          # 13 #
70 *          #####
71 *          16          1 10.0  1.0
72 *          #####
73 *          # cell #
74 *          # 3 #
75 *          #-----#
76 *          #vessel#
77 *          # 12 #
78 *          #-----#
79 *          # cell #
80 *          # 1 #
81 *          #####
82 *          14 15      -1 10.0  0.5x2
83 *          #####
84 *          # pipe # # pipe #
85 *          # 10 # # 11 #
86 *          #####
87 *          12 13      1 5.0  1.0x2
88 *          #####
89 *          # cell # # cell #
90 *          # 1 # # 3 #
91 *          #-----#
92 *          #vessel# #vessel#
93 *          # 8 # # 9 #
94 *          #-----#
95 *          # cell # # cell #
96 *          # 3 # # 1 #
97 *          #####
98 *          8 9 10 11  -1 5.0  0.5x4
99 *          #####
100 *          # pipe # # pipe # # pipe # # pipe #
101 *          # 4 # # 5 # # 6 # # 7 #
102 *          #####
103 *          4 5 6 7      1 2.5  1.0x4
104 *          #####
105 *          # plenum #
106 *          # 3 #
107 *          #####
108 *          3      -1 10.0  1.0
109 *          #####
110 *          # pipe #
111 *          # 2 #
112 *          #####
113 *          2      1 10.0  1.0
114 *          #####
115 *          # break# p = 1001758.5 pa
116 *          # 1 #
117 *          #####
118 *
119 *****
120 * namelist data *
121 *****
122 *

```



```

123 &inopts
124   iadded=10, ikfac=1, nvgrav=1, cpuflg=1,
125   idiag=4, nsdl=0, nsdu=5, nspl=0, nspl=0, nspl=0, nspl=0
126 &end
127 *
128 *           dstep           timet
129 *           0           0.0000e+00
130 *           stdyst           transi           ncomp           njun           ipak
131 *           0           1           26           31           0
132 *           epso           epss
133 *           1.0000e-04           1.0000e-04
134 *           oitmax           sitmax           isolut           ncontr           nccfl
135 *           10           10           0           0           0
136 *           ntsv           ntcbl           ntcf           ntrp           ntcp
137 *           1           0           0           0           0
138 *
139 *****
140 * component-number data *
141 *****
142 *
143 * iorder * 1 s * break           pressure b.c. for pipe 2 inlet
144 * iorder * 2 s * pipe           inlet pipe for plenum 3
145 * iorder * 3 s * plenum         manifold for parallel-channel pipes
146 * iorder * 4 s * pipe           1st inlet pipe for vessel 8
147 * iorder * 5 s * pipe           2nd inlet pipe for vessel 8
148 * iorder * 6 s * pipe           1st inlet pipe for vessel 9
149 * iorder * 7 s * pipe           2nd inlet pipe for vessel 9
150 * iorder * 8 s * vessel         first vessel component
151 * iorder * 9 s * vessel         second vessel component
152 * iorder * 10 s * pipe          outlet pipe for vessel 8
153 * iorder * 11 s * pipe          outlet pipe for vessel 9
154 * iorder * 12 s * vessel        third vessel component
155 * iorder * 13 s * pipe          outlet pipe for vessel 12
156 * iorder * 14 s * pipe          inlet pipe for vessel 15
157 * iorder * 15 s * vessel        fourth vessel component
158 * iorder * 16 s * pipe          inlet pipe for vessel 18
159 * iorder * 17 s * pipe          inlet pipe for vessel 19
160 * iorder * 18 s * vessel        fifth vessel component
161 * iorder * 19 s * vessel        sixth vessel component
162 * iorder * 20 s * pipe          1st outlet pipe for vessel 18
163 * iorder * 21 s * pipe          2nd outlet pipe for vessel 18
164 * iorder * 22 s * pipe          1st outlet pipe for vessel 19
165 * iorder * 23 s * pipe          2nd outlet pipe for vessel 19
166 * iorder * 24 s * plenum        manifold for parallel-channel pipes
167 * iorder * 25 s * pipe          outlet pipe for plenum 24
168 * iorder * 26 e * break         pressure b.c. for pipe 25 outlet
169 *
170 *****
171 * control parameters *
172 *****
173 *
174 * signal variable
175 *
176 *           idsv           isvn           icln           icn1           icn2
177 *           1           0           0           0           0
178 *
179 *****
180 * component data *
181 *****
182 *
183 * type           num           id           ctitle
184 break           1           1           pressure b.c. for pipe 2 inlet

```

```

185 *      jun1      ibty      isat      ioff
186      2          1          0          0
187 *      ibtr      ibsv      nbtb      nbsv      nbrf
188      0          1          2          0          0
189 *      dxin      volin      alpin      tin      pin
190      1.0000e+00  1.0000e+00  1.0000e+00  5.0000e+02  1.0000e+06
191 *      pain      concin     rbmx      poff      belv
192      0.0000e+00  0.0000e+00  1.7585e+03  0.0000e+00  0.0000e+00
193 *      pscl      tlscl      tvscl      pascl      conscl
194      1.0000e+00  0.0000e+00  0.0000e+00  0.0000e+00  0.0000e+00
195 *
196 * ptb *      0.0000e+00  1.0000e+06  1.0000e+00  1001758.50e
197 *
198 * type      num      id      ctitle
199 pipe      2          2      inlet pipe for plenum 3
200 *      ncells      nodes      jun1      jun2      epsw
201      1          0          2          3      1.0000e-05
202 *      ichf      iconc      iacc      ipow
203      0          0          0          0
204 *      radin      th      houtl      houtv      toutl
205      5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  5.0000e+02
206 *      toutv
207      5.0000e+02
208 *
209 * dx * f      1.0000e+00e
210 * vol * f      1.0000e+00e
211 * fa * f      1.0000e+00e
212 * fric * f      0.0000e+00e
213 * grav * f      1.0000e+00e
214 * hd * f      1.0000e+00e
215 * nff *      1          -1e
216 * alp * f      1.0000e+00e
217 * vl * f      0.0000e+00e
218 * vv * f      0.0000e+00e
219 * tl * f      5.0000e+02e
220 * tv * f      5.0000e+02e
221 * p * f      1.0000e+06e
222 * pa * f      0.0000e+00e
223 *
224 * type      num      id      ctitle
225 plenum      3          3      manifold plenum 3
226 *      npljn      iconc      juns1      juns2
227      5          0          1          4
228 *
229 * junj *      3s
230 * junj *      4          5          6          7e
231 * dx * f      1.0000e+00e
232 * vol * f      4.0000e+00e
233 * elev * f      2.0000e+00e
234 * alp * f      1.0000e+00e
235 * tl * f      5.0000e+02e
236 * tv * f      5.0000e+02e
237 * p * f      1.0000e+06e
238 * pa * f      0.0000e+00e
239 *
240 * type      num      id      ctitle
241 pipe      4          4      1st inlet pipe for vessel 8
242 *      ncells      nodes      jun1      jun2      epsw
243      1          0          4          8      1.0000e-05
244 *      ichf      iconc      iacc      ipow
245      0          0          0          0
246 *      radin      th      houtl      houtv      toutl

```

```

247      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
248 *          toutv
249      5.0000e+02
250 *
251 * dx      * f      1.0000e+00e
252 * vol      * f      1.0000e+00e
253 * fa      *      1.0000e+00      5.0000e-01e
254 * fric      * f      0.0000e+00e
255 * grav      * f      1.0000e+00e
256 * hd      * f      1.0000e+00e
257 * nff      *      1      -1e
258 * alp      * f      1.0000e+00e
259 * vl      * f      0.0000e+00e
260 * vv      * f      0.0000e+00e
261 * tl      * f      5.0000e+02e
262 * tv      * f      5.0000e+02e
263 * p      * f      1.0000e+06e
264 * pa      * f      0.0000e+00e
265 *
266 *****      type      num      id      ctitle
267 pipe      5      5 2nd inlet pipe for vessel 8
268 *      ncells      nodes      jun1      jun2      epsw
269      1      0      5      9      1.0000e-05
270 *      ichf      iconc      iacc      ipow
271      0      0      0      0
272 *      radin      th      hout1      houtv      tout1
273      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
274 *          toutv
275      5.0000e+02
276 *
277 * dx      * f      1.0000e+00e
278 * vol      * f      1.0000e+00e
279 * fa      *      1.0000e+00      5.0000e-01e
280 * fric      * f      0.0000e+00e
281 * grav      * f      1.0000e+00e
282 * hd      * f      1.0000e+00e
283 * nff      *      1      -1e
284 * alp      * f      1.0000e+00e
285 * vl      * f      0.0000e+00e
286 * vv      * f      0.0000e+00e
287 * tl      * f      5.0000e+02e
288 * tv      * f      5.0000e+02e
289 * p      * f      1.0000e+06e
290 * pa      * f      0.0000e+00e
291 *
292 *****      type      num      id      ctitle
293 pipe      6      6 1st inlet pipe for vessel 9
294 *      ncells      nodes      jun1      jun2      epsw
295      1      0      6      10      1.0000e-05
296 *      ichf      iconc      iacc      ipow
297      0      0      0      0
298 *      radin      th      hout1      houtv      tout1
299      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
300 *          toutv
301      5.0000e+02
302 *
303 * dx      * f      1.0000e+00e
304 * vol      * f      1.0000e+00e
305 * fa      *      1.0000e+00      5.0000e-01e
306 * fric      * f      0.0000e+00e
307 * grav      * f      1.0000e+00e
308 * hd      * f      1.0000e+00e

```

```

309 * nff * 1 -1e
310 * alp * f 1.0000e+00e
311 * vl * f 0.0000e+00e
312 * vv * f 0.0000e+00e
313 * tl * f 5.0000e+02e
314 * tv * f 5.0000e+02e
315 * p * f 1.0000e+06e
316 * pa * f 0.0000e+00e
317 *
318 ***** type num id ctitle
319 pipe 7 7 2nd inlet pipe for vessel 9
320 * ncells nodes jun1 jun2 epsw
321 1 0 7 11 1.0000e-05
322 * ichf iconc iacc ipow
323 0 0 0 0
324 * radin th houtl houtv toutl
325 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
326 * toutv
327 5.0000e+02
328 *
329 * dx * f 1.0000e+00e
330 * vol * f 1.0000e+00e
331 * fa * 1.0000e+00 5.0000e-01e
332 * fric * f 0.0000e+00e
333 * grav * f 1.0000e+00e
334 * hd * f 1.0000e+00e
335 * nff * 1 -1e
336 * alp * f 1.0000e+00e
337 * vl * f 0.0000e+00e
338 * vv * f 0.0000e+00e
339 * tl * f 5.0000e+02e
340 * tv * f 5.0000e+02e
341 * p * f 1.0000e+06e
342 * pa * f 0.0000e+00e
343 *
344 ***** type num id ctitle
345 vessel 8 8 first vessel component
346 * nasx nrsx ntsx ncsr ivssbf
347 3 1 1 3 0
348 * idcu idcl idcr icru icrl
349 0 0 0 0 0
350 * icrr ilcsp iucsp iuhp iconc
351 0 0 0 0 0
352 * igeom nvent nvvtb
353 1 0 0
354 * shelv epsw
355 6.5000e+00 1.0000e-05
356 *
357 * z * 1.0000e+00 2.0000e+00 3.0000e+00e
358 * rad * 1.0000e+00e
359 * th * 1.0000e+00e
360 *
361 * gc gytc gxrc gzc
362 9.8066e+00 0.0000e+00 0.0000e+00 1.0000e+00
363 *
364 * lisrl lisrc lisrf ljuns
365 3 1 2 8
366 3 1 2 9
367 1 1 -2 12
368 *
369 * level 1
370 *

```

371	*	cfzl-t*	0.0000e+00e
372	*	cfzl-z*	0.0000e+00e
373	*	cfzl-r*	0.0000e+00e
374	*	cfzv-t*	0.0000e+00e
375	*	cfzv-z*	0.0000e+00e
376	*	cfzv-r*	0.0000e+00e
377	*	vol	1.0000e+00e
378	*	fa-t	0.0000e+00e
379	*	fa-z	1.0000e+00e
380	*	fa-r	0.0000e+00e
381	*	hd-t	0.0000e+00e
382	*	hd-z	1.0000e+00e
383	*	hd-r	0.0000e+00e
384	*	alpn	1.0000e+00e
385	*	vvv-t	0.0000e+00e
386	*	vvv-z	0.0000e+00e
387	*	vvv-r	0.0000e+00e
388	*	vln-t	0.0000e+00e
389	*	vln-z	0.0000e+00e
390	*	vln-r	0.0000e+00e
391	*	tvn	5.0000e+02e
392	*	tln	5.0000e+02e
393	*	pn	1.0000e+06e
394	*	pan	0.0000e+00e
395	*		
396	*	level	2
397	*		
398	*	cfzl-t*	0.0000e+00e
399	*	cfzl-z*	0.0000e+00e
400	*	cfzl-r*	0.0000e+00e
401	*	cfzv-t*	0.0000e+00e
402	*	cfzv-z*	0.0000e+00e
403	*	cfzv-r*	0.0000e+00e
404	*	vol	1.0000e+00e
405	*	fa-t	0.0000e+00e
406	*	fa-z	1.0000e+00e
407	*	fa-r	0.0000e+00e
408	*	hd-t	0.0000e+00e
409	*	hd-z	1.0000e+00e
410	*	hd-r	0.0000e+00e
411	*	alpn	1.0000e+00e
412	*	vvv-t	0.0000e+00e
413	*	vvv-z	0.0000e+00e
414	*	vvv-r	0.0000e+00e
415	*	vln-t	0.0000e+00e
416	*	vln-z	0.0000e+00e
417	*	vln-r	0.0000e+00e
418	*	tvn	5.0000e+02e
419	*	tln	5.0000e+02e
420	*	pn	1.0000e+06e
421	*	pan	0.0000e+00e
422	*		
423	*	level	3
424	*		
425	*	cfzl-t*	0.0000e+00e
426	*	cfzl-z*	0.0000e+00e
427	*	cfzl-r*	0.0000e+00e
428	*	cfzv-t*	0.0000e+00e
429	*	cfzv-z*	0.0000e+00e
430	*	cfzv-r*	0.0000e+00e
431	*	vol	1.0000e+00e
432	*	fa-t	0.0000e+00e

```

433 * fa-z *      1.0000e+00e
434 * fa-r *      0.0000e+00e
435 * hd-t *      0.0000e+00e
436 * hd-z *      1.0000e+00e
437 * hd-r *      0.0000e+00e
438 * alpn *      1.0000e+00e
439 * vvn-t *      0.0000e+00e
440 * vvn-z *      0.0000e+00e
441 * vvn-r *      0.0000e+00e
442 * vln-t *      0.0000e+00e
443 * vln-z *      0.0000e+00e
444 * vln-r *      0.0000e+00e
445 * tvn *        5.0000e+02e
446 * tln *        5.0000e+02e
447 * pn *         1.0000e+06e
448 * pan *        0.0000e+00e
449 *
450 *****      type          num          id          ctitle
451 vessel                9          9 second vessel component
452 *      nasx          nrsx          ntsx          ncsr          ivssbf
453 *      3              1              1              3              0
454 *      idcu          idcl          idcr          icru          icrl
455 *      0              0              0              0              0
456 *      icrr          ilcsp          iucsp          iuhp          iconc
457 *      0              0              0              0              0
458 *      igeom          nvent          nvvtb
459 *      1              0              0
460 *      shelv          epsw
461 *      3.5000e+00    1.0000e-05
462 *
463 * z *      1.0000e+00    2.0000e+00    3.0000e+00e
464 * rad *      1.0000e+00e
465 * th *      1.0000e+00e
466 *
467 *      gc          gytc          gxrc          gzc
468 *      9.8066e+00    0.0000e+00    0.0000e+00    -1.0000e+00
469 *
470 *      lisrl          lisrc          lisrf          ljuns
471 *      1              1              -2              10
472 *      1              1              -2              11
473 *      3              1              2              13
474 *
475 * level 1
476 *
477 * cfzl-t*      0.0000e+00e
478 * cfzl-z*      0.0000e+00e
479 * cfzl-r*      0.0000e+00e
480 * cfzv-t*      0.0000e+00e
481 * cfzv-z*      0.0000e+00e
482 * cfzv-r*      0.0000e+00e
483 * vol *      1.0000e+00e
484 * fa-t *      0.0000e+00e
485 * fa-z *      1.0000e+00e
486 * fa-r *      0.0000e+00e
487 * hd-t *      0.0000e+00e
488 * hd-z *      1.0000e+00e
489 * hd-r *      0.0000e+00e
490 * alpn *      1.0000e+00e
491 * vvn-t *      0.0000e+00e
492 * vvn-z *      0.0000e+00e
493 * vvn-r *      0.0000e+00e
494 * vln-t *      0.0000e+00e

```

```

495 * vln-z *      0.0000e+00e
496 * vln-r *      0.0000e+00e
497 * tvn  *      5.0000e+02e
498 * tln  *      5.0000e+02e
499 * pn   *      1.0000e+06e
500 * pan  *      0.0000e+00e
501 *
502 * level  2
503 *
504 * cfzl-t*      0.0000e+00e
505 * cfzl-z*      0.0000e+00e
506 * cfzl-r*      0.0000e+00e
507 * cfzv-t*      0.0000e+00e
508 * cfzv-z*      0.0000e+00e
509 * cfzv-r*      0.0000e+00e
510 * vol   *      1.0000e+00e
511 * fa-t  *      0.0000e+00e
512 * fa-z  *      1.0000e+00e
513 * fa-r  *      0.0000e+00e
514 * hd-t  *      0.0000e+00e
515 * hd-z  *      1.0000e+00e
516 * hd-r  *      0.0000e+00e
517 * alpn  *      1.0000e+00e
518 * vvn-t *      0.0000e+00e
519 * vvn-z *      0.0000e+00e
520 * vvn-r *      0.0000e+00e
521 * vln-t *      0.0000e+00e
522 * vln-z *      0.0000e+00e
523 * vln-r *      0.0000e+00e
524 * tvn   *      5.0000e+02e
525 * tln   *      5.0000e+02e
526 * pn    *      1.0000e+06e
527 * pan   *      0.0000e+00e
528 *
529 * level  3
530 *
531 * cfzl-t*      0.0000e+00e
532 * cfzl-z*      0.0000e+00e
533 * cfzl-r*      0.0000e+00e
534 * cfzv-t*      0.0000e+00e
535 * cfzv-z*      0.0000e+00e
536 * cfzv-r*      0.0000e+00e
537 * vol   *      1.0000e+00e
538 * fa-t  *      0.0000e+00e
539 * fa-z  *      1.0000e+00e
540 * fa-r  *      0.0000e+00e
541 * hd-t  *      0.0000e+00e
542 * hd-z  *      1.0000e+00e
543 * hd-r  *      0.0000e+00e
544 * alpn  *      1.0000e+00e
545 * vvn-t *      0.0000e+00e
546 * vvn-z *      0.0000e+00e
547 * vvn-r *      0.0000e+00e
548 * vln-t *      0.0000e+00e
549 * vln-z *      0.0000e+00e
550 * vln-r *      0.0000e+00e
551 * tvn   *      5.0000e+02e
552 * tln   *      5.0000e+02e
553 * pn    *      1.0000e+06e
554 * pan   *      0.0000e+00e
555 *
556 *****      type      num      id      ctitle

```

```

557 pipe                10                10 outlet pipe for vessel 8
558 *      ncells      nodes      jun1      jun2      epsw
559 *      1            0            12        14      1.0000e-05
560 *      ichf         iconc         iacc         ipow
561 *      0            0            0            0
562 *      radin         th          houtl         houtv         toutl
563 *      5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    5.0000e+02
564 *      toutv
565 *      5.0000e+02
566 *
567 * dx      * f      1.0000e+00e
568 * vol     * f      1.0000e+00e
569 * fa      *      1.0000e+00      5.0000e-01e
570 * fric   * f      0.0000e+00e
571 * grav   * f      1.0000e+00e
572 * hd     * f      1.0000e+00e
573 * nff    *      1            -1e
574 * alp    * f      1.0000e+00e
575 * vl     * f      0.0000e+00e
576 * vv     * f      0.0000e+00e
577 * tl     * f      5.0000e+02e
578 * tv     * f      5.0000e+02e
579 * p      * f      1.0000e+06e
580 * pa     * f      0.0000e+00e
581 *
582 ***** type      num      id      ctitle
583 pipe                11      11 outlet pipe for vessel 9
584 *      ncells      nodes      jun1      jun2      epsw
585 *      1            0            13        15      1.0000e-05
586 *      ichf         iconc         iacc         ipow
587 *      0            0            0            0
588 *      radin         th          houtl         houtv         toutl
589 *      5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    5.0000e+02
590 *      toutv
591 *      5.0000e+02
592 *
593 * dx      * f      1.0000e+00e
594 * vol     * f      1.0000e+00e
595 * fa      *      1.0000e+00      5.0000e-01e
596 * fric   * f      0.0000e+00e
597 * grav   * f      1.0000e+00e
598 * hd     * f      1.0000e+00e
599 * nff    *      1            -1e
600 * alp    * f      1.0000e+00e
601 * vl     * f      0.0000e+00e
602 * vv     * f      0.0000e+00e
603 * tl     * f      5.0000e+02e
604 * tv     * f      5.0000e+02e
605 * p      * f      1.0000e+06e
606 * pa     * f      0.0000e+00e
607 *
608 ***** type      num      id      ctitle
609 vessel            12      12 third vessel component
610 *      nasx      nrsx      ntsx      ncsr      ivssbf
611 *      3            1            1            3            0
612 *      idcu      idcl      idcr      icru      icrl
613 *      0            0            0            0            0
614 *      icrr      ilcsp      iucsp      iuhp      iconc
615 *      0            0            0            0            0
616 *      igeom      nvent      nvvtb
617 *      1            0            0
618 *      shelv      epsw

```



```

619      7.5000e+00      1.0000e-05
620 *
621 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
622 * rad    *      1.0000e+00e
623 * th     *      1.0000e+00e
624 *
625 *          gc          gyc          gxrc          gzc
626      9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
627 *
628 *          lisrl          lisrc          lisrf          ljuns
629      1          1          -2          14
630      1          1          -2          15
631      3          1          2          16
632 *
633 * level    1
634 *
635 * cfzl-t*      0.0000e+00e
636 * cfzl-z*      0.0000e+00e
637 * cfzl-r*      0.0000e+00e
638 * cfzv-t*      0.0000e+00e
639 * cfzv-z*      0.0000e+00e
640 * cfzv-r*      0.0000e+00e
641 * vol      *      1.0000e+00e
642 * fa-t      *      0.0000e+00e
643 * fa-z      *      1.0000e+00e
644 * fa-r      *      0.0000e+00e
645 * hd-t      *      0.0000e+00e
646 * hd-z      *      1.0000e+00e
647 * hd-r      *      0.0000e+00e
648 * alpn      *      1.0000e+00e
649 * vvn-t      *      0.0000e+00e
650 * vvn-z      *      0.0000e+00e
651 * vvn-r      *      0.0000e+00e
652 * vln-t      *      0.0000e+00e
653 * vln-z      *      0.0000e+00e
654 * vln-r      *      0.0000e+00e
655 * tvn      *      5.0000e+02e
656 * tln      *      5.0000e+02e
657 * pn      *      1.0000e+06e
658 * pan      *      0.0000e+00e
659 *
660 * level    2
661 *
662 * cfzl-t*      0.0000e+00e
663 * cfzl-z*      0.0000e+00e
664 * cfzl-r*      0.0000e+00e
665 * cfzv-t*      0.0000e+00e
666 * cfzv-z*      0.0000e+00e
667 * cfzv-r*      0.0000e+00e
668 * vol      *      1.0000e+00e
669 * fa-t      *      0.0000e+00e
670 * fa-z      *      1.0000e+00e
671 * fa-r      *      0.0000e+00e
672 * hd-t      *      0.0000e+00e
673 * hd-z      *      1.0000e+00e
674 * hd-r      *      0.0000e+00e
675 * alpn      *      1.0000e+00e
676 * vvn-t      *      0.0000e+00e
677 * vvn-z      *      0.0000e+00e
678 * vvn-r      *      0.0000e+00e
679 * vln-t      *      0.0000e+00e
680 * vln-z      *      0.0000e+00e

```

```

681 * vln-r *      0.0000e+00e
682 * tvn   *      5.0000e+02e
683 * tln   *      5.0000e+02e
684 * pn    *      1.0000e+06e
685 * pan   *      0.0000e+00e
686 *
687 * level   3
688 *
689 * cfzl-t*      0.0000e+00e
690 * cfzl-z*      0.0000e+00e
691 * cfzl-r*      0.0000e+00e
692 * cfzv-t*      0.0000e+00e
693 * cfzv-z*      0.0000e+00e
694 * cfzv-r*      0.0000e+00e
695 * vol    *      1.0000e+00e
696 * fa-t   *      0.0000e+00e
697 * fa-z   *      1.0000e+00e
698 * fa-r   *      0.0000e+00e
699 * hd-t   *      0.0000e+00e
700 * hd-z   *      1.0000e+00e
701 * hd-r   *      0.0000e+00e
702 * alpn   *      1.0000e+00e
703 * vvn-t   *      0.0000e+00e
704 * vvn-z   *      0.0000e+00e
705 * vvn-r   *      0.0000e+00e
706 * vln-t   *      0.0000e+00e
707 * vln-z   *      0.0000e+00e
708 * vln-r   *      0.0000e+00e
709 * tvn    *      5.0000e+02e
710 * tln    *      5.0000e+02e
711 * pn     *      1.0000e+06e
712 * pan    *      0.0000e+00e
713 *

```

```

714 *****      type          num          id          ctitle
715 pipe                      13          13 outlet pipe for vessel 12
716 *      ncells          nodes          jun1          jun2          epsw
717 *      1              0              16              17          1.0000e-05
718 *      ichf          iconc          iacc          ipow
719 *      0              0              0              0
720 *      radin          th          houtl          houtv          toutl
721 *      5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    5.0000e+02
722 *      toutv
723 *      5.0000e+02
724 *

```

```

725 * dx      * f      1.0000e+00e
726 * vol     * f      1.0000e+00e
727 * fa      * f      1.0000e+00e
728 * fric    * f      0.0000e+00e
729 * grav    * f      1.0000e+00e
730 * hd      * f      1.0000e+00e
731 * nff     * f          1e
732 * alp     * f      1.0000e+00e
733 * vl      * f      0.0000e+00e
734 * vv      * f      0.0000e+00e
735 * tl      * f      5.0000e+02e
736 * tv      * f      5.0000e+02e
737 * p       * f      1.0000e+06e
738 * pa      * f      0.0000e+00e
739 *

```

```

740 *****      type          num          id          ctitle
741 pipe                      14          14 inlet pipe for vessel 15
742 *      ncells          nodes          jun1          jun2          epsw

```

743		1	0	18	17	1.0000e-05
744 *	ichf	iconc	iacc	ipow		
745	0	0	0	0		
746 *	radin	th	houtl	houtv	toutl	
747	5.0000e-01	5.0000e-02	0.0000e+00	0.0000e+00	5.0000e+02	
748 *	toutv					
749	5.0000e+02					
750 *						
751 *	dx	* f	1.0000e+00e			
752 *	vol	* f	1.0000e+00e			
753 *	fa	* f	1.0000e+00e			
754 *	fric	* f	0.0000e+00e			
755 *	grav	* f	-1.0000e+00e			
756 *	hd	* f	1.0000e+00e			
757 *	nff	* f	1e			
758 *	alp	* f	1.0000e+00e			
759 *	vl	* f	0.0000e+00e			
760 *	vv	* f	0.0000e+00e			
761 *	tl	* f	5.0000e+02e			
762 *	tv	* f	5.0000e+02e			
763 *	p	* f	1.0000e+06e			
764 *	pa	* f	0.0000e+00e			
765 *						
766	*****	type	num	id	ctitle	
767	vessel		15	15	fourth vessel component	
768 *	nasx	nrsx	ntsx	ncsr	ivssbf	
769	3	1	1	3	0	
770 *	idcu	idcl	idcr	icru	icrl	
771	0	0	0	0	0	
772 *	icrr	ilcsp	iucsp	iuhp	iconc	
773	0	0	0	0	0	
774 *	igeom	nvent	nvvtb			
775	1	0	0			
776 *	shelv	epsw				
777	1.5500e+01	1.0000e-05				
778 *						
779 *	z	* 1.0000e+00	2.0000e+00	3.0000e+00e		
780 *	rad	* 1.0000e+00e				
781 *	th	* 1.0000e+00e				
782 *						
783 *	gc	gytc	gxrc	gzc		
784	9.8066e+00	0.0000e+00	0.0000e+00	1.0000e+00		
785 *						
786 *	lisrl	lisrc	lisrf	ljuns		
787	1	1	-2	19		
788	1	1	-2	20		
789	3	1	2	18		
790 *						
791 *	level	1				
792 *						
793 *	cfzl-t*	0.0000e+00e				
794 *	cfzl-z*	0.0000e+00e				
795 *	cfzl-r*	0.0000e+00e				
796 *	cfzv-t*	0.0000e+00e				
797 *	cfzv-z*	0.0000e+00e				
798 *	cfzv-r*	0.0000e+00e				
799 *	vol	* 1.0000e+00e				
800 *	fa-t	* 0.0000e+00e				
801 *	fa-z	* 1.0000e+00e				
802 *	fa-r	* 0.0000e+00e				
803 *	hd-t	* 0.0000e+00e				
804 *	hd-z	* 1.0000e+00e				

805	*	hd-r	*	0.0000e+00e
806	*	alpn	*	1.0000e+00e
807	*	vvv-t	*	0.0000e+00e
808	*	vvv-z	*	0.0000e+00e
809	*	vvv-r	*	0.0000e+00e
810	*	vln-t	*	0.0000e+00e
811	*	vln-z	*	0.0000e+00e
812	*	vln-r	*	0.0000e+00e
813	*	tvn	*	5.0000e+02e
814	*	tlv	*	5.0000e+02e
815	*	pn	*	1.0000e+06e
816	*	pan	*	0.0000e+00e
817	*			
818	*	level	2	
819	*			
820	*	cfzl-t*		0.0000e+00e
821	*	cfzl-z*		0.0000e+00e
822	*	cfzl-r*		0.0000e+00e
823	*	cfzv-t*		0.0000e+00e
824	*	cfzv-z*		0.0000e+00e
825	*	cfzv-r*		0.0000e+00e
826	*	vol	*	1.0000e+00e
827	*	fa-t	*	0.0000e+00e
828	*	fa-z	*	1.0000e+00e
829	*	fa-r	*	0.0000e+00e
830	*	hd-t	*	0.0000e+00e
831	*	hd-z	*	1.0000e+00e
832	*	hd-r	*	0.0000e+00e
833	*	alpn	*	1.0000e+00e
834	*	vvv-t	*	0.0000e+00e
835	*	vvv-z	*	0.0000e+00e
836	*	vvv-r	*	0.0000e+00e
837	*	vln-t	*	0.0000e+00e
838	*	vln-z	*	0.0000e+00e
839	*	vln-r	*	0.0000e+00e
840	*	tvn	*	5.0000e+02e
841	*	tlv	*	5.0000e+02e
842	*	pn	*	1.0000e+06e
843	*	pan	*	0.0000e+00e
844	*			
845	*	level	3	
846	*			
847	*	cfzl-t*		0.0000e+00e
848	*	cfzl-z*		0.0000e+00e
849	*	cfzl-r*		0.0000e+00e
850	*	cfzv-t*		0.0000e+00e
851	*	cfzv-z*		0.0000e+00e
852	*	cfzv-r*		0.0000e+00e
853	*	vol	*	1.0000e+00e
854	*	fa-t	*	0.0000e+00e
855	*	fa-z	*	1.0000e+00e
856	*	fa-r	*	0.0000e+00e
857	*	hd-t	*	0.0000e+00e
858	*	hd-z	*	1.0000e+00e
859	*	hd-r	*	0.0000e+00e
860	*	alpn	*	1.0000e+00e
861	*	vvv-t	*	0.0000e+00e
862	*	vvv-z	*	0.0000e+00e
863	*	vvv-r	*	0.0000e+00e
864	*	vln-t	*	0.0000e+00e
865	*	vln-z	*	0.0000e+00e
866	*	vln-r	*	0.0000e+00e

```

867 * tvn      *      5.0000e+02e
868 * tln      *      5.0000e+02e
869 * pn       *      1.0000e+06e
870 * pan      *      0.0000e+00e
871 *
872 *****      type              num              id              ctitle
873 pipe              16              16 inlet pipe for vessel 18
874 *              ncells          nodes          jun1          jun2          epsw
875              1              0              21              19          1.0000e-05
876 *              ichf            iconc            iacc            ipow
877              0              0              0              0
878 *              radin            th              hout1            houtv            tout1
879              5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
880 *              toutv
881              5.0000e+02
882 *
883 * dx      * f      1.0000e+00e
884 * vol     * f      1.0000e+00e
885 * fa      *      1.0000e+00      5.0000e-01e
886 * fric    * f      0.0000e+00e
887 * grav     * f     -1.0000e+00e
888 * hd       * f      1.0000e+00e
889 * nff      *              1              -1e
890 * alp      * f      1.0000e+00e
891 * vl       * f      0.0000e+00e
892 * vv       * f      0.0000e+00e
893 * tl       * f      5.0000e+02e
894 * tv       * f      5.0000e+02e
895 * p        * f      1.0000e+06e
896 * pa       * f      0.0000e+00e
897 *
898 *****      type              num              id              ctitle
899 pipe              17              17 inlet pipe for vessel 19
900 *              ncells          nodes          jun1          jun2          epsw
901              1              0              22              20          1.0000e-05
902 *              ichf            iconc            iacc            ipow
903              0              0              0              0
904 *              radin            th              hout1            houtv            tout1
905              5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
906 *              toutv
907              5.0000e+02
908 *
909 * dx      * f      1.0000e+00e
910 * vol     * f      1.0000e+00e
911 * fa      *      1.0000e+00      5.0000e-01e
912 * fric    * f      0.0000e+00e
913 * grav     * f     -1.0000e+00e
914 * hd       * f      1.0000e+00e
915 * nff      *              1              -1e
916 * alp      * f      1.0000e+00e
917 * vl       * f      0.0000e+00e
918 * vv       * f      0.0000e+00e
919 * tl       * f      5.0000e+02e
920 * tv       * f      5.0000e+02e
921 * p        * f      1.0000e+06e
922 * pa       * f      0.0000e+00e
923 *
924 *****      type              num              id              ctitle
925 vessel              18              18 fifth vessel component
926 *              nasx            nrxx            ntsx            ncsr            ivssbf
927              3              1              1              3              0
928 *              idcu            idcl            idcr            icru            icrl

```

929		0	0	0	0	0
930	*	icrr	ilcsp	iucsp	iuhp	iconc
931		0	0	0	0	0
932	*	igeom	nvent	nvvtb		
933		1	0	0		
934	*	shelv	epsw			
935		1.6500e+01	1.0000e-05			
936	*					
937	* z	*	1.0000e+00	2.0000e+00	3.0000e+00e	
938	* rad	*	1.0000e+00e			
939	* th	*	1.0000e+00e			
940	*					
941	*	gc	gytc	gxrc	gzc	
942		9.8066e+00	0.0000e+00	0.0000e+00	-1.0000e+00	
943	*					
944	*	lisrl	lisrc	lisrf	ljuns	
945		3	1	2	23	
946		3	1	2	24	
947		1	1	-2	21	
948	*					
949	* level	1				
950	*					
951	* cfzl-t*	0.0000e+00e				
952	* cfzl-z*	0.0000e+00e				
953	* cfzl-r*	0.0000e+00e				
954	* cfzv-t*	0.0000e+00e				
955	* cfzv-z*	0.0000e+00e				
956	* cfzv-r*	0.0000e+00e				
957	* vol	1.0000e+00e				
958	* fa-t	0.0000e+00e				
959	* fa-z	1.0000e+00e				
960	* fa-r	0.0000e+00e				
961	* hd-t	0.0000e+00e				
962	* hd-z	1.0000e+00e				
963	* hd-r	0.0000e+00e				
964	* alpn	1.0000e+00e				
965	* vvn-t	0.0000e+00e				
966	* vvn-z	0.0000e+00e				
967	* vvn-r	0.0000e+00e				
968	* vln-t	0.0000e+00e				
969	* vln-z	0.0000e+00e				
970	* vln-r	0.0000e+00e				
971	* tvn	5.0000e+02e				
972	* tln	5.0000e+02e				
973	* pn	1.0000e+06e				
974	* pan	0.0000e+00e				
975	*					
976	* level	2				
977	*					
978	* cfzl-t*	0.0000e+00e				
979	* cfzl-z*	0.0000e+00e				
980	* cfzl-r*	0.0000e+00e				
981	* cfzv-t*	0.0000e+00e				
982	* cfzv-z*	0.0000e+00e				
983	* cfzv-r*	0.0000e+00e				
984	* vol	1.0000e+00e				
985	* fa-t	0.0000e+00e				
986	* fa-z	1.0000e+00e				
987	* fa-r	0.0000e+00e				
988	* hd-t	0.0000e+00e				
989	* hd-z	1.0000e+00e				
990	* hd-r	0.0000e+00e				

```

991 * alpn * 1.0000e+00e
992 * vvn-t * 0.0000e+00e
993 * vvn-z * 0.0000e+00e
994 * vvn-r * 0.0000e+00e
995 * vln-t * 0.0000e+00e
996 * vln-z * 0.0000e+00e
997 * vln-r * 0.0000e+00e
998 * tvn * 5.0000e+02e
999 * tln * 5.0000e+02e
1000 * pn * 1.0000e+06e
1001 * pan * 0.0000e+00e
1002 *
1003 * level 3
1004 *
1005 * cfzl-t* 0.0000e+00e
1006 * cfzl-z* 0.0000e+00e
1007 * cfzl-r* 0.0000e+00e
1008 * cfzv-t* 0.0000e+00e
1009 * cfzv-z* 0.0000e+00e
1010 * cfzv-r* 0.0000e+00e
1011 * vol * 1.0000e+00e
1012 * fa-t * 0.0000e+00e
1013 * fa-z * 1.0000e+00e
1014 * fa-r * 0.0000e+00e
1015 * hd-t * 0.0000e+00e
1016 * hd-z * 1.0000e+00e
1017 * hd-r * 0.0000e+00e
1018 * alpn * 1.0000e+00e
1019 * vvn-t * 0.0000e+00e
1020 * vvn-z * 0.0000e+00e
1021 * vvn-r * 0.0000e+00e
1022 * vln-t * 0.0000e+00e
1023 * vln-z * 0.0000e+00e
1024 * vln-r * 0.0000e+00e
1025 * tvn * 5.0000e+02e
1026 * tln * 5.0000e+02e
1027 * pn * 1.0000e+06e
1028 * pan * 0.0000e+00e

```

```

1029 *
1030 ***** type num id ctitle
1031 vessel 19 19 sixth vessel component
1032 * nasx nrsx ntsx ncsr ivssbf
1033 * 3 1 1 3 0
1034 * idcu idcl idcr icru icrl
1035 * 0 0 0 0 0
1036 * icrr ilcsp iucsp iuhp iconc
1037 * 0 0 0 0 0
1038 * igeom nvent nvvtb
1039 * 1 0 0
1040 * shelv epsw
1041 1.9500e+01 1.0000e-05
1042 *
1043 * z * 1.0000e+00 2.0000e+00 3.0000e+00e
1044 * rad * 1.0000e+00e
1045 * th * 1.0000e+00e
1046 *
1047 * gc gytc gxrc gzc
1048 9.8066e+00 0.0000e+00 0.0000e+00 1.0000e+00
1049 *
1050 * lisrl lisrc lisrf ljuns
1051 1 1 -2 25
1052 1 1 -2 26

```

1053		3	1	2	22
1054	*				
1055	* level	1			
1056	*				
1057	* cfzl-t*	0.0000e+00e			
1058	* cfzl-z*	0.0000e+00e			
1059	* cfzl-r*	0.0000e+00e			
1060	* cfzv-t*	0.0000e+00e			
1061	* cfzv-z*	0.0000e+00e			
1062	* cfzv-r*	0.0000e+00e			
1063	* vol *	1.0000e+00e			
1064	* fa-t *	0.0000e+00e			
1065	* fa-z *	1.0000e+00e			
1066	* fa-r *	0.0000e+00e			
1067	* hd-t *	0.0000e+00e			
1068	* hd-z *	1.0000e+00e			
1069	* hd-r *	0.0000e+00e			
1070	* alpn *	1.0000e+00e			
1071	* vvn-t *	0.0000e+00e			
1072	* vvn-z *	0.0000e+00e			
1073	* vvn-r *	0.0000e+00e			
1074	* vln-t *	0.0000e+00e			
1075	* vln-z *	0.0000e+00e			
1076	* vln-r *	0.0000e+00e			
1077	* tvn *	5.0000e+02e			
1078	* tln *	5.0000e+02e			
1079	* pn *	1.0000e+06e			
1080	* pan *	0.0000e+00e			
1081	*				
1082	* level	2			
1083	*				
1084	* cfzl-t*	0.0000e+00e			
1085	* cfzl-z*	0.0000e+00e			
1086	* cfzl-r*	0.0000e+00e			
1087	* cfzv-t*	0.0000e+00e			
1088	* cfzv-z*	0.0000e+00e			
1089	* cfzv-r*	0.0000e+00e			
1090	* vol *	1.0000e+00e			
1091	* fa-t *	0.0000e+00e			
1092	* fa-z *	1.0000e+00e			
1093	* fa-r *	0.0000e+00e			
1094	* hd-t *	0.0000e+00e			
1095	* hd-z *	1.0000e+00e			
1096	* hd-r *	0.0000e+00e			
1097	* alpn *	1.0000e+00e			
1098	* vvn-t *	0.0000e+00e			
1099	* vvn-z *	0.0000e+00e			
1100	* vvn-r *	0.0000e+00e			
1101	* vln-t *	0.0000e+00e			
1102	* vln-z *	0.0000e+00e			
1103	* vln-r *	0.0000e+00e			
1104	* tvn *	5.0000e+02e			
1105	* tln *	5.0000e+02e			
1106	* pn *	1.0000e+06e			
1107	* pan *	0.0000e+00e			
1108	*				
1109	* level	3			
1110	*				
1111	* cfzl-t*	0.0000e+00e			
1112	* cfzl-z*	0.0000e+00e			
1113	* cfzl-r*	0.0000e+00e			
1114	* cfzv-t*	0.0000e+00e			


```

1115 * cfzv-z*      0.0000e+00e
1116 * cfzv-r*      0.0000e+00e
1117 * vol      *      1.0000e+00e
1118 * fa-t      *      0.0000e+00e
1119 * fa-z      *      1.0000e+00e
1120 * fa-r      *      0.0000e+00e
1121 * hd-t      *      0.0000e+00e
1122 * hd-z      *      1.0000e+00e
1123 * hd-r      *      0.0000e+00e
1124 * alpn      *      1.0000e+00e
1125 * vvn-t      *      0.0000e+00e
1126 * vvn-z      *      0.0000e+00e
1127 * vvn-r      *      0.0000e+00e
1128 * vln-t      *      0.0000e+00e
1129 * vln-z      *      0.0000e+00e
1130 * vln-r      *      0.0000e+00e
1131 * tvn      *      5.0000e+02e
1132 * tln      *      5.0000e+02e
1133 * pn      *      1.0000e+06e
1134 * pan      *      0.0000e+00e
1135 *
1136 *****      type      num      id      ctitle
1137 pipe      20      20 1st outlet pipe from vessel 18
1138 *      ncells      nodes      jun1      jun2      epsw
1139      1      0      27      23      1.0000e-05
1140 *      ichf      iconc      iacc      ipow
1141      0      0      0      0
1142 *      radin      th      houtl      houtv      toutl
1143      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
1144 *      toutv
1145      5.0000e+02
1146 *
1147 * dx      * f      1.0000e+00e
1148 * vol      * f      1.0000e+00e
1149 * fa      *      1.0000e+00      5.0000e-01e
1150 * fric      * f      0.0000e+00e
1151 * grav      * f      -1.0000e+00e
1152 * hd      * f      1.0000e+00e
1153 * nff      *      1      -1e
1154 * alp      * f      1.0000e+00e
1155 * vl      * f      0.0000e+00e
1156 * vv      * f      0.0000e+00e
1157 * tl      * f      5.0000e+02e
1158 * tv      * f      5.0000e+02e
1159 * p      * f      1.0000e+06e
1160 * pa      * f      0.0000e+00e
1161 *
1162 *****      type      num      id      ctitle
1163 pipe      21      21 2nd outlet pipe from vessel 18
1164 *      ncells      nodes      jun1      jun2      epsw
1165      1      0      28      24      1.0000e-05
1166 *      ichf      iconc      iacc      ipow
1167      0      0      0      0
1168 *      radin      th      houtl      houtv      toutl
1169      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
1170 *      toutv
1171      5.0000e+02
1172 *
1173 * dx      * f      1.0000e+00e
1174 * vol      * f      1.0000e+00e
1175 * fa      *      1.0000e+00      5.0000e-01e
1176 * fric      * f      0.0000e+00e

```

```

1177 * grav * f -1.0000e+00e
1178 * hd * f 1.0000e+00e
1179 * nff * 1 -1e
1180 * alp * f 1.0000e+00e
1181 * vl * f 0.0000e+00e
1182 * vv * f 0.0000e+00e
1183 * tl * f 5.0000e+02e
1184 * tv * f 5.0000e+02e
1185 * p * f 1.0000e+06e
1186 * pa * f 0.0000e+00e
1187 *
1188 ***** type num id ctitle
1189 pipe 22 22 1st outlet pipe from vessel 19
1190 * ncells nodes jun1 jun2 epsw
1191 1 0 29 25 1.0000e-05
1192 * ichf iconc iacc ipow
1193 0 0 0 0
1194 * radin th houtl houtv toutl
1195 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
1196 * toutv
1197 5.0000e+02
1198 *
1199 * dx * f 1.0000e+00e
1200 * vol * f 1.0000e+00e
1201 * fa * 1.0000e+00 5.0000e-01e
1202 * fric * f 0.0000e+00e
1203 * grav * f -1.0000e+00e
1204 * hd * f 1.0000e+00e
1205 * nff * 1 -1e
1206 * alp * f 1.0000e+00e
1207 * vl * f 0.0000e+00e
1208 * vv * f 0.0000e+00e
1209 * tl * f 5.0000e+02e
1210 * tv * f 5.0000e+02e
1211 * p * f 1.0000e+06e
1212 * pa * f 0.0000e+00e
1213 *
1214 ***** type num id ctitle
1215 pipe 23 23 2nd outlet pipe from vessel 19
1216 * ncells nodes jun1 jun2 epsw
1217 1 0 30 26 1.0000e-05
1218 * ichf iconc iacc ipow
1219 0 0 0 0
1220 * radin th houtl houtv toutl
1221 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
1222 * toutv
1223 5.0000e+02
1224 *
1225 * dx * f 1.0000e+00e
1226 * vol * f 1.0000e+00e
1227 * fa * 1.0000e+00 5.0000e-01e
1228 * fric * f 0.0000e+00e
1229 * grav * f -1.0000e+00e
1230 * hd * f 1.0000e+00e
1231 * nff * 1 -1e
1232 * alp * f 1.0000e+00e
1233 * vl * f 0.0000e+00e
1234 * vv * f 0.0000e+00e
1235 * tl * f 5.0000e+02e
1236 * tv * f 5.0000e+02e
1237 * p * f 1.0000e+06e
1238 * pa * f 0.0000e+00e

```

```

1239 *
1240 ***** type num id ctitle
1241 plenum 24 24 manifold plenum 24
1242 * npljn iconc juns1 juns2
1243 5 0 1 4
1244 *
1245 * junj * 31s
1246 * junj * 27 28 29 30e
1247 * dx * f 1.0000e+00e
1248 * vol * f 4.0000e+00e
1249 * elev * f 2.1000e+01e
1250 * alp * f 1.0000e+00e
1251 * tl * f 5.0000e+02e
1252 * tv * f 5.0000e+02e
1253 * p * f 1.0000e+06e
1254 * pa * f 0.0000e+00e
1255 *
1256 ***** type num id ctitle
1257 pipe 25 25 outlet pipe from plenum 24
1258 * ncells nodes jun1 jun2 epsw
1259 1 0 32 31 1.0000e-05
1260 * ichf iconc iacc ipow
1261 0 0 0 0
1262 * radin th houtl houtv toutl
1263 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
1264 * toutv
1265 5.0000e+02
1266 *
1267 * dx * f 1.0000e+00e
1268 * vol * f 1.0000e+00e
1269 * fa * f 1.0000e+00e
1270 * fric * f 0.0000e+00e
1271 * grav * f -1.0000e+00e
1272 * hd * f 1.0000e+00e
1273 * nff * 1 -1e
1274 * alp * f 1.0000e+00e
1275 * vl * f 0.0000e+00e
1276 * vv * f 0.0000e+00e
1277 * tl * f 5.0000e+02e
1278 * tv * f 5.0000e+02e
1279 * p * f 1.0000e+06e
1280 * pa * f 0.0000e+00e
1281 *
1282 ***** type num id ctitle
1283 break 26 26 pressure b.c. for pipe 25 outlet
1284 * jun1 ibty isat ioff
1285 32 0 0 0
1286 * dxin volin alpin tin pin
1287 1.0000e+00 1.0000e+00 1.0000e+00 5.0000e+02 1.0000e+06
1288 * pain concin rbmx poff belv
1289 0.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00 2.3000e+01
1290 *
1291 end
1292 *
1293 *****
1294 * time-step data *
1295 *****
1296 *
1297 * dtmin dtmax tend rtwfp
1298 1.0000e-03 1.0000e+00 1.0000e+01 1.0000e+00
1299 * edint gfint dmpint sedint
1300 1.0000e+01 1.0000e+00 1.1000e+01 1.0000e+01

```

1301 *				
1302 *	dtmin	dtmax	tend	rtwfp
1303	1.0000e-03	5.0000e+00	1.0000e+02	1.0000e+00
1304 *	edint	gfint	dmpint	sedint
1305	9.0000e+01	2.5000e+00	9.5000e+01	9.0000e+01
1306 *				
1307 *	dtmin	dtmax	tend	rtwfp
1308	1.0000e-02	3.0000e+01	1.0000e+03	1.0000e+00
1309 *	edint	gfint	dmpint	sedint
1310	9.0000e+02	1.5000e+01	9.3000e+02	9.0000e+02
1311 *				
1312 *	dtmin	dtmax	tend	rtwfp
1313	1.0000e-01	2.0000e+02	1.0000e+04	1.0000e+00
1314 *	edint	gfint	dmpint	sedint
1315	9.0000e+03	2.0000e+02	9.0000e+03	9.0000e+03
1316 *				
1317 *	endflag			
1318	-1.0000e+00			

A-4.10 MSS2 Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              4              0              1              0              0
9 *--*--TEST PROBLEM MSS2 , Time = 10000.0 s
10 *          mirrored flow channel with two-phase fluid
11 * 2 plenums, 6 vessels, and 16 pipes replaced by a 22-cell pipe
12 * two pressure boundary conditions, tl = tsat = tv = 455.0 k
13 *
14 *
15 *          nff      vl      vv      fa
16 *          (-) (m/s) (m/s) (m2)
17 *          #####
18 *          # break#
19 *          # 26 #   p = 1.0000e+06 pa
20 *          #####
21 *          32          1      6.3      6.7      1.0
22 *          #####
23 *          # cell #
24 *          # 22 #
25 *          #####-----#####
26 *          #          cell          #          -1      5.8      5.8      1.0
27 *          #          21          #
28 *          #-----#
29 *          #          cell          #          1      1.2      1.4      4.0
30 *          #          20          #
31 *          #-----#
32 *          #####-----#####
33 *          #          cell          #          -1      2.4      2.6      2.0
34 *          #          19          #
35 *          #-----#
36 *          #          cell          #          1      2.5      2.6      2.0
37 *          #          18          #
38 *          #-----#
39 *          #          cell          #          1      2.6      2.7      2.0
40 *          #          17          #
41 *          #-----#
42 *          #          cell          #          1      2.7      2.8      2.0
43 *          #          16          #
44 *          #-----#
45 *          #####-----#####
46 *          #          cell          #          -1      5.7      5.9      1.0
47 *          #          15          #
48 *          #-----#
49 *          #          cell          #          1      6.2      6.4      1.0
50 *          #          14          #
51 *          #-----#
52 *          #          cell          #          1      6.6      6.7      1.0
53 *          #          13          #
54 *          #-----#
55 *          #          cell          #          1      6.8      7.0      1.0
56 *          #          pipe          #
57 *          #          2          #
58 *          #-----#
59 *          -- mirror plane -- #-----# -- mirror plane -- 1      7.1      7.3      1.0
60 *          #          cell          #
61 *          #          11          #
62 *          #-----#
63 *          #          cell          #          1      7.4      7.5      1.0
64 *          #          10          #
65 *          #-----#
66 *          #          cell          #          1      7.6      7.8      1.0
67 *          #          cell          #

```

```

61 *          # 9 #
62 *          #-----#
63 *          # cell #
64 *          # 8 #
65 *          #####-----#####
66 *          # cell #
67 *          # 7 #
68 *          #-----#
69 *          # cell #
70 *          # 6 #
71 *          #-----#
72 *          # cell #
73 *          # 5 #
74 *          #-----#
75 *          # cell #
76 *          # 4 #
77 *          #####-----#####
78 *          # cell #
79 *          # 3 #
80 *          #-----#
81 *          # cell #
82 *          # 2 #
83 *          #####-----#####
84 *          # cell #
85 *          # 1 #
86 *          #####
87 *          # 2 #
88 *          #####
89 *          # break# p = 1.1384e+06 pa
90 *          # 1 #
91 *          #####
92 *
93 *****
94 * namelist data *
95 *****
96 *
97 &inopts
98 iadded=10, ikfac=1, nifsh=1, ccif=1.0e+05,
99 idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5, cpuflg=1
100 &end
101 *
102 *          dstep          timet
103 *          0          0.0000e+00
104 *          stdyst          transi          ncomp          njun          ipak
105 *          0          1          3          2          0
106 *          epso          epss
107 *          1.0000e-04          1.0000e-04
108 *          oitmax          sitmax          isolut          ncontr          nccfl
109 *          10          10          0          0          0
110 *          ntsv          ntcb          ntcf          ntrp          ntcp
111 *          1          0          0          0          0
112 *
113 *****
114 * component-number data *
115 *****
116 *
117 * iorder * 1 s * break          pressure b.c. for pipe 2 inlet
118 * iorder * 2 s * pipe          replaces 2 plenum, 6 vessels & 16 pipes
119 * iorder * 26 e * break          pressure b.c. for pipe 2 outlet
120 *
121 *****
122 * control parameters *

```

			1	7.8	8.0	1.0
			-1	8.2	8.1	1.0
			1	4.0	4.2	2.0
			1	4.1	4.2	2.0
			1	4.2	4.3	2.0
			-1	4.3	4.4	2.0
			1	2.1	2.3	4.0
			-1	8.8	9.1	1.0
			1	9.8	10.0	1.0

```

123 *****
124 *
125 * signal variable
126 *
127 *      idsv      isvn      icln      icn1      icn2
128 *      1          0          0          0          0
129 *
130 *****
131 * component data *
132 *****
133 *
134 *****      type      num      id      ctitle
135 break          1          1 pressure b.c. for pipe 2 inlet
136 *      jun1      ibty      isat      ioff
137 *      2          1          0          0
138 *      ibtr      ibsv      nbtr      nbsv      nbrf
139 *      0          1          2          0          0
140 *      dxin      volin      alpin      tin      pin
141 *      1.0000e+00  1.0000e+00  5.0000e-01  4.5500e+02  1.0000e+06
142 *      pain      concin      rbmx      poff      belv
143 *      0.0000e+00  0.0000e+00  1.3840e+05  0.0000e+00  0.0000e+00
144 *      pscl      tpscl      tvscl      pascl      conscl
145 *      1.0000e+00  0.0000e+00  0.0000e+00  0.0000e+00  0.0000e+00
146 *
147 * ptb *      0.0000e+00  1.0000e+06  1.0000e+00  1.1384e+06e
148 *
149 *****      type      num      id      ctitle
150 pipe          2          2 replaces 2 plen/6 vssl/16 pipe
151 *      ncells      nodes      jun1      jun2      epsw
152 *      22          0          2          32      1.0000e-05
153 *      ichf      iconc      iacc      ipow
154 *      0          0          0          0
155 *      radin      th      houtl      houtv      toutl
156 *      5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  4.5500e+02
157 *      toutv
158 *      4.5500e+02
159 *
160 * dx * f 1.0000e+00e
161 * vol * 1.0000e+00r02 4.0000e+00r04 2.0000e+00r08 1.0000e+00s
162 * vol * r04 2.0000e+00r02 4.0000e+00 1.0000e+00e
163 * fa * r02 1.0000e+00 4.0000e+00r04 2.0000e+00r09 1.0000e+00s
164 * fa * r04 2.0000e+00 4.0000e+00r02 1.0000e+00e
165 * fric * f 0.0000e+00e
166 * grav * f 1.0000e+00e
167 * hd * f 1.0000e+00e
168 * nff * 1 -1 1 -1s
169 * nff * r03 1 -1r07 1 -1s
170 * nff * r03 1 -1 1 -1s
171 * nff * 1e
172 * alp * f 5.0000e-01e
173 * vl * f 0.0000e+00e
174 * vv * f 0.0000e+00e
175 * tl * f 4.5500e+02e
176 * tv * f 4.5500e+02e
177 * p * f 1.0000e+06e
178 * pa * f 0.0000e+00e
179 *
180 *****      type      num      id      ctitle
181 break          26          26 pressure b.c. pipe 2 outlet
182 *      jun1      ibty      isat      ioff
183 *      32          0          0          0
184 *      dxin      volin      alpin      tin      pin

```

```

185      1.0000e+00      1.0000e+00      5.0000e-01      4.5500e+02      1.0000e+06
186 *      pain      concin      rbmx      poff      belv
187      0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00      2.3000e+01
188 *
189 end
190 *
191 *****
192 * time-step data *
193 *****
194 *
195 *      dtmin      dtmax      tend      rtwfp
196      1.0000e-03      1.0000e+00      1.0000e+01      1.0000e+00
197 *      edint      gfint      dmpint      sedint
198      1.0000e+01      1.0000e+00      1.1000e+01      1.0000e+01
199 *
200 *      dtmin      dtmax      tend      rtwfp
201      1.0000e-03      5.0000e+00      1.0000e+02      1.0000e+00
202 *      edint      gfint      dmpint      sedint
203      9.0000e+01      2.5000e+00      9.5000e+01      9.0000e+01
204 *
205 *      dtmin      dtmax      tend      rtwfp
206      1.0000e-02      3.0000e+01      1.0000e+03      1.0000e+00
207 *      edint      gfint      dmpint      sedint
208      9.0000e+02      1.5000e+01      9.3000e+02      9.0000e+02
209 *
210 *      dtmin      dtmax      tend      rtwfp
211      1.0000e-01      2.0000e+02      1.0000e+04      1.0000e+00
212 *      edint      gfint      dmpint      sedint
213      9.0000e+03      2.0000e+02      9.0000e+03      9.0000e+03
214 *
215 *      endflag
216      -1.0000e+00

```


A-4.11 MSSL Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              4              0              1              0              0
9 *--*--TEST PROBLEM MSSL , Time = 10000.0 s
10      mirrored flow channel with single-phase liquid
11      2 plenums, 6 vessels, and 16 pipes replaced by a 22-cell pipe
12      two pressure boundary conditions, t1 = 300.0 k
13 *
14 *
15 *                                     nff          vl          fa
16 *                                     (-)        (m/s)      (m2)
17 *                                     #####
18 *                                     # break#
19 *                                     # 26 #   p = 1.0000e+06 pa
20 *                                     #####
21 *                                     32                1      10.0      1.0
22 *                                     #####
23 *                                     # cell #
24 *                                     # 22 #
25 * #####-----#####
26 * #          cell          #                -1      10.0      1.0
27 * #          21          #
28 * #-----#                1      2.5      4.0
29 * #          cell          #
30 * #          20          #
31 * #####-----#####
32 * #          cell          #                -1      5.0      2.0
33 * #          19          #
34 * #-----#                1      5.0      2.0
35 * #          cell          #
36 * #          18          #
37 * #-----#                1      5.0      2.0
38 * #          cell          #
39 * #          17          #
40 * #-----#                1      5.0      2.0
41 * #          cell          #
42 * #          16          #
43 * #####-----#####
44 * #          cell          #                -1      10.0      1.0
45 * #          15          #
46 * #-----#                1      10.0      1.0
47 * #          cell          #
48 * #          14          #
49 * #-----#                1      10.0      1.0
50 * #          cell          #
51 * #          13          #
52 * #-----#                1      10.0      1.0
53 * #          pipe          #
54 * #          2          #
55 * -- mirror plane -- #-----# -- mirror plane -- 1      10.0      1.0
56 * #          cell          #
57 * #          11          #
58 * #-----#                1      10.0      1.0
59 * #          cell          #
60 * #          10          #
61 * #-----#                1      10.0      1.0
62 * #          cell          #

```

```

61 *          # 9 #
62 *          #-----#
63 *          # cell #
64 *          # 8 #
65 *          #####-----#####
66 *          # cell #
67 *          # 7 #
68 *          #-----#
69 *          # cell #
70 *          # 6 #
71 *          #-----#
72 *          # cell #
73 *          # 5 #
74 *          #-----#
75 *          # cell #
76 *          # 4 #
77 *          #####-----#####
78 *          # cell #
79 *          # 3 #
80 *          #-----#
81 *          # cell #
82 *          # 2 #
83 *          #####-----#####
84 *          # cell #
85 *          # 1 #
86 *          #####
87 *          2
88 *          #####
89 *          # break# p = 1.4045e+06 pa
90 *          # 1 #
91 *          #####
92 *
93 *****
94 * namelist data *
95 *****
96 *
97 &inopts
98 iadded=10, ikfac=1, cpuflg=1,
99 idiag=4, nsdl=0, nsdu=5, nspl=0, nsps=5
100 &end
101 *
102 *          dstep          timet
103 *          0          0.0000e+00
104 *          stdyst          transi          ncomp          njun          ipak
105 *          0          1          3          2          0
106 *          epso          epss
107 *          1.0000e-04          1.0000e-04
108 *          oitmax          sitmax          isolut          ncontr          nccfl
109 *          10          10          0          0          0
110 *          ntsv          ntcbl          ntcf          ntrp          ntcp
111 *          1          0          0          0          0
112 *
113 *****
114 * component-number data *
115 *****
116 *
117 * iorder * 1 s * break          pressure b.c. for pipe 2 inlet
118 * iorder * 2 s * pipe          replaces 2 plenum, 6 vessels & 16 pipes
119 * iorder * 26 e * break          pressure b.c. for pipe 2 outlet
120 *
121 *****
122 * control parameters *

```

```

123 *****
124 *
125 * signal variable
126 *
127 *      idsv      isvn      icln      icn1      icn2
128 *      1          0          0          0          0
129 *
130 *****
131 * component data *
132 *****
133 *
134 *****      type      num      id      ctitle
135 break          1          1 pressure b.c. for pipe 2 inlet
136 *      jun1      ibty      isat      ioff
137 *      2          1          0          0
138 *      ibtr      ibsv      nbtr      nbsv      nbrf
139 *      0          1          2          0          0
140 *      dxin      volin      alpin      tin      pin
141 *      1.0000e+00  1.0000e+00  0.0000e+00  3.0000e+02  1.0000e+06
142 *      pain      concin      rbmx      poff      belv
143 *      0.0000e+00  0.0000e+00  4.0450e+05  0.0000e+00  0.0000e+00
144 *      pscl      tisccl      tvscl      pascl      conscl
145 *      1.0000e+00  0.0000e+00  0.0000e+00  0.0000e+00  0.0000e+00
146 *
147 * ptb *      0.0000e+00  1.0000e+06  1.0000e+00  1.4045e+06e
148 *
149 *****      type      num      id      ctitle
150 pipe          2          2 replaces 2 plen/6 vssl/16 pipe
151 *      ncells      nodes      jun1      jun2      epsw
152 *      22          0          2          32      1.0000e-05
153 *      ichf      iconc      iacc      ipow
154 *      0          0          0          0
155 *      radin      th      houtl      houtv      toutl
156 *      5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  3.0000e+02
157 *      toutv
158 *      3.0000e+02
159 *
160 * dx * f 1.0000e+00e
161 * vol * 1.0000e+00r02 4.0000e+00r04 2.0000e+00r08 1.0000e+00s
162 * vol * r04 2.0000e+00r02 4.0000e+00 1.0000e+00e
163 * fa * r02 1.0000e+00 4.0000e+00r04 2.0000e+00r09 1.0000e+00s
164 * fa * r04 2.0000e+00 4.0000e+00r02 1.0000e+00e
165 * fric * f 0.0000e+00e
166 * grav * f 1.0000e+00e
167 * hd * f 1.0000e+00e
168 * nff * 1 -1 1 -1s
169 * nff * r03 1 -1r07 1 -1s
170 * nff * r03 1 -1 1 -1s
171 * nff * 1e
172 * alp * f 0.0000e+00e
173 * vl * f 0.0000e+00e
174 * vv * f 0.0000e+00e
175 * tl * f 3.0000e+02e
176 * tv * f 3.0000e+02e
177 * p * f 1.0000e+06e
178 * pa * f 0.0000e+00e
179 *
180 *****      type      num      id      ctitle
181 break          26          26 pressure b.c. pipe 2 outlet
182 *      jun1      ibty      isat      ioff
183 *      32          0          0          0
184 *      dxin      volin      alpin      tin      pin

```

185	1.0000e+00	1.0000e+00	0.0000e+00	3.0000e+02	1.0000e+06
186 *	pain	concin	rbmx	poff	belv
187	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	2.3000e+01
188 *					
189	end				
190 *					
191	*****				
192 *	time-step data *				
193	*****				
194 *					
195 *	dtmin	dtmax	tend	rtwfp	
196	1.0000e-03	1.0000e+00	1.0000e+01	1.0000e+00	
197 *	edint	gfint	dmpint	sedint	
198	1.0000e+01	1.0000e+00	1.1000e+01	1.0000e+01	
199 *					
200 *	dtmin	dtmax	tend	rtwfp	
201	1.0000e-03	5.0000e+00	1.0000e+02	1.0000e+00	
202 *	edint	gfint	dmpint	sedint	
203	9.0000e+01	2.5000e+00	9.5000e+01	9.0000e+01	
204 *					
205 *	dtmin	dtmax	tend	rtwfp	
206	1.0000e-02	3.0000e+01	1.0000e+03	1.0000e+00	
207 *	edint	gfint	dmpint	sedint	
208	9.0000e+02	1.5000e+01	9.3000e+02	9.0000e+02	
209 *					
210 *	dtmin	dtmax	tend	rtwfp	
211	1.0000e-01	2.0000e+02	1.0000e+04	1.0000e+00	
212 *	edint	gfint	dmpint	sedint	
213	9.0000e+03	2.0000e+02	9.0000e+03	9.0000e+03	
214 *					
215 *	endflag				
216	-1.0000e+00				

A-4.12 MSSV Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              4              0              1              0              0
9 *--*--*TEST PROBLEM MSSV , Time = 10000.0 s
10 *      mirrored flow channel with single-phase vapor
11 * 2 plenums, 6 vessels, and 16 pipes replaced by a 22-cell pipe
12 *      two pressure boundary conditions, tv = 500.0 k
13 *
14 *
15 *                                     nff          vv          fa
16 *                                     (-)        (m/s)      (m2)
17 *
18 *      #####
19 *      # break#
20 *      # 26 #   p = 1.0000e+06 pa
21 *      #####
22 *      32
23 *      #####
24 *      # cell #
25 *      # 22 #
26 *      #####-----#####
27 *      #          cell          #
28 *      #          21          #
29 *      #-----#
30 *      #          cell          #
31 *      #          20          #
32 *      #####-----#####
33 *      #          cell          #
34 *      #          19          #
35 *      #-----#
36 *      #          cell          #
37 *      #          18          #
38 *      #-----#
39 *      #          cell          #
40 *      #          17          #
41 *      #-----#
42 *      #          cell          #
43 *      #          16          #
44 *      #####-----#####
45 *      # cell #
46 *      # 15 #
47 *      #-----#
48 *      # cell #
49 *      # 14 #
50 *      #-----#
51 *      # cell #
52 *      # 13 #
53 *      #-----#
54 *      # pipe #
55 *      # 2 #
56 *      #-----#
57 *      # cell #
58 *      # 11 #
59 *      #-----#
60 *      # cell #

```

nff	vv	fa
(-)	(m/s)	(m2)
1	10.0	1.0
-1	10.0	1.0
1	2.5	4.0
-1	5.0	2.0
1	5.0	2.0
1	5.0	2.0
1	5.0	2.0
-1	10.0	1.0
1	10.0	1.0
1	10.0	1.0
1	10.0	1.0
1	10.0	1.0
1	10.0	1.0
1	10.0	1.0

```

61 *           # 9 #
62 *           #-----#
63 *           # cell #
64 *           # 8 #
65 *           #####-----#####
66 *           # cell #
67 *           # 7 #
68 *           #-----#
69 *           # cell #
70 *           # 6 #
71 *           #-----#
72 *           # cell #
73 *           # 5 #
74 *           #-----#
75 *           # cell #
76 *           # 4 #
77 * #####-----#####
78 *           # cell #
79 *           # 3 #
80 *           #-----#
81 *           # cell #
82 *           # 2 #
83 * #####-----#####
84 *           # cell #
85 *           # 1 #
86 *           #####
87 *           2
88 *           #####
89 *           # break# p = 1001758.5 pa
90 *           # 1 #
91 *           #####
92 *
93 *****
94 * namelist data *
95 *****
96 *
97 &inopts
98 iadded=10, ikfac=1, cpufg=1,
99 idiag=4, nsdl=0, nsdu=5, nspl=0, nspl=5
100 &end
101 *
102 *           dstep          timet
103 *           0          0.0000e+00
104 *           stdyst          transi          ncomp          njun          ipak
105 *           0          1          3          2          0
106 *           epso          epss
107 *           1.0000e-04          1.0000e-04
108 *           oitmax          sitmax          isolut          ncontr          nccfl
109 *           10          10          0          0          0
110 *           ntsv          ntcbl          ntcfl          ntrp          ntcp
111 *           1          0          0          0          0
112 *
113 *****
114 * component-number data *
115 *****
116 *
117 * iorder * 1 s * break          pressure b.c. for pipe 2 inlet
118 * iorder * 2 s * pipe          replaces 2 plenum, 6 vessels & 16 pipes
119 * iorder * 26 e * break          pressure b.c. for pipe 2 outlet
120 *
121 *****
122 * control parameters *

```

```

123 *****
124 *
125 * signal variable
126 *
127 *      idsv      isvn      icln      icn1      icn2
128 *      1          0          0          0          0
129 *
130 *****
131 * component data *
132 *****
133 *
134 *****      type      num      id      ctitle
135 break          1          1 pressure b.c. for pipe 2 inlet
136 *      jun1      ibty      isat      ioff
137 *      2          1          0          0
138 *      ibtr      ibsv      nbth      nbsv      nbrf
139 *      0          1          2          0          0
140 *      dxin      volin      alpin      tin      pin
141 *      1.0000e+00  1.0000e+00  1.0000e+00  5.0000e+02  1.0000e+06
142 *      pain      concin      rbmx      poff      belv
143 *      0.0000e+00  0.0000e+00  1.7585e+03  0.0000e+00  0.0000e+00
144 *      pscl      tlscl      tvscl      pascl      conscl
145 *      1.0000e+00  0.0000e+00  0.0000e+00  0.0000e+00  0.0000e+00
146 *
147 * ptb *      0.0000e+00  1.0000e+06  1.0000e+00  1001758.50e
148 *
149 *****      type      num      id      ctitle
150 pipe          2          2 replaces 2 plen/6 vssl/16 pipe
151 *      ncells      nodes      jun1      jun2      epsw
152 *      22          0          2          32      1.0000e-05
153 *      ichf      iconc      iacc      ipow
154 *      0          0          0          0
155 *      radin      th      houtl      houtv      toutl
156 *      5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  5.0000e+02
157 *      toutv
158 *      5.0000e+02
159 *
160 * dx * f 1.0000e+00e
161 * vol * 1.0000e+00r02 4.0000e+00r04 2.0000e+00r08 1.0000e+00s
162 * vol * r04 2.0000e+00r02 4.0000e+00 1.0000e+00e
163 * fa * r02 1.0000e+00 4.0000e+00r04 2.0000e+00r09 1.0000e+00s
164 * fa * r04 2.0000e+00 4.0000e+00r02 1.0000e+00e
165 * fric * f 0.0000e+00e
166 * grav * f 1.0000e+00e
167 * hd * f 1.0000e+00e
168 * nff * 1 -1 1 -1s
169 * nff * r03 1 -1r07 1 -1s
170 * nff * r03 1 -1 1 -1s
171 * nff * le
172 * alp * f 1.0000e+00e
173 * vl * f 0.0000e+00e
174 * vv * f 0.0000e+00e
175 * tl * f 5.0000e+02e
176 * tv * f 5.0000e+02e
177 * p * f 1.0000e+06e
178 * pa * f 0.0000e+00e
179 *
180 *****      type      num      id      ctitle
181 break          26          26 pressure b.c. pipe 2 outlet
182 *      jun1      ibty      isat      ioff
183 *      32          0          0          0
184 *      dxin      volin      alpin      tin      pin

```

185	1.0000e+00	1.0000e+00	1.0000e+00	5.0000e+02	1.0000e+06
186 *	pain	concin	rbmx	poff	belv
187	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	2.3000e+01
188 *					
189	end				
190 *					
191	*****				
192 *	time-step data *				
193	*****				
194 *					
195 *	dtmin	dtmax	tend	rtwfp	
196	1.0000e-03	1.0000e+00	1.0000e+01	1.0000e+00	
197 *	edint	gfint	dmpint	sedint	
198	1.0000e+01	1.0000e+00	1.1000e+01	1.0000e+01	
199 *					
200 *	dtmin	dtmax	tend	rtwfp	
201	1.0000e-03	5.0000e+00	1.0000e+02	1.0000e+00	
202 *	edint	gfint	dmpint	sedint	
203	9.0000e+01	2.5000e+00	9.5000e+01	9.0000e+01	
204 *					
205 *	dtmin	dtmax	tend	rtwfp	
206	1.0000e-02	3.0000e+01	1.0000e+03	1.0000e+00	
207 *	edint	gfint	dmpint	sedint	
208	9.0000e+02	1.5000e+01	9.3000e+02	9.0000e+02	
209 *					
210 *	dtmin	dtmax	tend	rtwfp	
211	1.0000e-01	2.0000e+02	1.0000e+04	1.0000e+00	
212 *	edint	gfint	dmpint	sedint	
213	9.0000e+03	2.0000e+02	9.0000e+03	9.0000e+03	
214 *					
215 *	endflag				
216	-1.0000e+00				

A-4.13 MST2 Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              5              0              1              0              0
9 *--*TEST PROBLEM MST2 , Time = 10000.0 s
10 mirrored parallel-flow channel with two-phase fluid
11 6 tees replace 6 multiple-source connection vessels
12 tees have 4 cells and pipes & plenums have 1 cell
13 two pressure boundary conditions, tl = tsat = tv = 455.0 k
14 *
15 *
16 *          nff      vl      vv      fa
17 *          (-) (m/s) (m/s) (m2)
18 *          #####
19 *          # break#
20 *          # 26 #   p = 1.0000e+06 pa
21 *          #####
22 *          32
23 *          #####
24 *          # pipe #
25 *          # 25 #
26 *          #####
27 *          31
28 *          #####
29 *          # plenum #
30 *          # 24 #
31 *          #####
32 *          27      28      29      30      1  -1.2  -1.4  1.0x4
33 *          #####
34 *          # pipe # # pipe # # pipe # # pipe #
35 *          # 20 # # 21 # # 22 # # 23 #
36 *          #####
37 *          23      24      25      26      -1  -2.4  -2.6  0.5x4
38 *          #####
39 *          # cell# # tee # # cell# # tee #
40 *          # 1 ## 18 # # 1 ## 19 #
41 *          #-----# #-----#
42 *          # cell # # cell #
43 *          # 2 # # 2 #
44 *          #-----# #-----#
45 *          # cell # # cell #
46 *          # 3 # # 3 #
47 *          #####
48 *          21      22      1  -2.7  -2.8  1.0x2
49 *          #####
50 *          # pipe # # pipe #
51 *          # 16 # # 17 #
52 *          #####
53 *          19      20      -1  -5.7  -5.9  0.5x2
54 *          #####
55 *          # cell# # tee #
56 *          # 1 ## 15 #
57 *          #-----#
58 *          # cell #
59 *          # 2 #
60 *          #-----#
61 *          # cell #
62 *          # 3 #

```



```

123 *
124 &inopts
125   iadded=10, ikfac=1, nifsh=1, ccif=1.0e+05,
126   idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5, cpuflg=1
127 &end
128 *
129 *           dstep          timet
130             0      0.0000e+00
131 *           stdyst          transi          ncomp          njun          ipak
132             0              1              26              31              0
133 *           epso            epss
134       1.0000e-04    1.0000e-04
135 *           oitmax          sitmax          isolut          ncontr          nccfl
136             10              10              0              0              0
137 *           ntsv            ntcb            ntcf            ntrp            ntcp
138             1              0              0              0              0
139 *
140 *****
141 * component-number data *
142 *****
143 *
144 * iorder *    1 s    * break        pressure b.c. for pipe 2 inlet
145 * iorder *    2 s    * pipe         inlet pipe for plenum 3
146 * iorder *    3 s    * plenum       manifold for parallel-channel pipes
147 * iorder *    4 s    * pipe         1st inlet pipe for tee 8
148 * iorder *    5 s    * pipe         2nd inlet pipe for tee 8
149 * iorder *    6 s    * pipe         1st inlet pipe for tee 9
150 * iorder *    7 s    * pipe         2nd inlet pipe for tee 9
151 * iorder *    8 s    * tee          tee that replaces vessel 8
152 * iorder *    9 s    * tee          tee that replaces vessel 9
153 * iorder *   10 s    * pipe         outlet pipe for tee 8
154 * iorder *   11 s    * pipe         outlet pipe for tee 9
155 * iorder *   12 s    * tee          tee that replaces vessel 12
156 * iorder *   13 s    * pipe         outlet pipe for tee 12
157 * iorder *   14 s    * pipe         inlet pipe for tee 15
158 * iorder *   15 s    * tee          tee that replaces vessel 15
159 * iorder *   16 s    * pipe         inlet pipe for tee 18
160 * iorder *   17 s    * pipe         inlet pipe for tee 19
161 * iorder *   18 s    * tee          tee that replaces vessel 18
162 * iorder *   19 s    * tee          tee that replaces vessel 19
163 * iorder *   20 s    * pipe         1st outlet pipe for tee 18
164 * iorder *   21 s    * pipe         2nd outlet pipe for tee 18
165 * iorder *   22 s    * pipe         1st outlet pipe for tee 19
166 * iorder *   23 s    * pipe         2nd outlet pipe for tee 19
167 * iorder *   24 s    * plenum       manifold for parallel-channel pipes
168 * iorder *   25 s    * pipe         outlet pipe for plenum 24
169 * iorder *   26 e    * break        pressure b.c. for pipe 25 outlet
170 *
171 *****
172 * control parameters *
173 *****
174 *
175 * signal variable
176 *
177 *           idsv            isvn            icln            icn1            icn2
178             1              0              0              0              0
179 *
180 *****
181 * component data *
182 *****
183 *
184 ***** type num id cttitle

```

```

185 break                                1                                1 pressure b.c. for pipe 2 inlet
186 *      jun1                          ibty                          isat                          ioff
187      2                                1                                0                                0
188 *      ibtr                          ibsv                          nbtr                          nbsv                          nbrf
189      0                                1                                2                                0                                0
190 *      dxin                          volin                          alpin                          tin                          pin
191      1.0000e+00                      1.0000e+00                      5.0000e-01                      4.5500e+02                      1.0000e+06
192 *      pain                          concin                         rbmx                          poff                          belv
193      0.0000e+00                      0.0000e+00                      1.3840e+05                      0.0000e+00                      0.0000e+00
194 *      pscl                          tpscl                          tvscl                          pascl                          conscl
195      1.0000e+00                      0.0000e+00                      0.0000e+00                      0.0000e+00                      0.0000e+00
196 *
197 * ptb      *      0.0000e+00      1.0000e+06      1.0000e+00      1.1384e+06e
198 *
199 *****      type                      num                      id                      ctitle
200 pipe                      2                      2 inlet pipe for plenum 3
201 *      ncells                      nodes                      jun1                      jun2                      epsw
202      1                      0                      2                      3                      1.0000e-05
203 *      ichf                      iconc                      iacc                      ipow
204      0                      0                      0                      0
205 *      radin                      th                      houtl                      houtv                      toutl
206      5.0000e-01                      5.0000e-02                      0.0000e+00                      0.0000e+00                      4.5500e+02
207 *      toutv
208      4.5500e+02
209 *
210 * dx      * f      1.0000e+00e
211 * vol      * f      1.0000e+00e
212 * fa      * f      1.0000e+00e
213 * fric      * f      0.0000e+00e
214 * grav      * f      1.0000e+00e
215 * hd      * f      1.0000e+00e
216 * nff      *      1                      -1e
217 * alp      * f      5.0000e-01e
218 * vl      * f      0.0000e+00e
219 * vv      * f      0.0000e+00e
220 * tl      * f      4.5500e+02e
221 * tv      * f      4.5500e+02e
222 * p      * f      1.0000e+06e
223 * pa      * f      0.0000e+00e
224 *
225 *****      type                      num                      id                      ctitle
226 plenum                      3                      3 manifold plenum 3
227 *      npljn                      iconc                      juns1                      juns2
228      5                      0                      1                      4
229 *
230 * junj      *      3s
231 * junj      *      4                      5                      6                      7e
232 * dx      * f      1.0000e+00e
233 * vol      * f      4.0000e+00e
234 * elev      * f      2.0000e+00e
235 * alp      * f      5.0000e-01e
236 * tl      * f      4.5500e+02e
237 * tv      * f      4.5500e+02e
238 * p      * f      1.0000e+06e
239 * pa      * f      0.0000e+00e
240 *
241 *****      type                      num                      id                      ctitle
242 pipe                      4                      4 1st inlet pipe for tee 8
243 *      ncells                      nodes                      jun1                      jun2                      epsw
244      1                      0                      4                      8                      1.0000e-05
245 *      ichf                      iconc                      iacc                      ipow
246      0                      0                      0                      0

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247 *      radin      th      houtl      houtv      toutl
248      5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    4.5500e+02
249 *      toutv
250      4.5500e+02
251 *
252 * dx      * f      1.0000e+00e
253 * vol     * f      1.0000e+00e
254 * fa      *      1.0000e+00      5.0000e-01e
255 * fric    * f      0.0000e+00e
256 * grav     * f      1.0000e+00e
257 * hd      * f      1.0000e+00e
258 * nff     *      1      -1e
259 * alp     * f      5.0000e-01e
260 * vl      * f      0.0000e+00e
261 * vv      * f      0.0000e+00e
262 * tl      * f      4.5500e+02e
263 * tv      * f      4.5500e+02e
264 * p       * f      1.0000e+06e
265 * pa      * f      0.0000e+00e
266 *
267 *****      type      num      id      ctitle
268 pipe      5      5 2nd inlet pipe for tee 8
269 *      ncells      nodes      jun1      jun2      epsw
270      1      0      5      9      1.0000e-05
271 *      ichf      iconc      iacc      ipow
272      0      0      0      0
273 *      radin      th      houtl      houtv      toutl
274      5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    4.5500e+02
275 *      toutv
276      4.5500e+02
277 *
278 * dx      * f      1.0000e+00e
279 * vol     * f      1.0000e+00e
280 * fa      *      1.0000e+00      5.0000e-01e
281 * fric    * f      0.0000e+00e
282 * grav     * f      1.0000e+00e
283 * hd      * f      1.0000e+00e
284 * nff     *      1      -1e
285 * alp     * f      5.0000e-01e
286 * vl      * f      0.0000e+00e
287 * vv      * f      0.0000e+00e
288 * tl      * f      4.5500e+02e
289 * tv      * f      4.5500e+02e
290 * p       * f      1.0000e+06e
291 * pa      * f      0.0000e+00e
292 *
293 *****      type      num      id      ctitle
294 pipe      6      6 1st inlet pipe for tee 9
295 *      ncells      nodes      jun1      jun2      epsw
296      1      0      6      10      1.0000e-05
297 *      ichf      iconc      iacc      ipow
298      0      0      0      0
299 *      radin      th      houtl      houtv      toutl
300      5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    4.5500e+02
301 *      toutv
302      4.5500e+02
303 *
304 * dx      * f      1.0000e+00e
305 * vol     * f      1.0000e+00e
306 * fa      *      1.0000e+00      5.0000e-01e
307 * fric    * f      0.0000e+00e
308 * grav     * f      1.0000e+00e

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309 * hd      * f    1.0000e+00e
310 * nff      *          1          -1e
311 * alp      * f    5.0000e-01e
312 * vl       * f    0.0000e+00e
313 * vv       * f    0.0000e+00e
314 * tl       * f    4.5500e+02e
315 * tv       * f    4.5500e+02e
316 * p        * f    1.0000e+06e
317 * pa       * f    0.0000e+00e
318 *
319 *****      type          num          id          ctitle
320 pipe          7          7 2nd inlet pipe for tee 9
321 *          ncells          nodes          jun1          jun2          epsw
322          1          0          7          11          1.0000e-05
323 *          ichf          iconc          iacc          ipow
324          0          0          0          0
325 *          radin          th          hout1          houtv          tout1
326          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          4.5500e+02
327 *          toutv
328          4.5500e+02
329 *
330 * dx      * f    1.0000e+00e
331 * vol     * f    1.0000e+00e
332 * fa      *          1.0000e+00          5.0000e-01e
333 * fric    * f    0.0000e+00e
334 * grav    * f    1.0000e+00e
335 * hd      * f    1.0000e+00e
336 * nff      *          1          -1e
337 * alp      * f    5.0000e-01e
338 * vl       * f    0.0000e+00e
339 * vv       * f    0.0000e+00e
340 * tl       * f    4.5500e+02e
341 * tv       * f    4.5500e+02e
342 * p        * f    1.0000e+06e
343 * pa       * f    0.0000e+00e
344 *
345 *****      type          num          id          ctitle
346 tee          8          8 tee that replaces vessel 8
347 *          jcell          nodes          ichf          cost          epsw
348          2          0          0          1.0000e+00          1.0000e-05
349 *          iconc1          ncell1          jun1          jun2          ipow1
350          0          3          8          12          0
351 *          radin1          th1          hout11          houtv1          tout11
352          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          4.5500e+02
353 *          toutv1
354          4.5500e+02
355 *          iconc2          ncell2          jun3          ipow2
356          0          1          9          0
357 *          radin2          th2          hout12          houtv2          tout12
358          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          4.5500e+02
359 *          toutv2
360          4.5500e+02
361 *
362 * dx      * f    1.0000e+00e
363 * vol     *          5.0000e-01r02 1.0000e+00e
364 * fa      * r02 5.0000e-01r02 1.0000e+00e
365 * fric    * f    0.0000e+00e
366 * grav    * f    1.0000e+00e
367 * hd      * f    1.0000e+00e
368 * nff      *          -1r03          1e
369 * alp      * f    5.0000e-01e
370 * vl       * f    0.0000e+00e

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371 * vv      * f    0.0000e+00e
372 * tl      * f    4.5500e+02e
373 * tv      * f    4.5500e+02e
374 * p       * f    1.0000e+06e
375 * pa      * f    0.0000e+00e
376 *
377 * dx      * f    1.0000e+00e
378 * vol     * f    5.0000e-01e
379 * fa      * f    5.0000e-01e
380 * fric    * f    0.0000e+00e
381 * grav    * f   -1.0000e+00e
382 * hd      * f    1.0000e+00e
383 * nff     *      1          -1e
384 * alp     * f    5.0000e-01e
385 * vl      * f    0.0000e+00e
386 * vv      * f    0.0000e+00e
387 * tl      * f    4.5500e+02e
388 * tv      * f    4.5500e+02e
389 * p       * f    1.0000e+06e
390 * pa      * f    0.0000e+00e
391 *
392 *****      type          num          id          ctitle
393 tee          9          9 tee that replaces vessel 9
394 *          jcell          nodes          ichf          cost          epsw
395          2          0          0          1.0000e+00          1.0000e-05
396 *          iconcl          ncell1          jun1          jun2          ipow1
397          0          3          10          13          0
398 *          radin1          th1          hout11          houtv1          tout11
399          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          4.5500e+02
400 *          toutv1
401          4.5500e+02
402 *          iconc2          ncell2          jun3          ipow2
403          0          1          11          0
404 *          radin2          th2          hout12          houtv2          tout12
405          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          4.5500e+02
406 *          toutv2
407          4.5500e+02
408 *
409 * dx      * f    1.0000e+00e
410 * vol     *      5.0000e-01r02 1.0000e+00e
411 * fa      * r02 5.0000e-01r02 1.0000e+00e
412 * fric    * f    0.0000e+00e
413 * grav    * f    1.0000e+00e
414 * hd      * f    1.0000e+00e
415 * nff     *      -1r03          1e
416 * alp     * f    5.0000e-01e
417 * vl      * f    0.0000e+00e
418 * vv      * f    0.0000e+00e
419 * tl      * f    4.5500e+02e
420 * tv      * f    4.5500e+02e
421 * p       * f    1.0000e+06e
422 * pa      * f    0.0000e+00e
423 *
424 * dx      * f    1.0000e+00e
425 * vol     * f    5.0000e-01e
426 * fa      * f    5.0000e-01e
427 * fric    * f    0.0000e+00e
428 * grav    * f   -1.0000e+00e
429 * hd      * f    1.0000e+00e
430 * nff     *      1          -1e
431 * alp     * f    5.0000e-01e
432 * vl      * f    0.0000e+00e

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433 * vv      * f      0.0000e+00e
434 * tl      * f      4.5500e+02e
435 * tv      * f      4.5500e+02e
436 * p       * f      1.0000e+06e
437 * pa      * f      0.0000e+00e
438 *
439 *****   type          num          id          ctitle
440 pipe              10          10 outlet pipe for tee 8
441 *          ncells      nodes      jun1      jun2      epsw
442 *              1          0          12          14      1.0000e-05
443 *          ichf      iconc      iacc      ipow
444 *              0          0          0          0
445 *          radin      th      houtl      houtv      toutl
446 *      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
447 *          toutv
448 *      4.5500e+02
449 *
450 * dx      * f      1.0000e+00e
451 * vol     * f      1.0000e+00e
452 * fa      *      1.0000e+00      5.0000e-01e
453 * fric    * f      0.0000e+00e
454 * grav    * f      1.0000e+00e
455 * hd      * f      1.0000e+00e
456 * nff     *          1          -1e
457 * alp     * f      5.0000e-01e
458 * vl      * f      0.0000e+00e
459 * vv      * f      0.0000e+00e
460 * tl      * f      4.5500e+02e
461 * tv      * f      4.5500e+02e
462 * p       * f      1.0000e+06e
463 * pa      * f      0.0000e+00e
464 *
465 *****   type          num          id          ctitle
466 pipe              11          11 outlet pipe for tee 9
467 *          ncells      nodes      jun1      jun2      epsw
468 *              1          0          13          15      1.0000e-05
469 *          ichf      iconc      iacc      ipow
470 *              0          0          0          0
471 *          radin      th      houtl      houtv      toutl
472 *      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
473 *          toutv
474 *      4.5500e+02
475 *
476 * dx      * f      1.0000e+00e
477 * vol     * f      1.0000e+00e
478 * fa      *      1.0000e+00      5.0000e-01e
479 * fric    * f      0.0000e+00e
480 * grav    * f      1.0000e+00e
481 * hd      * f      1.0000e+00e
482 * nff     *          1          -1e
483 * alp     * f      5.0000e-01e
484 * vl      * f      0.0000e+00e
485 * vv      * f      0.0000e+00e
486 * tl      * f      4.5500e+02e
487 * tv      * f      4.5500e+02e
488 * p       * f      1.0000e+06e
489 * pa      * f      0.0000e+00e
490 *
491 *****   type          num          id          ctitle
492 tee              12          12 tee that replaces vessel 12
493 *          jcell      nodes      ichf      cost      epsw
494 *              2          0          0      1.0000e+00      1.0000e-05

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495 *      iconc1      ncell11      jun1      jun2      ipow1
496      0      3      14      16      0
497 *      radin1      th1      hout11      houtv1      tout11
498      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
499 *      toutv1
500      4.5500e+02
501 *      iconc2      ncell12      jun3      ipow2
502      0      1      15      0
503 *      radin2      th2      hout12      houtv2      tout12
504      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
505 *      toutv2
506      4.5500e+02
507 *
508 * dx      * f      1.0000e+00e
509 * vol      *      5.0000e-01r02 1.0000e+00e
510 * fa      * r02 5.0000e-01r02 1.0000e+00e
511 * fric      * f      0.0000e+00e
512 * grav      * f      1.0000e+00e
513 * hd      * f      1.0000e+00e
514 * nff      *      -1r03      1e
515 * alp      * f      5.0000e-01e
516 * vl      * f      0.0000e+00e
517 * vv      * f      0.0000e+00e
518 * tl      * f      4.5500e+02e
519 * tv      * f      4.5500e+02e
520 * p      * f      1.0000e+06e
521 * pa      * f      0.0000e+00e
522 *
523 * dx      * f      1.0000e+00e
524 * vol      * f      5.0000e-01e
525 * fa      * f      5.0000e-01e
526 * fric      * f      0.0000e+00e
527 * grav      * f      -1.0000e+00e
528 * hd      * f      1.0000e+00e
529 * nff      *      1      -1e
530 * alp      * f      5.0000e-01e
531 * vl      * f      0.0000e+00e
532 * vv      * f      0.0000e+00e
533 * tl      * f      4.5500e+02e
534 * tv      * f      4.5500e+02e
535 * p      * f      1.0000e+06e
536 * pa      * f      0.0000e+00e
537 *
538 *****      type      num      id      ctitle
539 pipe      13      13 outlet pipe for tee 12
540 *      ncells      nodes      jun1      jun2      epsw
541      1      0      16      17      1.0000e-05
542 *      ichf      iconc      iacc      ipow
543      0      0      0      0
544 *      radin      th      hout1      houtv      tout1
545      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
546 *      toutv
547      4.5500e+02
548 *
549 * dx      * f      1.0000e+00e
550 * vol      * f      1.0000e+00e
551 * fa      * f      1.0000e+00e
552 * fric      * f      0.0000e+00e
553 * grav      * f      1.0000e+00e
554 * hd      * f      1.0000e+00e
555 * nff      * f      1e
556 * alp      * f      5.0000e-01e

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557 * vl      * f      0.0000e+00e
558 * vv      * f      0.0000e+00e
559 * tl      * f      4.5500e+02e
560 * tv      * f      4.5500e+02e
561 * p       * f      1.0000e+06e
562 * pa      * f      0.0000e+00e
563 *
564 *****   type                num          id          ctitle
565 pipe                14          14 inlet pipe for tee 15
566 *          ncells          nodes          jun1          jun2          epsw
567 *          1              0              18              17      1.0000e-05
568 *          ichf          iconc          iacc          ipow
569 *          0              0              0              0
570 *          radin          th          hout1          houtv          tout1
571 *          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
572 *          toutv
573 *          4.5500e+02
574 *
575 * dx      * f      1.0000e+00e
576 * vol     * f      1.0000e+00e
577 * fa      * f      1.0000e+00e
578 * fric    * f      0.0000e+00e
579 * grav    * f      -1.0000e+00e
580 * hd      * f      1.0000e+00e
581 * nff     * f              1e
582 * alp     * f      5.0000e-01e
583 * vl      * f      0.0000e+00e
584 * vv      * f      0.0000e+00e
585 * tl      * f      4.5500e+02e
586 * tv      * f      4.5500e+02e
587 * p       * f      1.0000e+06e
588 * pa      * f      0.0000e+00e
589 *
590 *****   type                num          id          ctitle
591 tee                15          15 tee that replaces vessel 15
592 *          jcell          nodes          ichf          cost          epsw
593 *          2              0              0      1.0000e+00      1.0000e-05
594 *          iconc1          ncell1          jun1          jun2          ipow1
595 *          0              3              19              18      0
596 *          radin1          th1          hout11          houtv1          tout11
597 *          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
598 *          toutv1
599 *          4.5500e+02
600 *          iconc2          ncell2          jun3          ipow2
601 *          0              1              20              0
602 *          radin2          th2          hout12          houtv2          tout12
603 *          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
604 *          toutv2
605 *          4.5500e+02
606 *
607 * dx      * f      1.0000e+00e
608 * vol     *          5.0000e-01r02 1.0000e+00e
609 * fa      * r02 5.0000e-01r02 1.0000e+00e
610 * fric    * f      0.0000e+00e
611 * grav    * f      -1.0000e+00e
612 * hd      * f      1.0000e+00e
613 * nff     *          -1r03          1e
614 * alp     * f      5.0000e-01e
615 * vl      * f      0.0000e+00e
616 * vv      * f      0.0000e+00e
617 * tl      * f      4.5500e+02e
618 * tv      * f      4.5500e+02e

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```

619 * p      * f      1.0000e+06e
620 * pa     * f      0.0000e+00e
621 *
622 * dx      * f      1.0000e+00e
623 * vol     * f      5.0000e-01e
624 * fa      * f      5.0000e-01e
625 * fric    * f      0.0000e+00e
626 * grav    * f      1.0000e+00e
627 * hd      * f      1.0000e+00e
628 * nff     *          1          -1e
629 * alp     * f      5.0000e-01e
630 * vl      * f      0.0000e+00e
631 * vv      * f      0.0000e+00e
632 * tl      * f      4.5500e+02e
633 * tv      * f      4.5500e+02e
634 * p      * f      1.0000e+06e
635 * pa     * f      0.0000e+00e
636 *
637 *****   type          num          id          ctitle
638 pipe                16          16 inlet pipe for tee 18
639 *          ncells      nodes      jun1      jun2      epsw
640          1              0          21          19      1.0000e-05
641 *          ichf        iconc      iacc          ipow
642          0              0          0          0
643 *          radin      th          hout1      houtv      tout1
644          5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    4.5500e+02
645 *          toutv
646          4.5500e+02
647 *
648 * dx      * f      1.0000e+00e
649 * vol     * f      1.0000e+00e
650 * fa      *          5.0000e-01e
651 * fric    * f      0.0000e+00e
652 * grav    * f      -1.0000e+00e
653 * hd      * f      1.0000e+00e
654 * nff     *          1          -1e
655 * alp     * f      5.0000e-01e
656 * vl      * f      0.0000e+00e
657 * vv      * f      0.0000e+00e
658 * tl      * f      4.5500e+02e
659 * tv      * f      4.5500e+02e
660 * p      * f      1.0000e+06e
661 * pa     * f      0.0000e+00e
662 *
663 *****   type          num          id          ctitle
664 pipe                17          17 inlet pipe for tee 19
665 *          ncells      nodes      jun1      jun2      epsw
666          1              0          22          20      1.0000e-05
667 *          ichf        iconc      iacc          ipow
668          0              0          0          0
669 *          radin      th          hout1      houtv      tout1
670          5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    4.5500e+02
671 *          toutv
672          4.5500e+02
673 *
674 * dx      * f      1.0000e+00e
675 * vol     * f      1.0000e+00e
676 * fa      *          5.0000e-01e
677 * fric    * f      0.0000e+00e
678 * grav    * f      -1.0000e+00e
679 * hd      * f      1.0000e+00e
680 * nff     *          1          -1e

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```

681 * alp      * f  5.0000e-01e
682 * vl       * f  0.0000e+00e
683 * vv       * f  0.0000e+00e
684 * tl       * f  4.5500e+02e
685 * tv       * f  4.5500e+02e
686 * p        * f  1.0000e+06e
687 * pa       * f  0.0000e+00e
688 *
689 *****      type          num          id          ctitle
690 tee          18          18 tee that replaces vessel 18
691 *          jcell        nodes        ichf          cost          epsw
692          2          0          0          1.0000e+00          1.0000e-05
693 *          iconcl        ncell11        jun1          jun2          ipow1
694          0          3          23          21          0
695 *          radin1        th1          hout11          houtv1          tout11
696          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          4.5500e+02
697 *          toutv1
698          4.5500e+02
699 *          iconc2        ncell12        jun3          ipow2
700          0          1          24          0
701 *          radin2        th2          hout12          houtv2          tout12
702          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          4.5500e+02
703 *          toutv2
704          4.5500e+02
705 *
706 * dx      * f  1.0000e+00e
707 * vol     *      5.0000e-01r02 1.0000e+00e
708 * fa      * r02 5.0000e-01r02 1.0000e+00e
709 * fric    * f  0.0000e+00e
710 * grav    * f -1.0000e+00e
711 * hd      * f  1.0000e+00e
712 * nff     *          -1r03          1e
713 * alp     * f  5.0000e-01e
714 * vl      * f  0.0000e+00e
715 * vv      * f  0.0000e+00e
716 * tl      * f  4.5500e+02e
717 * tv      * f  4.5500e+02e
718 * p       * f  1.0000e+06e
719 * pa      * f  0.0000e+00e
720 *
721 * dx      * f  1.0000e+00e
722 * vol     * f  5.0000e-01e
723 * fa      * f  5.0000e-01e
724 * fric    * f  0.0000e+00e
725 * grav    * f  1.0000e+00e
726 * hd      * f  1.0000e+00e
727 * nff     *          1          -1e
728 * alp     * f  5.0000e-01e
729 * vl      * f  0.0000e+00e
730 * vv      * f  0.0000e+00e
731 * tl      * f  4.5500e+02e
732 * tv      * f  4.5500e+02e
733 * p       * f  1.0000e+06e
734 * pa      * f  0.0000e+00e
735 *
736 *****      type          num          id          ctitle
737 tee          19          19 tee that replaces vessel 19
738 *          jcell        nodes        ichf          cost          epsw
739          2          0          0          1.0000e+00          1.0000e-05
740 *          iconcl        ncell11        jun1          jun2          ipow1
741          0          3          25          22          0
742 *          radin1        th1          hout11          houtv1          tout11

```

```

743      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
744 *      toutv1
745      4.5500e+02
746 *      iconc2      ncell2      jun3      ipow2
747      0      1      26      0
748 *      radin2      th2      houtl2      houtv2      toutl2
749      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
750 *      toutv2
751      4.5500e+02
752 *
753 * dx      * f      1.0000e+00e
754 * vol      *      5.0000e-01r02 1.0000e+00e
755 * fa      * r02 5.0000e-01r02 1.0000e+00e
756 * fric      * f      0.0000e+00e
757 * grav      * f      -1.0000e+00e
758 * hd      * f      1.0000e+00e
759 * nff      *      -1r03      1e
760 * alp      * f      5.0000e-01e
761 * vl      * f      0.0000e+00e
762 * vv      * f      0.0000e+00e
763 * tl      * f      4.5500e+02e
764 * tv      * f      4.5500e+02e
765 * p      * f      1.0000e+06e
766 * pa      * f      0.0000e+00e
767 *
768 * dx      * f      1.0000e+00e
769 * vol      * f      5.0000e-01e
770 * fa      * f      5.0000e-01e
771 * fric      * f      0.0000e+00e
772 * grav      * f      1.0000e+00e
773 * hd      * f      1.0000e+00e
774 * nff      *      1      -1e
775 * alp      * f      5.0000e-01e
776 * vl      * f      0.0000e+00e
777 * vv      * f      0.0000e+00e
778 * tl      * f      4.5500e+02e
779 * tv      * f      4.5500e+02e
780 * p      * f      1.0000e+06e
781 * pa      * f      0.0000e+00e
782 *
783 *****      type      num      id      ctitle
784 pipe      20      20 1st outlet pipe from tee 18
785 *      ncells      nodes      jun1      jun2      epsw
786      1      0      27      23      1.0000e-05
787 *      ichf      iconc      iacc      ipow
788      0      0      0      0
789 *      radin      th      houtl      houtv      toutl
790      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
791 *      toutv
792      4.5500e+02
793 *
794 * dx      * f      1.0000e+00e
795 * vol      * f      1.0000e+00e
796 * fa      *      1.0000e+00      5.0000e-01e
797 * fric      * f      0.0000e+00e
798 * grav      * f      -1.0000e+00e
799 * hd      * f      1.0000e+00e
800 * nff      *      1      -1e
801 * alp      * f      5.0000e-01e
802 * vl      * f      0.0000e+00e
803 * vv      * f      0.0000e+00e
804 * tl      * f      4.5500e+02e

```

```

805 * tv      * f    4.5500e+02e
806 * p       * f    1.0000e+06e
807 * pa      * f    0.0000e+00e
808 *
809 *****   type          num          id          ctitle
810 pipe                21          21 2nd outlet pipe from tee 18
811 *          ncells      nodes      jun1      jun2      epsw
812 *          1           0          28         24      1.0000e-05
813 *          ichf        iconc      iacc      ipow
814 *          0           0           0         0
815 *          radin        th        hout1      houtv      tout1
816 *          5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    4.5500e+02
817 *          toutv
818 *          4.5500e+02
819 *
820 * dx      * f    1.0000e+00e
821 * vol     * f    1.0000e+00e
822 * fa      *      1.0000e+00    5.0000e-01e
823 * fric    * f    0.0000e+00e
824 * grav    * f   -1.0000e+00e
825 * hd      * f    1.0000e+00e
826 * nff     *      1          -1e
827 * alp     * f    5.0000e-01e
828 * vl      * f    0.0000e+00e
829 * vv      * f    0.0000e+00e
830 * tl      * f    4.5500e+02e
831 * tv      * f    4.5500e+02e
832 * p       * f    1.0000e+06e
833 * pa      * f    0.0000e+00e
834 *
835 *****   type          num          id          ctitle
836 pipe                22          22 1st outlet pipe from tee 19
837 *          ncells      nodes      jun1      jun2      epsw
838 *          1           0          29         25      1.0000e-05
839 *          ichf        iconc      iacc      ipow
840 *          0           0           0         0
841 *          radin        th        hout1      houtv      tout1
842 *          5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    4.5500e+02
843 *          toutv
844 *          4.5500e+02
845 *
846 * dx      * f    1.0000e+00e
847 * vol     * f    1.0000e+00e
848 * fa      *      1.0000e+00    5.0000e-01e
849 * fric    * f    0.0000e+00e
850 * grav    * f   -1.0000e+00e
851 * hd      * f    1.0000e+00e
852 * nff     *      1          -1e
853 * alp     * f    5.0000e-01e
854 * vl      * f    0.0000e+00e
855 * vv      * f    0.0000e+00e
856 * tl      * f    4.5500e+02e
857 * tv      * f    4.5500e+02e
858 * p       * f    1.0000e+06e
859 * pa      * f    0.0000e+00e
860 *
861 *****   type          num          id          ctitle
862 pipe                23          23 2nd outlet pipe from tee 19
863 *          ncells      nodes      jun1      jun2      epsw
864 *          1           0          30         26      1.0000e-05
865 *          ichf        iconc      iacc      ipow
866 *          0           0           0         0

```

```

867 *      radin      th      houtl      houtv      toutl
868      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
869 *      toutv
870      4.5500e+02
871 *
872 * dx      * f      1.0000e+00e
873 * vol      * f      1.0000e+00e
874 * fa      *      1.0000e+00      5.0000e-01e
875 * fric      * f      0.0000e+00e
876 * grav      * f      -1.0000e+00e
877 * hd      * f      1.0000e+00e
878 * nff      *      1      -1e
879 * alp      * f      5.0000e-01e
880 * vl      * f      0.0000e+00e
881 * vv      * f      0.0000e+00e
882 * tl      * f      4.5500e+02e
883 * tv      * f      4.5500e+02e
884 * p      * f      1.0000e+06e
885 * pa      * f      0.0000e+00e
886 *
887 *****      type      num      id      ctitle
888 plenum      24      24 manifold plenum 24
889 *      npljn      iconc      juns1      juns2
890      5      0      1      4
891 *
892 * junj      *      31s
893 * junj      *      27      28      29      30e
894 * dx      * f      1.0000e+00e
895 * vol      * f      4.0000e+00e
896 * elev      * f      2.1000e+01e
897 * alp      * f      5.0000e-01e
898 * tl      * f      4.5500e+02e
899 * tv      * f      4.5500e+02e
900 * p      * f      1.0000e+06e
901 * pa      * f      0.0000e+00e
902 *
903 *****      type      num      id      ctitle
904 pipe      25      25 outlet pipe from plenum 24
905 *      ncells      nodes      jun1      jun2      epsw
906      1      0      32      31      1.0000e-05
907 *      ichf      iconc      iacc      ipow
908      0      0      0      0
909 *      radin      th      houtl      houtv      toutl
910      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
911 *      toutv
912      4.5500e+02
913 *
914 * dx      * f      1.0000e+00e
915 * vol      * f      1.0000e+00e
916 * fa      * f      1.0000e+00e
917 * fric      * f      0.0000e+00e
918 * grav      * f      -1.0000e+00e
919 * hd      * f      1.0000e+00e
920 * nff      *      1      -1e
921 * alp      * f      5.0000e-01e
922 * vl      * f      0.0000e+00e
923 * vv      * f      0.0000e+00e
924 * tl      * f      4.5500e+02e
925 * tv      * f      4.5500e+02e
926 * p      * f      1.0000e+06e
927 * pa      * f      0.0000e+00e
928 *

```

```

929 ***** type          num          id          ctitle
930 break                26          26 pressure b.c. for pipe 25 outlet
931 *          jun1        ibty        isat        ioff
932          32            0            0            0
933 *          dxin        volin        alpin        tin          pin
934          1.0000e+00    1.0000e+00    5.0000e-01    4.5500e+02    1.0000e+06
935 *          pain        concin        rbmx        poff        belv
936          0.0000e+00    0.0000e+00    0.0000e+00    0.0000e+00    2.3000e+01
937 *
938 end
939 *
940 *****
941 * time-step data *
942 *****
943 *
944 *          dtmin        dtmax        tend        rtwfp
945          1.0000e-03    1.0000e+00    1.0000e+01    1.0000e+00
946 *          edint        gfint        dmpint        sedint
947          1.0000e+01    1.0000e+00    1.1000e+01    1.0000e+01
948 *
949 *          dtmin        dtmax        tend        rtwfp
950          1.0000e-03    5.0000e+00    1.0000e+02    1.0000e+00
951 *          edint        gfint        dmpint        sedint
952          9.0000e+01    2.5000e+00    9.5000e+01    9.0000e+01
953 *
954 *          dtmin        dtmax        tend        rtwfp
955          1.0000e-02    3.0000e+01    1.0000e+03    1.0000e+00
956 *          edint        gfint        dmpint        sedint
957          9.0000e+02    1.5000e+01    9.3000e+02    9.0000e+02
958 *
959 *          dtmin        dtmax        tend        rtwfp
960          1.0000e-01    2.0000e+02    1.0000e+04    1.0000e+00
961 *          edint        gfint        dmpint        sedint
962          9.0000e+03    2.0000e+02    9.0000e+03    9.0000e+03
963 *
964 *          endflag
965          -1.0000e+00

```


A-4.14 MSTL Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              5              0              1              0              0
9 *--*--*TEST PROBLEM MSTL , Time = 10000.0 s
10 mirrored parallel-flow channel with single-phase liquid
11 6 tees replace 6 multiple-source connection vessels
12 tees have 4 cells and pipes & plenums have 1 cell
13 two pressure boundary conditions, t1 = 300.0 k
14 *
15 *
16 *          nff          vl          fa
17 *          (-)        (m/s)        (m2)
18 *          #####
19 *          # break#
20 *          # 26 # p = 1.0000e+06 pa
21 *          #####
22 *          32          1          -10.0          1.0
23 *          #####
24 *          # pipe #
25 *          # 25 #
26 *          #####
27 *          31          -1          -10.0          1.0
28 *          #####
29 *          #          plenum          #
30 *          #          24          #
31 *          #####
32 *          27          28          29          30          1          -2.5          1.0x4
33 *          #####
34 *          # pipe # # pipe # # pipe # # pipe #
35 *          # 20 # # 21 # # 22 # # 23 #
36 *          #####
37 *          23          24          25          26          -1          -5.0          0.5x4
38 *          #####
39 *          # cell# # tee # # cell# # tee #
40 *          # 1 ## 18 # # 1 ## 19 #
41 *          #-----# #-----#
42 *          # cell # # cell #
43 *          # 2 # # 2 #
44 *          #-----# #-----#
45 *          # cell # # cell #
46 *          # 3 # # 3 #
47 *          #####
48 *          21          22          1          -5.0          1.0x2
49 *          #####
50 *          # pipe # # pipe #
51 *          # 16 # # 17 #
52 *          #####
53 *          19          20          -1          -10.0          0.5x2
54 *          #####
55 *          # cell# # tee #
56 *          # 1 ## 15 #
57 *          #-----#
58 *          # cell #
59 *          # 2 #
60 *          #-----#
61 *          # cell #
62 *          # 3 #

```

```

61 *          #####
62 *          18                      1  -10.0    1.0
63 *          #####
64 *          # pipe #
65 *          # 14 #
66 *          #####
67 * -- mirror plane -- 17 -- mirror plane -- 1    10.0    1.0
68 *          #####
69 *          # pipe #
70 *          # 13 #
71 *          #####
72 *          16                      1    10.0    1.0
73 *          #####
74 *          # cell #
75 *          # 3 #
76 *          #-----#
77 *          # cell #
78 *          # 2 #
79 *          #-----#
80 *          #cell ## tee #
81 *          # 1 # # 12 #
82 *          #####
83 *          14          15          -1    10.0    0.5x2
84 *          #####
85 *          # pipe # # pipe #
86 *          # 10 # # 11 #
87 *          #####
88 *          12          13          1    5.0    1.0x2
89 *          #####
90 *          # cell # # cell #
91 *          # 3 # # 3 #
92 *          #-----#
93 *          # cell # # cell #
94 *          # 2 # # 2 #
95 *          #-----#
96 *          #cell ## tee # #cell ## tee #
97 *          # 1 # # 8 # # 1 # # 9 #
98 *          #####
99 *          8          9          10          11          -1    5.0    0.5x4
100 *          #####
101 *          # pipe # # pipe # # pipe # # pipe #
102 *          # 4 # # 5 # # 6 # # 7 #
103 *          #####
104 *          4          5          6          7          1    2.5    1.0x4
105 *          #####
106 *          #          plenum          #
107 *          #          3          #
108 *          #####
109 *          3          -1    10.0    1.0
110 *          #####
111 *          # pipe #
112 *          # 2 #
113 *          #####
114 *          2          1    10.0    1.0
115 *          #####
116 *          # break# p = 1.4045e+06 pa
117 *          # 1 #
118 *          #####
119 *
120 * *****
121 * namelist data *
122 * *****

```

```

123 *
124 &inopts
125   iadded=10, ikfac=1, cpuflg=1,
126   idiag=4, nsdl=0, nsdu=5, nspl=0, nspl=5
127 &end
128 *
129 *           dstep           timet
130           0           0.0000e+00
131 *           stdyst           transi           ncomp           njun           ipak
132           0           1           26           31           0
133 *           epso           epss
134           1.0000e-04           1.0000e-04
135 *           oitmax           sitmax           isolut           ncontr           nccfl
136           10           10           0           0           0
137 *           ntsv           ntcb           ntcf           ntrp           ntcp
138           1           0           0           0           0
139 *
140 *****
141 * component-number data *
142 *****
143 *
144 * iorder * 1 s * break           pressure b.c. for pipe 2 inlet
145 * iorder * 2 s * pipe           inlet pipe for plenum 3
146 * iorder * 3 s * plenum        manifold for parallel-channel pipes
147 * iorder * 4 s * pipe           1st inlet pipe for tee 8
148 * iorder * 5 s * pipe           2nd inlet pipe for tee 8
149 * iorder * 6 s * pipe           1st inlet pipe for tee 9
150 * iorder * 7 s * pipe           2nd inlet pipe for tee 9
151 * iorder * 8 s * tee           tee that replaces vessel 8
152 * iorder * 9 s * tee           tee that replaces vessel 9
153 * iorder * 10 s * pipe          outlet pipe for tee 8
154 * iorder * 11 s * pipe          outlet pipe for tee 9
155 * iorder * 12 s * tee           tee that replaces vessel 12
156 * iorder * 13 s * pipe          outlet pipe for tee 12
157 * iorder * 14 s * pipe          inlet pipe for tee 15
158 * iorder * 15 s * tee           tee that replaces vessel 15
159 * iorder * 16 s * pipe          inlet pipe for tee 18
160 * iorder * 17 s * pipe          inlet pipe for tee 19
161 * iorder * 18 s * tee           tee that replaces vessel 18
162 * iorder * 19 s * tee           tee that replaces vessel 19
163 * iorder * 20 s * pipe          1st outlet pipe for tee 18
164 * iorder * 21 s * pipe          2nd outlet pipe for tee 18
165 * iorder * 22 s * pipe          1st outlet pipe for tee 19
166 * iorder * 23 s * pipe          2nd outlet pipe for tee 19
167 * iorder * 24 s * plenum        manifold for parallel-channel pipes
168 * iorder * 25 s * pipe          outlet pipe for plenum 24
169 * iorder * 26 e * break          pressure b.c. for pipe 25 outlet
170 *
171 *****
172 * control parameters *
173 *****
174 *
175 * signal variable
176 *
177 *           idsv           isvn           icln           icn1           icn2
178           1           0           0           0           0
179 *
180 *****
181 * component data *
182 *****
183 *
184 *****      type           num           id           ctitle

```

```

185 break 1 1 pressure b.c. for pipe 2 inlet
186 * jun1 ibty isat ioff
187 2 1 0 0
188 * ibtr ibsv nbtr nbsv nbrf
189 0 1 2 0 0
190 * dxin volin alpin tin pin
191 1.0000e+00 1.0000e+00 0.0000e+00 3.0000e+02 1.0000e+06
192 * pain concin rbmx poff belv
193 0.0000e+00 0.0000e+00 4.0450e+05 0.0000e+00 0.0000e+00
194 * pscl tpscl tvscl pascl conscl
195 1.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00
196 *
197 * ptb * 0.0000e+00 1.0000e+06 1.0000e+00 1.4045e+06e
198 *
199 ***** type num id ctitle
200 pipe 2 2 inlet pipe for plenum 3
201 * ncells nodes jun1 jun2 epsw
202 1 0 2 3 1.0000e-05
203 * ichf iconc iacc ipow
204 0 0 0 0
205 * radin th hout1 houtv tout1
206 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
207 * toutv
208 3.0000e+02
209 *
210 * dx * f 1.0000e+00e
211 * vol * f 1.0000e+00e
212 * fa * f 1.0000e+00e
213 * fric * f 0.0000e+00e
214 * grav * f 1.0000e+00e
215 * hd * f 1.0000e+00e
216 * nff * 1 -1e
217 * alp * f 0.0000e+00e
218 * vl * f 0.0000e+00e
219 * vv * f 0.0000e+00e
220 * tl * f 3.0000e+02e
221 * tv * f 3.0000e+02e
222 * p * f 1.0000e+06e
223 * pa * f 0.0000e+00e
224 *
225 ***** type num id ctitle
226 plenum 3 3 manifold plenum 3
227 * npljn iconc juns1 juns2
228 5 0 1 4
229 *
230 * junj * 3s
231 * junj * 4 5 6 7e
232 * dx * f 1.0000e+00e
233 * vol * f 4.0000e+00e
234 * elev * f 2.0000e+00e
235 * alp * f 0.0000e+00e
236 * tl * f 3.0000e+02e
237 * tv * f 3.0000e+02e
238 * p * f 1.0000e+06e
239 * pa * f 0.0000e+00e
240 *
241 ***** type num id ctitle
242 pipe 4 4 1st inlet pipe for tee 8
243 * ncells nodes jun1 jun2 epsw
244 1 0 4 8 1.0000e-05
245 * ichf iconc iacc ipow
246 0 0 0 0

```

```

247 *          radin          th          houtl          houtv          toutl
248      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
249 *          toutv
250      3.0000e+02
251 *
252 * dx      * f      1.0000e+00e
253 * vol      * f      1.0000e+00e
254 * fa      *      1.0000e+00      5.0000e-01e
255 * fric      * f      0.0000e+00e
256 * grav      * f      1.0000e+00e
257 * hd      * f      1.0000e+00e
258 * nff      *      1      -1e
259 * alp      * f      0.0000e+00e
260 * vl      * f      0.0000e+00e
261 * vv      * f      0.0000e+00e
262 * tl      * f      3.0000e+02e
263 * tv      * f      3.0000e+02e
264 * p      * f      1.0000e+06e
265 * pa      * f      0.0000e+00e
266 *
267 *****      type          num          id          ctitle
268 pipe          5          5 2nd inlet pipe for tee 8
269 *          ncells          nodes          jun1          jun2          epsw
270      1          0          5          9      1.0000e-05
271 *          ichf          iconc          iacc          ipow
272      0          0          0          0
273 *          radin          th          houtl          houtv          toutl
274      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
275 *          toutv
276      3.0000e+02
277 *
278 * dx      * f      1.0000e+00e
279 * vol      * f      1.0000e+00e
280 * fa      *      1.0000e+00      5.0000e-01e
281 * fric      * f      0.0000e+00e
282 * grav      * f      1.0000e+00e
283 * hd      * f      1.0000e+00e
284 * nff      *      1      -1e
285 * alp      * f      0.0000e+00e
286 * vl      * f      0.0000e+00e
287 * vv      * f      0.0000e+00e
288 * tl      * f      3.0000e+02e
289 * tv      * f      3.0000e+02e
290 * p      * f      1.0000e+06e
291 * pa      * f      0.0000e+00e
292 *
293 *****      type          num          id          ctitle
294 pipe          6          6 1st inlet pipe for tee 9
295 *          ncells          nodes          jun1          jun2          epsw
296      1          0          6          10      1.0000e-05
297 *          ichf          iconc          iacc          ipow
298      0          0          0          0
299 *          radin          th          houtl          houtv          toutl
300      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
301 *          toutv
302      3.0000e+02
303 *
304 * dx      * f      1.0000e+00e
305 * vol      * f      1.0000e+00e
306 * fa      *      1.0000e+00      5.0000e-01e
307 * fric      * f      0.0000e+00e
308 * grav      * f      1.0000e+00e

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309 * hd      * f      1.0000e+00e
310 * nff      *          1          -1e
311 * alp      * f      0.0000e+00e
312 * vl      * f      0.0000e+00e
313 * vv      * f      0.0000e+00e
314 * tl      * f      3.0000e+02e
315 * tv      * f      3.0000e+02e
316 * p       * f      1.0000e+06e
317 * pa      * f      0.0000e+00e
318 *
319 *****      type          num          id          ctitle
320 pipe          7          7 2nd inlet pipe for tee 9
321 *          ncells          nodes          jun1          jun2          epsw
322          1          0          7          11          1.0000e-05
323 *          ichf          iconc          iacc          ipow
324          0          0          0          0
325 *          radin          th          hout1          houtv          tout1
326          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          3.0000e+02
327 *          toutv
328          3.0000e+02
329 *
330 * dx      * f      1.0000e+00e
331 * vol      * f      1.0000e+00e
332 * fa      *          1.0000e+00          5.0000e-01e
333 * fric     * f      0.0000e+00e
334 * grav     * f      1.0000e+00e
335 * hd      * f      1.0000e+00e
336 * nff      *          1          -1e
337 * alp      * f      0.0000e+00e
338 * vl      * f      0.0000e+00e
339 * vv      * f      0.0000e+00e
340 * tl      * f      3.0000e+02e
341 * tv      * f      3.0000e+02e
342 * p       * f      1.0000e+06e
343 * pa      * f      0.0000e+00e
344 *
345 *****      type          num          id          ctitle
346 tee          8          8 tee that replaces vessel 8
347 *          jcell          nodes          ichf          cost          epsw
348          2          0          0          1.0000e+00          1.0000e-05
349 *          iconc1          ncell1          jun1          jun2          ipow1
350          0          3          8          12          0
351 *          radin1          th1          hout1          houtv1          tout1
352          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          3.0000e+02
353 *          toutv1
354          3.0000e+02
355 *          iconc2          ncell2          jun3          ipow2
356          0          1          9          0
357 *          radin2          th2          hout2          houtv2          tout2
358          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          3.0000e+02
359 *          toutv2
360          3.0000e+02
361 *
362 * dx      * f      1.0000e+00e
363 * vol      *          5.0000e-01r02          1.0000e+00e
364 * fa      * r02          5.0000e-01r02          1.0000e+00e
365 * fric     * f      0.0000e+00e
366 * grav     * f      1.0000e+00e
367 * hd      * f      1.0000e+00e
368 * nff      *          -1r03          1e
369 * alp      * f      0.0000e+00e
370 * vl      * f      0.0000e+00e

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```

371 * vv      * f    0.0000e+00e
372 * tl      * f    3.0000e+02e
373 * tv      * f    3.0000e+02e
374 * p       * f    1.0000e+06e
375 * pa      * f    0.0000e+00e
376 *
377 * dx      * f    1.0000e+00e
378 * vol     * f    5.0000e-01e
379 * fa      * f    5.0000e-01e
380 * fric    * f    0.0000e+00e
381 * grav    * f   -1.0000e+00e
382 * hd      * f    1.0000e+00e
383 * nff     *      1          -1e
384 * alp     * f    0.0000e+00e
385 * vl      * f    0.0000e+00e
386 * vv      * f    0.0000e+00e
387 * tl      * f    3.0000e+02e
388 * tv      * f    3.0000e+02e
389 * p       * f    1.0000e+06e
390 * pa      * f    0.0000e+00e
391 *
392 *****   type          num          id          ctitle
393 tee                9          9 tee that replaces vessel 9
394 *      jcell        nodes      ichf      cost      epsw
395          2          0          0      1.0000e+00      1.0000e-05
396 *      iconcl       ncell1     jun1      jun2      ipow1
397          0          3          10      13          0
398 *      radin1        th1      hout11     houtv1     tout11
399      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
400 *      toutv1
401      3.0000e+02
402 *      iconc2        ncell2     jun3      ipow2
403          0          1          11          0
404 *      radin2        th2      hout12     houtv2     tout12
405      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
406 *      toutv2
407      3.0000e+02
408 *
409 * dx      * f    1.0000e+00e
410 * vol     *      5.0000e-01r02 1.0000e+00e
411 * fa      * r02 5.0000e-01r02 1.0000e+00e
412 * fric    * f    0.0000e+00e
413 * grav    * f    1.0000e+00e
414 * hd      * f    1.0000e+00e
415 * nff     *      -1r03          1e
416 * alp     * f    0.0000e+00e
417 * vl      * f    0.0000e+00e
418 * vv      * f    0.0000e+00e
419 * tl      * f    3.0000e+02e
420 * tv      * f    3.0000e+02e
421 * p       * f    1.0000e+06e
422 * pa      * f    0.0000e+00e
423 *
424 * dx      * f    1.0000e+00e
425 * vol     * f    5.0000e-01e
426 * fa      * f    5.0000e-01e
427 * fric    * f    0.0000e+00e
428 * grav    * f   -1.0000e+00e
429 * hd      * f    1.0000e+00e
430 * nff     *      1          -1e
431 * alp     * f    0.0000e+00e
432 * vl      * f    0.0000e+00e

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```

433 * vv      * f  0.0000e+00e
434 * tl      * f  3.0000e+02e
435 * tv      * f  3.0000e+02e
436 * p       * f  1.0000e+06e
437 * pa      * f  0.0000e+00e
438 *
439 *****   type          num          id          ctitle
440 pipe                10          10 outlet pipe for tee 8
441 *          ncells      nodes      jun1      jun2      epsw
442          1              0          12          14      1.0000e-05
443 *          ichf        iconc        iacc        ipow
444          0              0              0              0
445 *          radin        th          hout1        houtv        tout1
446          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
447 *          toutv
448          3.0000e+02
449 *
450 * dx      * f  1.0000e+00e
451 * vol     * f  1.0000e+00e
452 * fa      *      1.0000e+00      5.0000e-01e
453 * fric    * f  0.0000e+00e
454 * grav    * f  1.0000e+00e
455 * hd      * f  1.0000e+00e
456 * nff     *      1          -1e
457 * alp     * f  0.0000e+00e
458 * vl      * f  0.0000e+00e
459 * vv      * f  0.0000e+00e
460 * tl      * f  3.0000e+02e
461 * tv      * f  3.0000e+02e
462 * p       * f  1.0000e+06e
463 * pa      * f  0.0000e+00e
464 *
465 *****   type          num          id          ctitle
466 pipe                11          11 outlet pipe for tee 9
467 *          ncells      nodes      jun1      jun2      epsw
468          1              0          13          15      1.0000e-05
469 *          ichf        iconc        iacc        ipow
470          0              0              0              0
471 *          radin        th          hout1        houtv        tout1
472          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
473 *          toutv
474          3.0000e+02
475 *
476 * dx      * f  1.0000e+00e
477 * vol     * f  1.0000e+00e
478 * fa      *      1.0000e+00      5.0000e-01e
479 * fric    * f  0.0000e+00e
480 * grav    * f  1.0000e+00e
481 * hd      * f  1.0000e+00e
482 * nff     *      1          -1e
483 * alp     * f  0.0000e+00e
484 * vl      * f  0.0000e+00e
485 * vv      * f  0.0000e+00e
486 * tl      * f  3.0000e+02e
487 * tv      * f  3.0000e+02e
488 * p       * f  1.0000e+06e
489 * pa      * f  0.0000e+00e
490 *
491 *****   type          num          id          ctitle
492 tee                12          12 tee that replaces vessel 12
493 *          jcell      nodes      ichf        cost      epsw
494          2              0              0      1.0000e+00      1.0000e-05

```



```

495 *      iconc1      ncell11      jun1      jun2      ipow1
496          0          3          14          16          0
497 *      radin1      th1      hout11      houtv1      tout11
498      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
499 *      toutv1
500      3.0000e+02
501 *      iconc2      ncell12      jun3      ipow2
502          0          1          15          0
503 *      radin2      th2      hout12      houtv2      tout12
504      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
505 *      toutv2
506      3.0000e+02
507 *
508 * dx      * f      1.0000e+00e
509 * vol      *      5.0000e-01r02 1.0000e+00e
510 * fa      * r02 5.0000e-01r02 1.0000e+00e
511 * fric      * f      0.0000e+00e
512 * grav      * f      1.0000e+00e
513 * hd      * f      1.0000e+00e
514 * nff      *      -1r03          1e
515 * alp      * f      0.0000e+00e
516 * vl      * f      0.0000e+00e
517 * vv      * f      0.0000e+00e
518 * tl      * f      3.0000e+02e
519 * tv      * f      3.0000e+02e
520 * p      * f      1.0000e+06e
521 * pa      * f      0.0000e+00e
522 *
523 * dx      * f      1.0000e+00e
524 * vol      * f      5.0000e-01e
525 * fa      * f      5.0000e-01e
526 * fric      * f      0.0000e+00e
527 * grav      * f      -1.0000e+00e
528 * hd      * f      1.0000e+00e
529 * nff      *      1          -1e
530 * alp      * f      0.0000e+00e
531 * vl      * f      0.0000e+00e
532 * vv      * f      0.0000e+00e
533 * tl      * f      3.0000e+02e
534 * tv      * f      3.0000e+02e
535 * p      * f      1.0000e+06e
536 * pa      * f      0.0000e+00e
537 *
538 *****      type      num      id      ctitle
539 pipe      13      13 outlet pipe for tee 12
540 *      ncells      nodes      jun1      jun2      epsw
541          1          0          16          17      1.0000e-05
542 *      ichf      iconc      iacc      ipow
543          0          0          0          0
544 *      radin      th      hout1      houtv      tout1
545      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
546 *      toutv
547      3.0000e+02
548 *
549 * dx      * f      1.0000e+00e
550 * vol      * f      1.0000e+00e
551 * fa      * f      1.0000e+00e
552 * fric      * f      0.0000e+00e
553 * grav      * f      1.0000e+00e
554 * hd      * f      1.0000e+00e
555 * nff      * f      1e
556 * alp      * f      0.0000e+00e

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```

557 * vl      * f    0.0000e+00e
558 * vv      * f    0.0000e+00e
559 * tl      * f    3.0000e+02e
560 * tv      * f    3.0000e+02e
561 * p       * f    1.0000e+06e
562 * pa      * f    0.0000e+00e
563 *
564 *****   type          num          id          ctitle
565 pipe              14          14 inlet pipe for tee 15
566 *      ncells      nodes      jun1      jun2      epsw
567 *          1          0          18          17      1.0000e-05
568 *      ichf      iconc      iacc      ipow
569 *          0          0          0          0
570 *      radin      th      hout1      houtv      tout1
571 *      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
572 *      toutv
573 *      3.0000e+02
574 *
575 * dx      * f    1.0000e+00e
576 * vol     * f    1.0000e+00e
577 * fa      * f    1.0000e+00e
578 * fric    * f    0.0000e+00e
579 * grav    * f   -1.0000e+00e
580 * hd      * f    1.0000e+00e
581 * nff     * f          1e
582 * alp     * f    0.0000e+00e
583 * vl      * f    0.0000e+00e
584 * vv      * f    0.0000e+00e
585 * tl      * f    3.0000e+02e
586 * tv      * f    3.0000e+02e
587 * p       * f    1.0000e+06e
588 * pa      * f    0.0000e+00e
589 *
590 *****   type          num          id          ctitle
591 tee              15          15 tee that replaces vessel 15
592 *      jcell      nodes      ichf      cost      epsw
593 *          2          0          0      1.0000e+00      1.0000e-05
594 *      iconc1      ncell1      jun1      jun2      ipow1
595 *          0          3          19          18          0
596 *      radin1      th1      hout11      houtv1      tout11
597 *      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
598 *      toutv1
599 *      3.0000e+02
600 *      iconc2      ncell2      jun3      ipow2
601 *          0          1          20          0
602 *      radin2      th2      hout12      houtv2      tout12
603 *      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
604 *      toutv2
605 *      3.0000e+02
606 *
607 * dx      * f    1.0000e+00e
608 * vol     *      5.0000e-01r02 1.0000e+00e
609 * fa      * r02 5.0000e-01r02 1.0000e+00e
610 * fric    * f    0.0000e+00e
611 * grav    * f   -1.0000e+00e
612 * hd      * f    1.0000e+00e
613 * nff     *      -1r03          1e
614 * alp     * f    0.0000e+00e
615 * vl      * f    0.0000e+00e
616 * vv      * f    0.0000e+00e
617 * tl      * f    3.0000e+02e
618 * tv      * f    3.0000e+02e

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```

619 * p      * f      1.0000e+06e
620 * pa     * f      0.0000e+00e
621 *
622 * dx     * f      1.0000e+00e
623 * vol    * f      5.0000e-01e
624 * fa     * f      5.0000e-01e
625 * fric   * f      0.0000e+00e
626 * grav   * f      1.0000e+00e
627 * hd     * f      1.0000e+00e
628 * nff    *          1          -1e
629 * alp    * f      0.0000e+00e
630 * vl     * f      0.0000e+00e
631 * vv     * f      0.0000e+00e
632 * tl     * f      3.0000e+02e
633 * tv     * f      3.0000e+02e
634 * p      * f      1.0000e+06e
635 * pa     * f      0.0000e+00e
636 *
637 *****      type          num          id          ctitle
638 pipe          16          16 inlet pipe for tee 18
639 *          ncells          nodes          jun1          jun2          epsw
640          1          0          21          19          1.0000e-05
641 *          ichf          iconc          iacc          ipow
642          0          0          0          0
643 *          radin          th          hout1          houtv          tout1
644          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          3.0000e+02
645 *          toutv
646          3.0000e+02
647 *
648 * dx     * f      1.0000e+00e
649 * vol    * f      1.0000e+00e
650 * fa     *          5.0000e-01e
651 * fric   * f      0.0000e+00e
652 * grav   * f      -1.0000e+00e
653 * hd     * f      1.0000e+00e
654 * nff    *          1          -1e
655 * alp    * f      0.0000e+00e
656 * vl     * f      0.0000e+00e
657 * vv     * f      0.0000e+00e
658 * tl     * f      3.0000e+02e
659 * tv     * f      3.0000e+02e
660 * p      * f      1.0000e+06e
661 * pa     * f      0.0000e+00e
662 *
663 *****      type          num          id          ctitle
664 pipe          17          17 inlet pipe for tee 19
665 *          ncells          nodes          jun1          jun2          epsw
666          1          0          22          20          1.0000e-05
667 *          ichf          iconc          iacc          ipow
668          0          0          0          0
669 *          radin          th          hout1          houtv          tout1
670          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          3.0000e+02
671 *          toutv
672          3.0000e+02
673 *
674 * dx     * f      1.0000e+00e
675 * vol    * f      1.0000e+00e
676 * fa     *          5.0000e-01e
677 * fric   * f      0.0000e+00e
678 * grav   * f      -1.0000e+00e
679 * hd     * f      1.0000e+00e
680 * nff    *          1          -1e

```

```

681 * alp      * f      0.0000e+00e
682 * vl       * f      0.0000e+00e
683 * vv       * f      0.0000e+00e
684 * tl       * f      3.0000e+02e
685 * tv       * f      3.0000e+02e
686 * p        * f      1.0000e+06e
687 * pa       * f      0.0000e+00e
688 *
689 *****      type              num              id              ctitle
690 tee          18              18 tee that replaces vessel 18
691 *           jcell          nodes          ichf          cost          epsw
692             2              0              0          1.0000e+00      1.0000e-05
693 *           iconcl          ncell11          jun1          jun2          ipow1
694             0              3              23          21              0
695 *           radin1          th1          hout11          houtv1          tout11
696       5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
697 *           toutv1
698       3.0000e+02
699 *           iconc2          ncell12          jun3          ipow2
700             0              1              24              0
701 *           radin2          th2          hout12          houtv2          tout12
702       5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
703 *           toutv2
704       3.0000e+02
705 *
706 * dx        * f      1.0000e+00e
707 * vol       *          5.0000e-01r02 1.0000e+00e
708 * fa        * r02 5.0000e-01r02 1.0000e+00e
709 * fric      * f      0.0000e+00e
710 * grav     * f      -1.0000e+00e
711 * hd       * f      1.0000e+00e
712 * nff      *          -1r03          1e
713 * alp      * f      0.0000e+00e
714 * vl       * f      0.0000e+00e
715 * vv       * f      0.0000e+00e
716 * tl       * f      3.0000e+02e
717 * tv       * f      3.0000e+02e
718 * p        * f      1.0000e+06e
719 * pa       * f      0.0000e+00e
720 *
721 * dx        * f      1.0000e+00e
722 * vol       * f      5.0000e-01e
723 * fa        * f      5.0000e-01e
724 * fric     * f      0.0000e+00e
725 * grav     * f      1.0000e+00e
726 * hd       * f      1.0000e+00e
727 * nff      *          1          -1e
728 * alp      * f      0.0000e+00e
729 * vl       * f      0.0000e+00e
730 * vv       * f      0.0000e+00e
731 * tl       * f      3.0000e+02e
732 * tv       * f      3.0000e+02e
733 * p        * f      1.0000e+06e
734 * pa       * f      0.0000e+00e
735 *
736 *****      type              num              id              ctitle
737 tee          19              19 tee that replaces vessel 19
738 *           jcell          nodes          ichf          cost          epsw
739             2              0              0          1.0000e+00      1.0000e-05
740 *           iconcl          ncell11          jun1          jun2          ipow1
741             0              3              25          22              0
742 *           radin1          th1          hout11          houtv1          tout11

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```

743      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
744 *      toutv1
745      3.0000e+02
746 *      iconc2      ncell2      jun3      ipow2
747      0      1      26      0
748 *      radin2      th2      houtl2      houtv2      toutl2
749      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
750 *      toutv2
751      3.0000e+02
752 *
753 * dx      * f      1.0000e+00e
754 * vol      *      5.0000e-01r02 1.0000e+00e
755 * fa      * r02 5.0000e-01r02 1.0000e+00e
756 * fric      * f      0.0000e+00e
757 * grav      * f      -1.0000e+00e
758 * hd      * f      1.0000e+00e
759 * nff      *      -1r03      1e
760 * alp      * f      0.0000e+00e
761 * vl      * f      0.0000e+00e
762 * vv      * f      0.0000e+00e
763 * tl      * f      3.0000e+02e
764 * tv      * f      3.0000e+02e
765 * p      * f      1.0000e+06e
766 * pa      * f      0.0000e+00e
767 *
768 * dx      * f      1.0000e+00e
769 * vol      * f      5.0000e-01e
770 * fa      * f      5.0000e-01e
771 * fric      * f      0.0000e+00e
772 * grav      * f      1.0000e+00e
773 * hd      * f      1.0000e+00e
774 * nff      *      1      -1e
775 * alp      * f      0.0000e+00e
776 * vl      * f      0.0000e+00e
777 * vv      * f      0.0000e+00e
778 * tl      * f      3.0000e+02e
779 * tv      * f      3.0000e+02e
780 * p      * f      1.0000e+06e
781 * pa      * f      0.0000e+00e
782 *
783 *****      type      num      id      ctitle
784 pipe      20      20 1st outlet pipe from tee 18
785 *      ncells      nodes      jun1      jun2      epsw
786      1      0      27      23      1.0000e-05
787 *      ichf      iconc      iacc      ipow
788      0      0      0      0
789 *      radin      th      houtl      houtv      toutl
790      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
791 *      toutv
792      3.0000e+02
793 *
794 * dx      * f      1.0000e+00e
795 * vol      * f      1.0000e+00e
796 * fa      *      1.0000e+00      5.0000e-01e
797 * fric      * f      0.0000e+00e
798 * grav      * f      -1.0000e+00e
799 * hd      * f      1.0000e+00e
800 * nff      *      1      -1e
801 * alp      * f      0.0000e+00e
802 * vl      * f      0.0000e+00e
803 * vv      * f      0.0000e+00e
804 * tl      * f      3.0000e+02e

```

```

805 * tv      * f    3.0000e+02e
806 * p       * f    1.0000e+06e
807 * pa      * f    0.0000e+00e
808 *
809 *****   type          num          id          ctitle
810 pipe                21          21 2nd outlet pipe from tee 18
811 *          ncells      nodes      jun1      jun2      epsw
812 *          1          0          28          24      1.0000e-05
813 *          ichf        iconc      iacc      ipow
814 *          0          0          0          0
815 *          radin      th          hout1      houtv      tout1
816 *          5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  3.0000e+02
817 *          toutv
818 *          3.0000e+02
819 *
820 * dx      * f    1.0000e+00e
821 * vol     * f    1.0000e+00e
822 * fa      *      1.0000e+00      5.0000e-01e
823 * fric    * f    0.0000e+00e
824 * grav    * f   -1.0000e+00e
825 * hd      * f    1.0000e+00e
826 * nff     *      1          -1e
827 * alp     * f    0.0000e+00e
828 * vl      * f    0.0000e+00e
829 * vv      * f    0.0000e+00e
830 * tl      * f    3.0000e+02e
831 * tv      * f    3.0000e+02e
832 * p       * f    1.0000e+06e
833 * pa      * f    0.0000e+00e
834 *
835 *****   type          num          id          ctitle
836 pipe                22          22 1st outlet pipe from tee 19
837 *          ncells      nodes      jun1      jun2      epsw
838 *          1          0          29          25      1.0000e-05
839 *          ichf        iconc      iacc      ipow
840 *          0          0          0          0
841 *          radin      th          hout1      houtv      tout1
842 *          5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  3.0000e+02
843 *          toutv
844 *          3.0000e+02
845 *
846 * dx      * f    1.0000e+00e
847 * vol     * f    1.0000e+00e
848 * fa      *      1.0000e+00      5.0000e-01e
849 * fric    * f    0.0000e+00e
850 * grav    * f   -1.0000e+00e
851 * hd      * f    1.0000e+00e
852 * nff     *      1          -1e
853 * alp     * f    0.0000e+00e
854 * vl      * f    0.0000e+00e
855 * vv      * f    0.0000e+00e
856 * tl      * f    3.0000e+02e
857 * tv      * f    3.0000e+02e
858 * p       * f    1.0000e+06e
859 * pa      * f    0.0000e+00e
860 *
861 *****   type          num          id          ctitle
862 pipe                23          23 2nd outlet pipe from tee 19
863 *          ncells      nodes      jun1      jun2      epsw
864 *          1          0          30          26      1.0000e-05
865 *          ichf        iconc      iacc      ipow
866 *          0          0          0          0

```

```

867 *      radin      th      houtl      houtv      toutl
868      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
869 *      toutv
870      3.0000e+02
871 *
872 * dx      * f      1.0000e+00e
873 * vol      * f      1.0000e+00e
874 * fa      *      1.0000e+00      5.0000e-01e
875 * fric      * f      0.0000e+00e
876 * grav      * f      -1.0000e+00e
877 * hd      * f      1.0000e+00e
878 * nff      *      1      -1e
879 * alp      * f      0.0000e+00e
880 * vl      * f      0.0000e+00e
881 * vv      * f      0.0000e+00e
882 * tl      * f      3.0000e+02e
883 * tv      * f      3.0000e+02e
884 * p      * f      1.0000e+06e
885 * pa      * f      0.0000e+00e
886 *
887 * type      num      id      ctitle
888 plenum      24      24 manifold plenum 24
889 *      npljn      iconc      juns1      juns2
890      5      0      1      4
891 *
892 * junj      *      31s
893 * junj      *      27      28      29      30e
894 * dx      * f      1.0000e+00e
895 * vol      * f      4.0000e+00e
896 * elev      * f      2.1000e+01e
897 * alp      * f      0.0000e+00e
898 * tl      * f      3.0000e+02e
899 * tv      * f      3.0000e+02e
900 * p      * f      1.0000e+06e
901 * pa      * f      0.0000e+00e
902 *
903 * type      num      id      ctitle
904 pipe      25      25 outlet pipe from plenum 24
905 *      ncells      nodes      jun1      jun2      epsw
906      1      0      32      31      1.0000e-05
907 *      ichf      iconc      iacc      ipow
908      0      0      0      0
909 *      radin      th      houtl      houtv      toutl
910      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
911 *      toutv
912      3.0000e+02
913 *
914 * dx      * f      1.0000e+00e
915 * vol      * f      1.0000e+00e
916 * fa      * f      1.0000e+00e
917 * fric      * f      0.0000e+00e
918 * grav      * f      -1.0000e+00e
919 * hd      * f      1.0000e+00e
920 * nff      *      1      -1e
921 * alp      * f      0.0000e+00e
922 * vl      * f      0.0000e+00e
923 * vv      * f      0.0000e+00e
924 * tl      * f      3.0000e+02e
925 * tv      * f      3.0000e+02e
926 * p      * f      1.0000e+06e
927 * pa      * f      0.0000e+00e
928 *

```

```

929 ***** type          num          id          ctitle
930 break                26          26 pressure b.c. for pipe 25 outlet
931 *          jun1        ibty        isat        ioff
932          32            0            0            0
933 *          dxin        volin        alpin        tin          pin
934    1.0000e+00    1.0000e+00    0.0000e+00    3.0000e+02    1.0000e+06
935 *          pain        concin        rbmx        poff        belv
936    0.0000e+00    0.0000e+00    0.0000e+00    0.0000e+00    2.3000e+01
937 *
938 end
939 *
940 *****
941 * time-step data *
942 *****
943 *
944 *          dtmin        dtmax        tend        rtwfp
945    1.0000e-03    1.0000e+00    1.0000e+01    1.0000e+00
946 *          edint        gfint        dmpint        sedint
947    1.0000e+01    1.0000e+00    1.1000e+01    1.0000e+01
948 *
949 *          dtmin        dtmax        tend        rtwfp
950    1.0000e-03    5.0000e+00    1.0000e+02    1.0000e+00
951 *          edint        gfint        dmpint        sedint
952    9.0000e+01    2.5000e+00    9.5000e+01    9.0000e+01
953 *
954 *          dtmin        dtmax        tend        rtwfp
955    1.0000e-02    3.0000e+01    1.0000e+03    1.0000e+00
956 *          edint        gfint        dmpint        sedint
957    9.0000e+02    1.5000e+01    9.3000e+02    9.0000e+02
958 *
959 *          dtmin        dtmax        tend        rtwfp
960    1.0000e-01    2.0000e+02    1.0000e+04    1.0000e+00
961 *          edint        gfint        dmpint        sedint
962    9.0000e+03    2.0000e+02    9.0000e+03    9.0000e+03
963 *
964 *          endflag
965    -1.0000e+00

```


A-4.15 MSTV Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              5              0              1              0              0
9 *--*--TEST PROBLEM MSTV , Time = 10000.0 s
10 mirrored parallel-flow channel with single-phase vapor
11 6 tees replace 6 multiple-source connection vessels
12 tees have 4 cells and pipes & plenums have 1 cell
13 two pressure boundary conditions, tv = 500.0 k
14 *
15 *
16 *          nff          vv          fa
17 *          (-)          (m/s)          (m2)
18 *          #####
19 *          # break#
20 *          # 26 # p = 1.0000e+06 pa
21 *          #####
22 *          32          1          -10.0          1.0
23 *          #####
24 *          # pipe #
25 *          # 25 #
26 *          #####
27 *          31          -1          -10.0          1.0
28 *          #####
29 *          #          plenum          #
30 *          #          24          #
31 *          #####
32 *          27          28          29          30          1          -2.5          1.0x4
33 *          #####
34 *          # pipe # # pipe # # pipe # # pipe #
35 *          # 20 # # 21 # # 22 # # 23 #
36 *          #####
37 *          23          24          25          26          -1          -5.0          0.5x4
38 *          #####
39 *          # cell# # tee # # cell# # tee #
40 *          # 1 ## 18 # # 1 ## 19 #
41 *          #-----# #-----#
42 *          # cell # # cell #
43 *          # 2 # # 2 #
44 *          #-----# #-----#
45 *          # cell # # cell #
46 *          # 3 # # 3 #
47 *          #####
48 *          21          22          1          -5.0          1.0x2
49 *          #####
50 *          # pipe # # pipe #
51 *          # 16 # # 17 #
52 *          #####
53 *          19          20          -1          -10.0          0.5x2
54 *          #####
55 *          # cell# # tee #
56 *          # 1 ## 15 #
57 *          #-----#
58 *          # cell #
59 *          # 2 #
60 *          #-----#
61 *          # cell #
62 *          # 3 #

```

```

61 *          #####
62 *          18                      1  -10.0    1.0
63 *          #####
64 *          # pipe #
65 *          # 14 #
66 *          #####
67 * -- mirror plane -- 17 -- mirror plane -- 1  10.0    1.0
68 *          #####
69 *          # pipe #
70 *          # 13 #
71 *          #####
72 *          16                      1  10.0    1.0
73 *          #####
74 *          # cell #
75 *          # 3 #
76 *          #-----#
77 *          # cell #
78 *          # 2 #
79 *          #-----#
80 *          #cell ## tee #
81 *          # 1 # # 12 #
82 *          #####
83 *          14 15                  -1  10.0    0.5x2
84 *          #####
85 *          # pipe # # pipe #
86 *          # 10 # # 11 #
87 *          #####
88 *          12 13                  1  5.0    1.0x2
89 *          #####
90 *          # cell # # cell #
91 *          # 3 # # 3 #
92 *          #-----#
93 *          # cell # # cell #
94 *          # 2 # # 2 #
95 *          #-----#
96 *          #cell ## tee # #cell ## tee #
97 *          # 1 # # 8 # # 1 # # 9 #
98 *          #####
99 *          8 9 10 11              -1  5.0    0.5x4
100 *          #####
101 *          # pipe # # pipe # # pipe # # pipe #
102 *          # 4 # # 5 # # 6 # # 7 #
103 *          #####
104 *          4 5 6 7                1  2.5    1.0x4
105 *          #####
106 *          # plenum #
107 *          # 3 #
108 *          #####
109 *          3                      -1  10.0    1.0
110 *          #####
111 *          # pipe #
112 *          # 2 #
113 *          #####
114 *          2                      1  10.0    1.0
115 *          #####
116 *          # break# p = 1001758.5 pa
117 *          # 1 #
118 *          #####
119 *
120 *****
121 * namelist data *
122 *****

```

```

123 *
124 &inopts
125   iadded=10, ikfac=1, cpuflg=1,
126   idiag=4, nsdl=0, nsdu=5, nspl=0, nsps=5
127 &end
128 *
129 *           dstep           timet
130           0           0.0000e+00
131 *           stdyst           transi           ncomp           njun           ipak
132           0           1           26           31           0
133 *           epso           epss
134           1.0000e-04           1.0000e-04
135 *           oitmax           sitmax           isolut           ncontr           nccfl
136           10           10           0           0           0
137 *           ntsv           ntcb           ntcf           ntrp           ntcp
138           1           0           0           0           0
139 *
140 *****
141 * component-number data *
142 *****
143 *
144 * iorder * 1 s * break           pressure b.c. for pipe 2 inlet
145 * iorder * 2 s * pipe           inlet pipe for plenum 3
146 * iorder * 3 s * plenum        manifold for parallel-channel pipes
147 * iorder * 4 s * pipe           1st inlet pipe for tee 8
148 * iorder * 5 s * pipe           2nd inlet pipe for tee 8
149 * iorder * 6 s * pipe           1st inlet pipe for tee 9
150 * iorder * 7 s * pipe           2nd inlet pipe for tee 9
151 * iorder * 8 s * tee           tee that replaces vessel 8
152 * iorder * 9 s * tee           tee that replaces vessel 9
153 * iorder * 10 s * pipe          outlet pipe for tee 8
154 * iorder * 11 s * pipe          outlet pipe for tee 9
155 * iorder * 12 s * tee           tee that replaces vessel 12
156 * iorder * 13 s * pipe          outlet pipe for tee 12
157 * iorder * 14 s * pipe          inlet pipe for tee 15
158 * iorder * 15 s * tee           tee that replaces vessel 15
159 * iorder * 16 s * pipe          inlet pipe for tee 18
160 * iorder * 17 s * pipe          inlet pipe for tee 19
161 * iorder * 18 s * tee           tee that replaces vessel 18
162 * iorder * 19 s * tee           tee that replaces vessel 19
163 * iorder * 20 s * pipe          1st outlet pipe for tee 18
164 * iorder * 21 s * pipe          2nd outlet pipe for tee 18
165 * iorder * 22 s * pipe          1st outlet pipe for tee 19
166 * iorder * 23 s * pipe          2nd outlet pipe for tee 19
167 * iorder * 24 s * plenum        manifold for parallel-channel pipes
168 * iorder * 25 s * pipe          outlet pipe for plenum 24
169 * iorder * 26 e * break         pressure b.c. for pipe 25 outlet
170 *
171 *****
172 * control parameters *
173 *****
174 *
175 * signal variable
176 *
177 *           idsv           isvn           icln           icn1           icn2
178           1           0           0           0           0
179 *
180 *****
181 * component data *
182 *****
183 *
184 *****           type           num           id           ctitle

```

```

185 break                      1                      1 pressure b.c. for pipe 2 inlet
186 *      jun1                ibty                isat                ioff
187          2                  1                    0                    0
188 *      ibtr                ibsv                nbtb                nbsv                nbrf
189          0                  1                    2                    0                    0
190 *      dxin                volin                alpin                tin                pin
191      1.0000e+00            1.0000e+00            1.0000e+00            5.0000e+02            1.0000e+06
192 *      pain                concin                rbmx                poff                belv
193      0.0000e+00            0.0000e+00            1.7585e+03            0.0000e+00            0.0000e+00
194 *      pscl                tlscl                tvscl                pascl                conscl
195      1.0000e+00            0.0000e+00            0.0000e+00            0.0000e+00            0.0000e+00
196 *
197 * ptb *      0.0000e+00      1.0000e+06      1.0000e+00      1001758.50e
198 *
199 *****      type                num                id                ctitle
200 pipe                2                2 inlet pipe for plenum 3
201 *      ncells                nodes                jun1                jun2                epsw
202          1                  0                  2                  3                1.0000e-05
203 *      ichf                iconc                iacc                ipow
204          0                  0                  0                  0
205 *      radin                th                houtl                houtv                toutl
206      5.0000e-01            5.0000e-02            0.0000e+00            0.0000e+00            5.0000e+02
207 *      toutv
208      5.0000e+02
209 *
210 * dx      * f      1.0000e+00e
211 * vol      * f      1.0000e+00e
212 * fa      * f      1.0000e+00e
213 * fric      * f      0.0000e+00e
214 * grav      * f      1.0000e+00e
215 * hd      * f      1.0000e+00e
216 * nff      *      1
217 * alp      * f      1.0000e+00e
218 * vl      * f      0.0000e+00e
219 * vv      * f      0.0000e+00e
220 * tl      * f      5.0000e+02e
221 * tv      * f      5.0000e+02e
222 * p      * f      1.0000e+06e
223 * pa      * f      0.0000e+00e
224 *
225 *****      type                num                id                ctitle
226 plenum                3                3 manifold plenum 3
227 *      npljn                iconc                juns1                juns2
228          5                  0                  1                  4
229 *
230 * junj      *      3s
231 * junj      *      4                5                6                7e
232 * dx      * f      1.0000e+00e
233 * vol      * f      4.0000e+00e
234 * elev      * f      2.0000e+00e
235 * alp      * f      1.0000e+00e
236 * tl      * f      5.0000e+02e
237 * tv      * f      5.0000e+02e
238 * p      * f      1.0000e+06e
239 * pa      * f      0.0000e+00e
240 *
241 *****      type                num                id                ctitle
242 pipe                4                4 1st inlet pipe for tee 8
243 *      ncells                nodes                jun1                jun2                epsw
244          1                  0                  4                  8                1.0000e-05
245 *      ichf                iconc                iacc                ipow
246          0                  0                  0                  0

```

```

247 *          radin          th          houtl          houtv          toutl
248      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
249 *          toutv
250      5.0000e+02
251 *
252 * dx      * f      1.0000e+00e
253 * vol     * f      1.0000e+00e
254 * fa      *      1.0000e+00      5.0000e-01e
255 * fric    * f      0.0000e+00e
256 * grav    * f      1.0000e+00e
257 * hd      * f      1.0000e+00e
258 * nff     *          1          -1e
259 * alp     * f      1.0000e+00e
260 * vl      * f      0.0000e+00e
261 * vv      * f      0.0000e+00e
262 * tl      * f      5.0000e+02e
263 * tv      * f      5.0000e+02e
264 * p       * f      1.0000e+06e
265 * pa      * f      0.0000e+00e
266 *
267 * type          num          id          ctitle
268 pipe          5          5 2nd inlet pipe for tee 8
269 * ncells      nodes          jun1          jun2          epsw
270      1          0          5          9      1.0000e-05
271 * ichf          iconc          iacc          ipow
272      0          0          0          0
273 *          radin          th          houtl          houtv          toutl
274      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
275 *          toutv
276      5.0000e+02
277 *
278 * dx      * f      1.0000e+00e
279 * vol     * f      1.0000e+00e
280 * fa      *      1.0000e+00      5.0000e-01e
281 * fric    * f      0.0000e+00e
282 * grav    * f      1.0000e+00e
283 * hd      * f      1.0000e+00e
284 * nff     *          1          -1e
285 * alp     * f      1.0000e+00e
286 * vl      * f      0.0000e+00e
287 * vv      * f      0.0000e+00e
288 * tl      * f      5.0000e+02e
289 * tv      * f      5.0000e+02e
290 * p       * f      1.0000e+06e
291 * pa      * f      0.0000e+00e
292 *
293 * type          num          id          ctitle
294 pipe          6          6 1st inlet pipe for tee 9
295 * ncells      nodes          jun1          jun2          epsw
296      1          0          6          10      1.0000e-05
297 * ichf          iconc          iacc          ipow
298      0          0          0          0
299 *          radin          th          houtl          houtv          toutl
300      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
301 *          toutv
302      5.0000e+02
303 *
304 * dx      * f      1.0000e+00e
305 * vol     * f      1.0000e+00e
306 * fa      *      1.0000e+00      5.0000e-01e
307 * fric    * f      0.0000e+00e
308 * grav    * f      1.0000e+00e

```

```

309 * hd      * f      1.0000e+00e
310 * nff      *          1          -1e
311 * alp      * f      1.0000e+00e
312 * vl      * f      0.0000e+00e
313 * vv      * f      0.0000e+00e
314 * tl      * f      5.0000e+02e
315 * tv      * f      5.0000e+02e
316 * p        * f      1.0000e+06e
317 * pa      * f      0.0000e+00e
318 *
319 *****      type          num          id          ctitle
320 pipe          7          7 2nd inlet pipe for tee 9
321 *          ncells          nodes          jun1          jun2          epsw
322          1          0          7          11          1.0000e-05
323 *          ichf          iconc          iacc          ipow
324          0          0          0          0
325 *          radin          th          hout1          houtv          tout1
326          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
327 *          toutv
328          5.0000e+02
329 *
330 * dx      * f      1.0000e+00e
331 * vol      * f      1.0000e+00e
332 * fa      *          1.0000e+00          5.0000e-01e
333 * fric      * f      0.0000e+00e
334 * grav      * f      1.0000e+00e
335 * hd      * f      1.0000e+00e
336 * nff      *          1          -1e
337 * alp      * f      1.0000e+00e
338 * vl      * f      0.0000e+00e
339 * vv      * f      0.0000e+00e
340 * tl      * f      5.0000e+02e
341 * tv      * f      5.0000e+02e
342 * p        * f      1.0000e+06e
343 * pa      * f      0.0000e+00e
344 *
345 *****      type          num          id          ctitle
346 tee          8          8 tee that replaces vessel 8
347 *          jcell          nodes          ichf          cost          epsw
348          2          0          0          1.0000e+00          1.0000e-05
349 *          iconc1          ncell1          jun1          jun2          ipow1
350          0          3          8          12          0
351 *          radin1          th1          hout11          houtv1          tout11
352          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
353 *          toutv1
354          5.0000e+02
355 *          iconc2          ncell2          jun3          ipow2
356          0          1          9          0
357 *          radin2          th2          hout12          houtv2          tout12
358          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
359 *          toutv2
360          5.0000e+02
361 *
362 * dx      * f      1.0000e+00e
363 * vol      *          5.0000e-01r02          1.0000e+00e
364 * fa      * r02          5.0000e-01r02          1.0000e+00e
365 * fric      * f      0.0000e+00e
366 * grav      * f      1.0000e+00e
367 * hd      * f      1.0000e+00e
368 * nff      *          -1r03          1e
369 * alp      * f      1.0000e+00e
370 * vl      * f      0.0000e+00e

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```

371 * vv      * f    0.0000e+00e
372 * tl      * f    5.0000e+02e
373 * tv      * f    5.0000e+02e
374 * p       * f    1.0000e+06e
375 * pa      * f    0.0000e+00e
376 *
377 * dx      * f    1.0000e+00e
378 * vol     * f    5.0000e-01e
379 * fa      * f    5.0000e-01e
380 * fric    * f    0.0000e+00e
381 * grav    * f   -1.0000e+00e
382 * hd      * f    1.0000e+00e
383 * nff     *      1          -1e
384 * alp     * f    1.0000e+00e
385 * vl      * f    0.0000e+00e
386 * vv      * f    0.0000e+00e
387 * tl      * f    5.0000e+02e
388 * tv      * f    5.0000e+02e
389 * p       * f    1.0000e+06e
390 * pa      * f    0.0000e+00e
391 *
392 *****   type          num          id          ctitle
393 tee                9          9 tee that replaces vessel 9
394 *      jcell        nodes      ichf      cost      epsw
395      2              0          0      1.0000e+00      1.0000e-05
396 *      iconcl       ncell1     jun1      jun2      ipow1
397      0              3          10      13          0
398 *      radin1       th1        hout1     houtv1     tout1
399      5.0000e-01     5.0000e-02  0.0000e+00  0.0000e+00  5.0000e+02
400 *      toutv1
401      5.0000e+02
402 *      iconc2       ncell2     jun3      ipow2
403      0              1          11      0
404 *      radin2       th2        hout2     houtv2     tout2
405      5.0000e-01     5.0000e-02  0.0000e+00  0.0000e+00  5.0000e+02
406 *      toutv2
407      5.0000e+02
408 *
409 * dx      * f    1.0000e+00e
410 * vol     *      5.0000e-01r02 1.0000e+00e
411 * fa      * r02 5.0000e-01r02 1.0000e+00e
412 * fric    * f    0.0000e+00e
413 * grav    * f    1.0000e+00e
414 * hd      * f    1.0000e+00e
415 * nff     *      -1r03          1e
416 * alp     * f    1.0000e+00e
417 * vl      * f    0.0000e+00e
418 * vv      * f    0.0000e+00e
419 * tl      * f    5.0000e+02e
420 * tv      * f    5.0000e+02e
421 * p       * f    1.0000e+06e
422 * pa      * f    0.0000e+00e
423 *
424 * dx      * f    1.0000e+00e
425 * vol     * f    5.0000e-01e
426 * fa      * f    5.0000e-01e
427 * fric    * f    0.0000e+00e
428 * grav    * f   -1.0000e+00e
429 * hd      * f    1.0000e+00e
430 * nff     *      1          -1e
431 * alp     * f    1.0000e+00e
432 * vl      * f    0.0000e+00e

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```

433 * vv      * f  0.0000e+00e
434 * tl      * f  5.0000e+02e
435 * tv      * f  5.0000e+02e
436 * p       * f  1.0000e+06e
437 * pa      * f  0.0000e+00e
438 *
439 *****   type          num          id          ctitle
440 pipe              10          10 outlet pipe for tee 8
441 *          ncells      nodes      jun1      jun2      epsw
442          1              0          12          14      1.0000e-05
443 *          ichf        iconc      iacc          ipow
444          0              0          0          0
445 *          radin        th          houtl      houtv      toutl
446          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
447 *          toutv
448          5.0000e+02
449 *
450 * dx      * f  1.0000e+00e
451 * vol     * f  1.0000e+00e
452 * fa      *      1.0000e+00      5.0000e-01e
453 * fric    * f  0.0000e+00e
454 * grav    * f  1.0000e+00e
455 * hd      * f  1.0000e+00e
456 * nff     *      1          -1e
457 * alp     * f  1.0000e+00e
458 * vl      * f  0.0000e+00e
459 * vv      * f  0.0000e+00e
460 * tl      * f  5.0000e+02e
461 * tv      * f  5.0000e+02e
462 * p       * f  1.0000e+06e
463 * pa      * f  0.0000e+00e
464 *
465 *****   type          num          id          ctitle
466 pipe              11          11 outlet pipe for tee 9
467 *          ncells      nodes      jun1      jun2      epsw
468          1              0          13          15      1.0000e-05
469 *          ichf        iconc      iacc          ipow
470          0              0          0          0
471 *          radin        th          houtl      houtv      toutl
472          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
473 *          toutv
474          5.0000e+02
475 *
476 * dx      * f  1.0000e+00e
477 * vol     * f  1.0000e+00e
478 * fa      *      1.0000e+00      5.0000e-01e
479 * fric    * f  0.0000e+00e
480 * grav    * f  1.0000e+00e
481 * hd      * f  1.0000e+00e
482 * nff     *      1          -1e
483 * alp     * f  1.0000e+00e
484 * vl      * f  0.0000e+00e
485 * vv      * f  0.0000e+00e
486 * tl      * f  5.0000e+02e
487 * tv      * f  5.0000e+02e
488 * p       * f  1.0000e+06e
489 * pa      * f  0.0000e+00e
490 *
491 *****   type          num          id          ctitle
492 tee              12          12 tee that replaces vessel 12
493 *          jcell      nodes      ichf          cost      epsw
494          2              0          0      1.0000e+00      1.0000e-05

```



```

495 *      iconc1      ncell11      jun1      jun2      ipow1
496      0      3      14      16      0
497 *      radin1      th1      hout11      houtv1      tout11
498      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
499 *      toutv1
500      5.0000e+02
501 *      iconc2      ncell12      jun3      ipow2
502      0      1      15      0
503 *      radin2      th2      hout12      houtv2      tout12
504      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
505 *      toutv2
506      5.0000e+02
507 *
508 * dx      * f      1.0000e+00e
509 * vol      *      5.0000e-01r02 1.0000e+00e
510 * fa      * r02 5.0000e-01r02 1.0000e+00e
511 * fric      * f      0.0000e+00e
512 * grav      * f      1.0000e+00e
513 * hd      * f      1.0000e+00e
514 * nff      *      -1r03      1e
515 * alp      * f      1.0000e+00e
516 * vl      * f      0.0000e+00e
517 * vv      * f      0.0000e+00e
518 * tl      * f      5.0000e+02e
519 * tv      * f      5.0000e+02e
520 * p      * f      1.0000e+06e
521 * pa      * f      0.0000e+00e
522 *
523 * dx      * f      1.0000e+00e
524 * vol      * f      5.0000e-01e
525 * fa      * f      5.0000e-01e
526 * fric      * f      0.0000e+00e
527 * grav      * f      -1.0000e+00e
528 * hd      * f      1.0000e+00e
529 * nff      *      1      -1e
530 * alp      * f      1.0000e+00e
531 * vl      * f      0.0000e+00e
532 * vv      * f      0.0000e+00e
533 * tl      * f      5.0000e+02e
534 * tv      * f      5.0000e+02e
535 * p      * f      1.0000e+06e
536 * pa      * f      0.0000e+00e
537 *
538 *****      type      num      id      ctitle
539 pipe      13      13 outlet pipe for tee 12
540 *      ncells      nodes      jun1      jun2      epsw
541      1      0      16      17      1.0000e-05
542 *      ichf      iconc      iacc      ipow
543      0      0      0      0
544 *      radin      th      hout1      houtv      tout1
545      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
546 *      toutv
547      5.0000e+02
548 *
549 * dx      * f      1.0000e+00e
550 * vol      * f      1.0000e+00e
551 * fa      * f      1.0000e+00e
552 * fric      * f      0.0000e+00e
553 * grav      * f      1.0000e+00e
554 * hd      * f      1.0000e+00e
555 * nff      * f      1e
556 * alp      * f      1.0000e+00e

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```

557 * vl      * f    0.0000e+00e
558 * vv      * f    0.0000e+00e
559 * tl      * f    5.0000e+02e
560 * tv      * f    5.0000e+02e
561 * p       * f    1.0000e+06e
562 * pa      * f    0.0000e+00e
563 *
564 *****   type          num          id          ctitle
565 pipe              14          14 inlet pipe for tee 15
566 *              ncells      nodes      jun1      jun2      epsw
567 *                1          0          18          17      1.0000e-05
568 *              ichf      iconc      iacc      ipow
569 *                0          0          0          0
570 *              radin      th          hout1      houtv      tout1
571 *    5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    5.0000e+02
572 *              toutv
573 *    5.0000e+02
574 *
575 * dx      * f    1.0000e+00e
576 * vol     * f    1.0000e+00e
577 * fa      * f    1.0000e+00e
578 * fric    * f    0.0000e+00e
579 * grav     * f   -1.0000e+00e
580 * hd      * f    1.0000e+00e
581 * nff     * f          1e
582 * alp     * f    1.0000e+00e
583 * vl      * f    0.0000e+00e
584 * vv      * f    0.0000e+00e
585 * tl      * f    5.0000e+02e
586 * tv      * f    5.0000e+02e
587 * p       * f    1.0000e+06e
588 * pa      * f    0.0000e+00e
589 *
590 *****   type          num          id          ctitle
591 tee              15          15 tee that replaces vessel 15
592 *              jcell      nodes      ichf      cost      epsw
593 *                2          0          0      1.0000e+00    1.0000e-05
594 *              iconc1      ncell1      jun1      jun2      ipow1
595 *                0          3          19          18          0
596 *              radin1      th1          hout11      houtv1      tout11
597 *    5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    5.0000e+02
598 *              toutv1
599 *    5.0000e+02
600 *              iconc2      ncell2      jun3      ipow2
601 *                0          1          20          0
602 *              radin2      th2          hout12      houtv2      tout12
603 *    5.0000e-01    5.0000e-02    0.0000e+00    0.0000e+00    5.0000e+02
604 *              toutv2
605 *    5.0000e+02
606 *
607 * dx      * f    1.0000e+00e
608 * vol     *      5.0000e-01r02 1.0000e+00e
609 * fa      * r02 5.0000e-01r02 1.0000e+00e
610 * fric    * f    0.0000e+00e
611 * grav     * f   -1.0000e+00e
612 * hd      * f    1.0000e+00e
613 * nff     *      -1r03          1e
614 * alp     * f    1.0000e+00e
615 * vl      * f    0.0000e+00e
616 * vv      * f    0.0000e+00e
617 * tl      * f    5.0000e+02e
618 * tv      * f    5.0000e+02e

```

```

619 * p      * f      1.0000e+06e
620 * pa     * f      0.0000e+00e
621 *
622 * dx      * f      1.0000e+00e
623 * vol     * f      5.0000e-01e
624 * fa      * f      5.0000e-01e
625 * fric    * f      0.0000e+00e
626 * grav    * f      1.0000e+00e
627 * hd      * f      1.0000e+00e
628 * nff     *          1          -1e
629 * alp     * f      1.0000e+00e
630 * vl      * f      0.0000e+00e
631 * vv      * f      0.0000e+00e
632 * tl      * f      5.0000e+02e
633 * tv      * f      5.0000e+02e
634 * p      * f      1.0000e+06e
635 * pa     * f      0.0000e+00e
636 *
637 *****      type          num          id          ctitle
638 pipe          16          16 inlet pipe for tee 18
639 *          ncells          nodes          jun1          jun2          epsw
640          1          0          21          19          1.0000e-05
641 *          ichf          iconc          iacc          ipow
642          0          0          0          0
643 *          radin          th          houtl          houtv          toutl
644          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
645 *          toutv
646          5.0000e+02
647 *
648 * dx      * f      1.0000e+00e
649 * vol     * f      1.0000e+00e
650 * fa      *          1.0000e+00          5.0000e-01e
651 * fric    * f      0.0000e+00e
652 * grav    * f      -1.0000e+00e
653 * hd      * f      1.0000e+00e
654 * nff     *          1          -1e
655 * alp     * f      1.0000e+00e
656 * vl      * f      0.0000e+00e
657 * vv      * f      0.0000e+00e
658 * tl      * f      5.0000e+02e
659 * tv      * f      5.0000e+02e
660 * p      * f      1.0000e+06e
661 * pa     * f      0.0000e+00e
662 *
663 *****      type          num          id          ctitle
664 pipe          17          17 inlet pipe for tee 19
665 *          ncells          nodes          jun1          jun2          epsw
666          1          0          22          20          1.0000e-05
667 *          ichf          iconc          iacc          ipow
668          0          0          0          0
669 *          radin          th          houtl          houtv          toutl
670          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
671 *          toutv
672          5.0000e+02
673 *
674 * dx      * f      1.0000e+00e
675 * vol     * f      1.0000e+00e
676 * fa      *          1.0000e+00          5.0000e-01e
677 * fric    * f      0.0000e+00e
678 * grav    * f      -1.0000e+00e
679 * hd      * f      1.0000e+00e
680 * nff     *          1          -1e

```

```

681 * alp * f 1.0000e+00e
682 * vl * f 0.0000e+00e
683 * vv * f 0.0000e+00e
684 * tl * f 5.0000e+02e
685 * tv * f 5.0000e+02e
686 * p * f 1.0000e+06e
687 * pa * f 0.0000e+00e
688 *
689 ***** type num id ctitle
690 tee 18 18 tee that replaces vessel 18
691 * jcell nodes ichf cost epsw
692 2 0 0 1.0000e+00 1.0000e-05
693 * iconcl ncell1 jun1 jun2 ipow1
694 0 3 23 21 0
695 * radin1 th1 hout11 houtv1 tout11
696 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
697 * toutv1
698 5.0000e+02
699 * iconc2 ncell2 jun3 ipow2
700 0 1 24 0
701 * radin2 th2 hout12 houtv2 tout12
702 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
703 * toutv2
704 5.0000e+02
705 *
706 * dx * f 1.0000e+00e
707 * vol * 5.0000e-01r02 1.0000e+00e
708 * fa * r02 5.0000e-01r02 1.0000e+00e
709 * fric * f 0.0000e+00e
710 * grav * f -1.0000e+00e
711 * hd * f 1.0000e+00e
712 * nff * -1r03 1e
713 * alp * f 1.0000e+00e
714 * vl * f 0.0000e+00e
715 * vv * f 0.0000e+00e
716 * tl * f 5.0000e+02e
717 * tv * f 5.0000e+02e
718 * p * f 1.0000e+06e
719 * pa * f 0.0000e+00e
720 *
721 * dx * f 1.0000e+00e
722 * vol * f 5.0000e-01e
723 * fa * f 5.0000e-01e
724 * fric * f 0.0000e+00e
725 * grav * f 1.0000e+00e
726 * hd * f 1.0000e+00e
727 * nff * 1 -1e
728 * alp * f 1.0000e+00e
729 * vl * f 0.0000e+00e
730 * vv * f 0.0000e+00e
731 * tl * f 5.0000e+02e
732 * tv * f 5.0000e+02e
733 * p * f 1.0000e+06e
734 * pa * f 0.0000e+00e
735 *
736 ***** type num id ctitle
737 tee 19 19 tee that replaces vessel 19
738 * jcell nodes ichf cost epsw
739 2 0 0 1.0000e+00 1.0000e-05
740 * iconcl ncell1 jun1 jun2 ipow1
741 0 3 25 22 0
742 * radin1 th1 hout11 houtv1 tout11

```

```

743      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
744 *      toutv1
745      5.0000e+02
746 *      iconc2      ncell2      jun3      ipow2
747      0      1      26      0
748 *      radin2      th2      houtl2      houtv2      toutl2
749      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
750 *      toutv2
751      5.0000e+02
752 *
753 * dx      * f      1.0000e+00e
754 * vol      *      5.0000e-01r02 1.0000e+00e
755 * fa      * r02 5.0000e-01r02 1.0000e+00e
756 * fric      * f      0.0000e+00e
757 * grav      * f      -1.0000e+00e
758 * hd      * f      1.0000e+00e
759 * nff      *      -1r03      1e
760 * alp      * f      1.0000e+00e
761 * vl      * f      0.0000e+00e
762 * vv      * f      0.0000e+00e
763 * tl      * f      5.0000e+02e
764 * tv      * f      5.0000e+02e
765 * p      * f      1.0000e+06e
766 * pa      * f      0.0000e+00e
767 *
768 * dx      * f      1.0000e+00e
769 * vol      * f      5.0000e-01e
770 * fa      * f      5.0000e-01e
771 * fric      * f      0.0000e+00e
772 * grav      * f      1.0000e+00e
773 * hd      * f      1.0000e+00e
774 * nff      *      1      -1e
775 * alp      * f      1.0000e+00e
776 * vl      * f      0.0000e+00e
777 * vv      * f      0.0000e+00e
778 * tl      * f      5.0000e+02e
779 * tv      * f      5.0000e+02e
780 * p      * f      1.0000e+06e
781 * pa      * f      0.0000e+00e
782 *
783 *****      type      num      id      ctitle
784 pipe      20      20 1st outlet pipe from tee 18
785 *      ncells      nodes      jun1      jun2      epsw
786      1      0      27      23      1.0000e-05
787 *      ichf      iconc      iacc      ipow
788      0      0      0      0
789 *      radin      th      houtl      houtv      toutl
790      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
791 *      toutv
792      5.0000e+02
793 *
794 * dx      * f      1.0000e+00e
795 * vol      * f      1.0000e+00e
796 * fa      *      1.0000e+00      5.0000e-01e
797 * fric      * f      0.0000e+00e
798 * grav      * f      -1.0000e+00e
799 * hd      * f      1.0000e+00e
800 * nff      *      1      -1e
801 * alp      * f      1.0000e+00e
802 * vl      * f      0.0000e+00e
803 * vv      * f      0.0000e+00e
804 * tl      * f      5.0000e+02e

```

```

805 * tv      * f    5.0000e+02e
806 * p       * f    1.0000e+06e
807 * pa      * f    0.0000e+00e
808 *
809 *****   type          num          id          ctitle
810 pipe                21          21 2nd outlet pipe from tee 18
811 *          ncells      nodes      jun1      jun2      epsw
812 *          1           0          28         24      1.0000e-05
813 *          ichf        iconc      iacc      ipow
814 *          0           0           0         0
815 *          radin       th          hout1      houtv      tout1
816 *          5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  5.0000e+02
817 *          toutv
818 *          5.0000e+02
819 *
820 * dx      * f    1.0000e+00e
821 * vol     * f    1.0000e+00e
822 * fa      *      1.0000e+00      5.0000e-01e
823 * fric    * f    0.0000e+00e
824 * grav    * f   -1.0000e+00e
825 * hd      * f    1.0000e+00e
826 * nff     *      1          -1e
827 * alp     * f    1.0000e+00e
828 * vl      * f    0.0000e+00e
829 * vv      * f    0.0000e+00e
830 * tl      * f    5.0000e+02e
831 * tv      * f    5.0000e+02e
832 * p       * f    1.0000e+06e
833 * pa      * f    0.0000e+00e
834 *
835 *****   type          num          id          ctitle
836 pipe                22          22 1st outlet pipe from tee 19
837 *          ncells      nodes      jun1      jun2      epsw
838 *          1           0          29         25      1.0000e-05
839 *          ichf        iconc      iacc      ipow
840 *          0           0           0         0
841 *          radin       th          hout1      houtv      tout1
842 *          5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  5.0000e+02
843 *          toutv
844 *          5.0000e+02
845 *
846 * dx      * f    1.0000e+00e
847 * vol     * f    1.0000e+00e
848 * fa      *      1.0000e+00      5.0000e-01e
849 * fric    * f    0.0000e+00e
850 * grav    * f   -1.0000e+00e
851 * hd      * f    1.0000e+00e
852 * nff     *      1          -1e
853 * alp     * f    1.0000e+00e
854 * vl      * f    0.0000e+00e
855 * vv      * f    0.0000e+00e
856 * tl      * f    5.0000e+02e
857 * tv      * f    5.0000e+02e
858 * p       * f    1.0000e+06e
859 * pa      * f    0.0000e+00e
860 *
861 *****   type          num          id          ctitle
862 pipe                23          23 2nd outlet pipe from tee 19
863 *          ncells      nodes      jun1      jun2      epsw
864 *          1           0          30         26      1.0000e-05
865 *          ichf        iconc      iacc      ipow
866 *          0           0           0         0

```

```

867 *      radin      th      houtl      houtv      toutl
868      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
869 *      toutv
870      5.0000e+02
871 *
872 * dx      * f      1.0000e+00e
873 * vol      * f      1.0000e+00e
874 * fa      *      1.0000e+00      5.0000e-01e
875 * fric      * f      0.0000e+00e
876 * grav      * f      -1.0000e+00e
877 * hd      * f      1.0000e+00e
878 * nff      *      1      -1e
879 * alp      * f      1.0000e+00e
880 * vl      * f      0.0000e+00e
881 * vv      * f      0.0000e+00e
882 * tl      * f      5.0000e+02e
883 * tv      * f      5.0000e+02e
884 * p      * f      1.0000e+06e
885 * pa      * f      0.0000e+00e
886 *
887 *****      type      num      id      ctitle
888 plenum      24      24 manifold plenum 24
889 *      npljn      iconc      juns1      juns2
890      5      0      1      4
891 *
892 * junj      *      31s
893 * junj      *      27      28      29      30e
894 * dx      * f      1.0000e+00e
895 * vol      * f      4.0000e+00e
896 * elev      * f      2.1000e+01e
897 * alp      * f      1.0000e+00e
898 * tl      * f      5.0000e+02e
899 * tv      * f      5.0000e+02e
900 * p      * f      1.0000e+06e
901 * pa      * f      0.0000e+00e
902 *
903 *****      type      num      id      ctitle
904 pipe      25      25 outlet pipe from plenum 24
905 *      ncells      nodes      jun1      jun2      epsw
906      1      0      32      31      1.0000e-05
907 *      ichf      iconc      iacc      ipow
908      0      0      0      0
909 *      radin      th      houtl      houtv      toutl
910      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
911 *      toutv
912      5.0000e+02
913 *
914 * dx      * f      1.0000e+00e
915 * vol      * f      1.0000e+00e
916 * fa      * f      1.0000e+00e
917 * fric      * f      0.0000e+00e
918 * grav      * f      -1.0000e+00e
919 * hd      * f      1.0000e+00e
920 * nff      *      1      -1e
921 * alp      * f      1.0000e+00e
922 * vl      * f      0.0000e+00e
923 * vv      * f      0.0000e+00e
924 * tl      * f      5.0000e+02e
925 * tv      * f      5.0000e+02e
926 * p      * f      1.0000e+06e
927 * pa      * f      0.0000e+00e
928 *

```

```

929 ***** type          num          id          ctitle
930 break                26          26 pressure b.c. for pipe 25 outlet
931 *                   jun1         ibty         isat         ioff
932                   32              0              0              0
933 *                   dxin          volin          alpin          tin          pin
934         1.0000e+00      1.0000e+00      1.0000e+00      5.0000e+02      1.0000e+06
935 *                   pain          concin          rbmx          poff          belv
936         0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00      2.3000e+01
937 *
938 end
939 *
940 *****
941 * time-step data *
942 *****
943 *
944 *           dtmin          dtmax          tend          rtwfp
945         1.0000e-03      1.0000e+00      1.0000e+01      1.0000e+00
946 *           edint          gfint          dmpint          sedint
947         1.0000e+01      1.0000e+00      1.1000e+01      1.0000e+01
948 *
949 *           dtmin          dtmax          tend          rtwfp
950         1.0000e-03      5.0000e+00      1.0000e+02      1.0000e+00
951 *           edint          gfint          dmpint          sedint
952         9.0000e+01      2.5000e+00      9.5000e+01      9.0000e+01
953 *
954 *           dtmin          dtmax          tend          rtwfp
955         1.0000e-02      3.0000e+01      1.0000e+03      1.0000e+00
956 *           edint          gfint          dmpint          sedint
957         9.0000e+02      1.5000e+01      9.3000e+02      9.0000e+02
958 *
959 *           dtmin          dtmax          tend          rtwfp
960         1.0000e-01      2.0000e+02      1.0000e+04      1.0000e+00
961 *           edint          gfint          dmpint          sedint
962         9.0000e+03      2.0000e+02      9.0000e+03      9.0000e+03
963 *
964 *           endflag
965         -1.0000e+00

```


A-4.16 MSV2 Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              3              0              1              0              0
9 *--*--*TEST PROBLEM MSV2 , TIME = 10000.0 s
10 mirrored parallel-flow channel with two-phase fluid
11 two pressure boundary conditions, t1 = tsat = tv = 455.0 k
12 *
13 *                                     nff    vl    vv    fa
14 *                                     (-) (m/s) (m/s) (m2)
15 *
16 *          #####
17 *          # break#
18 *          # 26 #   p = 1.0000e+06 pa
19 *          #####
20 *          32
21 *          #####
22 *          # pipe #
23 *          # 25 #
24 *          #####
25 *          31
26 *          #####
27 *          # plenum #
28 *          # 24 #
29 *          #####
30 *          27      28      29      30      1  -1.2  -1.4  1.0x4
31 *          #####
32 *          # pipe # # pipe # # pipe # # pipe #
33 *          # 20 # # 21 # # 22 # # 23 #
34 *          #####
35 *          23      24      25      26      -1  -2.4  -2.6  0.5x4
36 *          #####
37 *          # cell # # cell #
38 *          # 1 # # 1 #
39 *          #-----#
40 *          #vessel# #vessel#
41 *          # 18 # # 19 #
42 *          #-----#
43 *          # cell # # cell #
44 *          # 3 # # 3 #
45 *          #####
46 *          21      22      1  -2.7  -2.8  1.0x2
47 *          #####
48 *          # pipe # # pipe #
49 *          # 16 # # 17 #
50 *          #####
51 *          19      20      -1  -5.7  -5.9  0.5x2
52 *          #####
53 *          # cell #
54 *          # 1 #
55 *          #-----#
56 *          #vessel#
57 *          # 15 #
58 *          #-----#
59 *          # cell #
60 *          # 3 #
61 *          #####
62 *          18      1  -6.8  -7.0  1.0

```

```

61 *          #####
62 *          # pipe #
63 *          # 14 #
64 *          #####
65 * -- mirror plane -- 17 -- mirror plane -- 1 7.1 7.3 1.0
66 *          #####
67 *          # pipe #
68 *          # 13 #
69 *          #####
70 *          16 1 7.4 7.5 1.0
71 *          #####
72 *          # cell #
73 *          # 3 #
74 *          #-----# 1 7.6 7.8 1.0
75 *          #vessel#
76 *          # 12 #
77 *          #-----# 1 7.8 8.0 1.0
78 *          # cell #
79 *          # 1 #
80 *          #####
81 *          14 15 -1 8.2 8.1 0.5x2
82 *          #####
83 *          # pipe # # pipe #
84 *          # 10 # # 11 #
85 *          #####
86 *          12 13 1 4.0 4.2 1.0x2
87 *          #####
88 *          # cell # # cell #
89 *          # 3 # # 3 #
90 *          #-----# #-----# 1 4.1 4.2 1.0x2
91 *          #vessel# #vessel#
92 *          # 8 # # 9 #
93 *          #-----# #-----# 1 4.2 4.3 1.0x2
94 *          # cell # # cell #
95 *          # 1 # # 1 #
96 *          #####
97 *          8 9 10 11 -1 4.3 4.4 0.5x4
98 *          #####
99 *          # pipe # # pipe # # pipe # # pipe #
100 *          # 4 # # 5 # # 6 # # 7 #
101 *          #####
102 *          4 5 6 7 1 2.1 2.3 1.0x4
103 *          #####
104 *          # plenum #
105 *          # 3 #
106 *          #####
107 *          3 -1 8.8 9.1 1.0
108 *          #####
109 *          # pipe #
110 *          # 2 #
111 *          #####
112 *          2 1 9.8 10.0 1.0
113 *          #####
114 *          # break# p = 1.1384e+06 pa
115 *          # 1 #
116 *          #####
117 *
118 * *****
119 * namelist data *
120 * *****
121 *
122 * &inopts

```

```

123 iadded=10, ikfac=1, nifsh=1, ccif=1.0e+05, cpuflg=1,
124 idiag=4, nsdl=0, nsdu=5, nspl=0, nspl=0, nspl=5, nvgrav=1
125 &end
126 *
127 *          dstep          timet
128 *          0          0.0000e+00
129 *          stdyst          transi          ncomp          njun          ipak
130 *          0          1          26          31          0
131 *          epso          epss
132 *          1.0000e-04          1.0000e-04
133 *          oitmax          sitmax          isolut          ncontr          nccfl
134 *          10          10          0          0          0
135 *          ntsv          ntcb          ntcf          ntrp          ntcp
136 *          1          0          0          0          0
137 *
138 *****
139 * component-number data *
140 *****
141 *
142 * iorder * 1 s * break          pressure b.c. for pipe 2 inlet
143 * iorder * 2 s * pipe          inlet pipe for plenum 3
144 * iorder * 3 s * plenum        manifold for parallel-channel pipes
145 * iorder * 4 s * pipe          1st inlet pipe for vessel 8
146 * iorder * 5 s * pipe          2nd inlet pipe for vessel 8
147 * iorder * 6 s * pipe          1st inlet pipe for vessel 9
148 * iorder * 7 s * pipe          2nd inlet pipe for vessel 9
149 * iorder * 8 s * vessel        first vessel component
150 * iorder * 9 s * vessel        second vessel component
151 * iorder * 10 s * pipe         outlet pipe for vessel 8
152 * iorder * 11 s * pipe         outlet pipe for vessel 9
153 * iorder * 12 s * vessel       third vessel component
154 * iorder * 13 s * pipe         outlet pipe for vessel 12
155 * iorder * 14 s * pipe         inlet pipe for vessel 15
156 * iorder * 15 s * vessel       fourth vessel component
157 * iorder * 16 s * pipe         inlet pipe for vessel 18
158 * iorder * 17 s * pipe         inlet pipe for vessel 19
159 * iorder * 18 s * vessel       fifth vessel component
160 * iorder * 19 s * vessel       sixth vessel component
161 * iorder * 20 s * pipe         1st outlet pipe for vessel 18
162 * iorder * 21 s * pipe         2nd outlet pipe for vessel 18
163 * iorder * 22 s * pipe         1st outlet pipe for vessel 19
164 * iorder * 23 s * pipe         2nd outlet pipe for vessel 19
165 * iorder * 24 s * plenum       manifold for parallel-channel pipes
166 * iorder * 25 s * pipe         outlet pipe for plenum 24
167 * iorder * 26 e * break        pressure b.c. for pipe 25 outlet
168 *
169 *****
170 * control parameters *
171 *****
172 *
173 * signal variable
174 *
175 *          idsv          isvn          icln          icn1          icn2
176 *          1          0          0          0          0
177 *
178 *****
179 * component data *
180 *****
181 *
182 *          type          num          id          ctitle
183 break          1          1          pressure b.c. for pipe 2 inlet
184 *          jun1          ibty          isat          ioff

```

185		2	1	0	0	
186 *	ibtr		ibsv	nbtb	nbsv	nbrf
187	0		1	2	0	0
188 *	dxin		volin	alpin	tin	pin
189	1.0000e+00		1.0000e+00	5.0000e-01	4.5500e+02	1.0000e+06
190 *	pain		concin	rbmx	poff	belv
191	0.0000e+00		0.0000e+00	1.3840e+05	0.0000e+00	0.0000e+00
192 *	pscl		tlscl	tvsc1	pascl	conscl
193	1.0000e+00		0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
194 *						
195 * ptb *		0.0000e+00	1.0000e+06	1.0000e+00	1.1384e+06e	
196 *						
197 *****	type		num	id	ctitle	
198 pipe			2	2	inlet pipe for plenum 3	
199 *	ncells		nodes	jun1	jun2	epsw
200	1		0	2	3	1.0000e-05
201 *	ichf		iconc	iacc	ipow	
202	0		0	0	0	
203 *	radin		th	hout1	houtv	tout1
204	5.0000e-01		5.0000e-02	0.0000e+00	0.0000e+00	4.5500e+02
205 *	toutv					
206	4.5500e+02					
207 *						
208 * dx	* f	1.0000e+00e				
209 * vol	* f	1.0000e+00e				
210 * fa	* f	1.0000e+00e				
211 * fric	* f	0.0000e+00e				
212 * grav	* f	1.0000e+00e				
213 * hd	* f	1.0000e+00e				
214 * nff	*	1				
215 * alp	* f	5.0000e-01e				
216 * vl	* f	0.0000e+00e				
217 * vv	* f	0.0000e+00e				
218 * tl	* f	4.5500e+02e				
219 * tv	* f	4.5500e+02e				
220 * p	* f	1.0000e+06e				
221 * pa	* f	0.0000e+00e				
222 *						
223 *****	type		num	id	ctitle	
224 plenum			3	3	manifold plenum 3	
225 *	npljn		iconc	juns1	juns2	
226	5		0	1	4	
227 *						
228 * junj	*	3s				
229 * junj	*	4		5	6	7e
230 * dx	* f	1.0000e+00e				
231 * vol	* f	4.0000e+00e				
232 * elev	* f	2.0000e+00e				
233 * alp	* f	5.0000e-01e				
234 * tl	* f	4.5500e+02e				
235 * tv	* f	4.5500e+02e				
236 * p	* f	1.0000e+06e				
237 * pa	* f	0.0000e+00e				
238 *						
239 *****	type		num	id	ctitle	
240 pipe			4	4	1st inlet pipe for vessel 8	
241 *	ncells		nodes	jun1	jun2	epsw
242	1		0	4	8	1.0000e-05
243 *	ichf		iconc	iacc	ipow	
244	0		0	0	0	
245 *	radin		th	hout1	houtv	tout1
246	5.0000e-01		5.0000e-02	0.0000e+00	0.0000e+00	4.5500e+02

-1e

```

247 *          toutv
248      4.5500e+02
249 *
250 * dx      * f    1.0000e+00e
251 * vol     * f    1.0000e+00e
252 * fa      *      1.0000e+00    5.0000e-01e
253 * fric    * f    0.0000e+00e
254 * grav    * f    1.0000e+00e
255 * hd      * f    1.0000e+00e
256 * nff     *      1          -1e
257 * alp     * f    5.0000e-01e
258 * vl      * f    0.0000e+00e
259 * vv      * f    0.0000e+00e
260 * tl      * f    4.5500e+02e
261 * tv      * f    4.5500e+02e
262 * p       * f    1.0000e+06e
263 * pa      * f    0.0000e+00e
264 *
265 *****      type          num          id          ctitle
266 pipe          5          5 2nd inlet pipe for vessel 8
267 *          ncells        nodes        jun1        jun2        epsw
268      1          0          5          9        1.0000e-05
269 *          ichf          iconc          iacc          ipow
270      0          0          0          0
271 *          radin          th          hout1          houtv          tout1
272      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
273 *          toutv
274      4.5500e+02
275 *
276 * dx      * f    1.0000e+00e
277 * vol     * f    1.0000e+00e
278 * fa      *      1.0000e+00    5.0000e-01e
279 * fric    * f    0.0000e+00e
280 * grav    * f    1.0000e+00e
281 * hd      * f    1.0000e+00e
282 * nff     *      1          -1e
283 * alp     * f    5.0000e-01e
284 * vl      * f    0.0000e+00e
285 * vv      * f    0.0000e+00e
286 * tl      * f    4.5500e+02e
287 * tv      * f    4.5500e+02e
288 * p       * f    1.0000e+06e
289 * pa      * f    0.0000e+00e
290 *
291 *****      type          num          id          ctitle
292 pipe          6          6 1st inlet pipe for vessel 9
293 *          ncells        nodes        jun1        jun2        epsw
294      1          0          6          10       1.0000e-05
295 *          ichf          iconc          iacc          ipow
296      0          0          0          0
297 *          radin          th          hout1          houtv          tout1
298      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
299 *          toutv
300      4.5500e+02
301 *
302 * dx      * f    1.0000e+00e
303 * vol     * f    1.0000e+00e
304 * fa      *      1.0000e+00    5.0000e-01e
305 * fric    * f    0.0000e+00e
306 * grav    * f    1.0000e+00e
307 * hd      * f    1.0000e+00e
308 * nff     *      1          -1e

```

```

309 * alp      * f    5.0000e-01e
310 * vl       * f    0.0000e+00e
311 * vv       * f    0.0000e+00e
312 * tl       * f    4.5500e+02e
313 * tv       * f    4.5500e+02e
314 * p        * f    1.0000e+06e
315 * pa       * f    0.0000e+00e
316 *
317 *****   type                num                id                ctitle
318 pipe                        7                7 2nd inlet pipe for vessel 9
319 *          ncells            nodes            jun1            jun2            epsw
320             1                0                7                11            1.0000e-05
321 *          ichf              iconc            iacc            ipow
322             0                0                0                0
323 *          radin              th              hout1            houtv            tout1
324      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
325 *          toutv
326      4.5500e+02
327 *
328 * dx      * f    1.0000e+00e
329 * vol     * f    1.0000e+00e
330 * fa      *      1.0000e+00      5.0000e-01e
331 * fric    * f    0.0000e+00e
332 * grav    * f    1.0000e+00e
333 * hd      * f    1.0000e+00e
334 * nff     *      1                -1e
335 * alp     * f    5.0000e-01e
336 * vl      * f    0.0000e+00e
337 * vv      * f    0.0000e+00e
338 * tl      * f    4.5500e+02e
339 * tv      * f    4.5500e+02e
340 * p       * f    1.0000e+06e
341 * pa      * f    0.0000e+00e
342 *
343 *****   type                num                id                ctitle
344 vessel                        8                8 first vessel component
345 *          nasx              nrsv              ntsx              ncsr              ivssbf
346             3                1                1                3                0
347 *          idcu              idcl              idcr              icru              icrl
348             0                0                0                0                0
349 *          icrr              ilcsp              iucsp              iuhp              iconc
350             0                0                0                0                0
351 *          igeom              nvent              nvvtb
352             1                0                0
353 *          shelv              epsw
354      3.5000e+00      1.0000e-05
355 *
356 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
357 * rad    *      1.0000e+00e
358 * th     *      1.0000e+00e
359 *
360 *          gc              gytc              gxrc              gzc
361      9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
362 *
363 *          lisrl              lisrc              lisrf              ljuns
364             1                1                -2                8
365             1                1                -2                9
366             3                1                2                12
367 *
368 * level   1
369 *
370 * cfzl-t*      0.0000e+00e

```

```

371 * cfzl-z*      0.0000e+00e
372 * cfzl-r*      0.0000e+00e
373 * cfzv-t*      0.0000e+00e
374 * cfzv-z*      0.0000e+00e
375 * cfzv-r*      0.0000e+00e
376 * vol *        1.0000e+00e
377 * fa-t *        0.0000e+00e
378 * fa-z *        1.0000e+00e
379 * fa-r *        0.0000e+00e
380 * hd-t *        0.0000e+00e
381 * hd-z *        1.0000e+00e
382 * hd-r *        0.0000e+00e
383 * alpn *        5.0000e-01e
384 * vvn-t *        0.0000e+00e
385 * vvn-z *        0.0000e+00e
386 * vvn-r *        0.0000e+00e
387 * vln-t *        0.0000e+00e
388 * vln-z *        0.0000e+00e
389 * vln-r *        0.0000e+00e
390 * tvn *         4.5500e+02e
391 * tln *         4.5500e+02e
392 * pn *          1.0000e+06e
393 * pan *         0.0000e+00e
394 *
395 * level 2
396 *
397 * cfzl-t*      0.0000e+00e
398 * cfzl-z*      0.0000e+00e
399 * cfzl-r*      0.0000e+00e
400 * cfzv-t*      0.0000e+00e
401 * cfzv-z*      0.0000e+00e
402 * cfzv-r*      0.0000e+00e
403 * vol *        1.0000e+00e
404 * fa-t *        0.0000e+00e
405 * fa-z *        1.0000e+00e
406 * fa-r *        0.0000e+00e
407 * hd-t *        0.0000e+00e
408 * hd-z *        1.0000e+00e
409 * hd-r *        0.0000e+00e
410 * alpn *        5.0000e-01e
411 * vvn-t *        0.0000e+00e
412 * vvn-z *        0.0000e+00e
413 * vvn-r *        0.0000e+00e
414 * vln-t *        0.0000e+00e
415 * vln-z *        0.0000e+00e
416 * vln-r *        0.0000e+00e
417 * tvn *         4.5500e+02e
418 * tln *         4.5500e+02e
419 * pn *          1.0000e+06e
420 * pan *         0.0000e+00e
421 *
422 * level 3
423 *
424 * cfzl-t*      0.0000e+00e
425 * cfzl-z*      0.0000e+00e
426 * cfzl-r*      0.0000e+00e
427 * cfzv-t*      0.0000e+00e
428 * cfzv-z*      0.0000e+00e
429 * cfzv-r*      0.0000e+00e
430 * vol *        1.0000e+00e
431 * fa-t *        0.0000e+00e
432 * fa-z *        1.0000e+00e

```

```

433 * fa-r *      0.0000e+00e
434 * hd-t *      0.0000e+00e
435 * hd-z *      1.0000e+00e
436 * hd-r *      0.0000e+00e
437 * alpn *      5.0000e-01e
438 * vvn-t *      0.0000e+00e
439 * vvn-z *      0.0000e+00e
440 * vvn-r *      0.0000e+00e
441 * vln-t *      0.0000e+00e
442 * vln-z *      0.0000e+00e
443 * vln-r *      0.0000e+00e
444 * tvn *        4.5500e+02e
445 * tln *        4.5500e+02e
446 * pn *         1.0000e+06e
447 * pan *        0.0000e+00e
448 *
449 *****      type          num          id          ctitle
450 vessel          9          9 second vessel component
451 *      nasx      nrsx      ntsx      ncsr      ivssbf
452 *      3          1          1          3          0
453 *      idcu      idcl      idcr      icru      icrl
454 *      0          0          0          0          0
455 *      icrr      ilcsp      iucsp      iuhp      iconc
456 *      0          0          0          0          0
457 *      igeom      nvent      nvvtb
458 *      1          0          0
459 *      shelv      epsw
460      3.5000e+00      1.0000e-05
461 *
462 * z *      1.0000e+00      2.0000e+00      3.0000e+00e
463 * rad *      1.0000e+00e
464 * th *      1.0000e+00e
465 *
466 *      gc      gytc      gxrc      gzc
467      9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
468 *
469 *      lisrl      lisrc      lisrf      ljuns
470      1          1          -2          10
471      1          1          -2          11
472      3          1          2          13
473 *
474 * level 1
475 *
476 * cfzl-t*      0.0000e+00e
477 * cfzl-z*      0.0000e+00e
478 * cfzl-r*      0.0000e+00e
479 * cfzv-t*      0.0000e+00e
480 * cfzv-z*      0.0000e+00e
481 * cfzv-r*      0.0000e+00e
482 * vol *      1.0000e+00e
483 * fa-t *      0.0000e+00e
484 * fa-z *      1.0000e+00e
485 * fa-r *      0.0000e+00e
486 * hd-t *      0.0000e+00e
487 * hd-z *      1.0000e+00e
488 * hd-r *      0.0000e+00e
489 * alpn *      5.0000e-01e
490 * vvn-t *      0.0000e+00e
491 * vvn-z *      0.0000e+00e
492 * vvn-r *      0.0000e+00e
493 * vln-t *      0.0000e+00e
494 * vln-z *      0.0000e+00e

```



```

495 * vln-r *      0.0000e+00e
496 * tvn   *      4.5500e+02e
497 * tln   *      4.5500e+02e
498 * pn     *      1.0000e+06e
499 * pan    *      0.0000e+00e
500 *
501 * level    2
502 *
503 * cfzl-t*      0.0000e+00e
504 * cfzl-z*      0.0000e+00e
505 * cfzl-r*      0.0000e+00e
506 * cfzv-t*      0.0000e+00e
507 * cfzv-z*      0.0000e+00e
508 * cfzv-r*      0.0000e+00e
509 * vol      *      1.0000e+00e
510 * fa-t     *      0.0000e+00e
511 * fa-z     *      1.0000e+00e
512 * fa-r     *      0.0000e+00e
513 * hd-t     *      0.0000e+00e
514 * hd-z     *      1.0000e+00e
515 * hd-r     *      0.0000e+00e
516 * alpn     *      5.0000e-01e
517 * vvn-t    *      0.0000e+00e
518 * vvn-z    *      0.0000e+00e
519 * vvn-r    *      0.0000e+00e
520 * vln-t    *      0.0000e+00e
521 * vln-z    *      0.0000e+00e
522 * vln-r    *      0.0000e+00e
523 * tvn      *      4.5500e+02e
524 * tln      *      4.5500e+02e
525 * pn       *      1.0000e+06e
526 * pan      *      0.0000e+00e
527 *
528 * level    3
529 *
530 * cfzl-t*      0.0000e+00e
531 * cfzl-z*      0.0000e+00e
532 * cfzl-r*      0.0000e+00e
533 * cfzv-t*      0.0000e+00e
534 * cfzv-z*      0.0000e+00e
535 * cfzv-r*      0.0000e+00e
536 * vol      *      1.0000e+00e
537 * fa-t     *      0.0000e+00e
538 * fa-z     *      1.0000e+00e
539 * fa-r     *      0.0000e+00e
540 * hd-t     *      0.0000e+00e
541 * hd-z     *      1.0000e+00e
542 * hd-r     *      0.0000e+00e
543 * alpn     *      5.0000e-01e
544 * vvn-t    *      0.0000e+00e
545 * vvn-z    *      0.0000e+00e
546 * vvn-r    *      0.0000e+00e
547 * vln-t    *      0.0000e+00e
548 * vln-z    *      0.0000e+00e
549 * vln-r    *      0.0000e+00e
550 * tvn      *      4.5500e+02e
551 * tln      *      4.5500e+02e
552 * pn       *      1.0000e+06e
553 * pan      *      0.0000e+00e
554 *

```

```

555 *****      type      num      id      ctitle
556 pipe              10      10 outlet pipe for vessel 8

```

```

557 *          ncells          nodes          jun1          jun2          epsw
558           1              0              12              14      1.0000e-05
559 *          ichf          iconc          iacc          ipow
560           0              0              0              0
561 *          radin          th          hout1          houtv          tout1
562      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
563 *          toutv
564      4.5500e+02
565 *
566 * dx      * f      1.0000e+00e
567 * vol      * f      1.0000e+00e
568 * fa      *      1.0000e+00      5.0000e-01e
569 * fric      * f      0.0000e+00e
570 * grav      * f      1.0000e+00e
571 * hd      * f      1.0000e+00e
572 * nff      *      1      -1e
573 * alp      * f      5.0000e-01e
574 * vl      * f      0.0000e+00e
575 * vv      * f      0.0000e+00e
576 * tl      * f      4.5500e+02e
577 * tv      * f      4.5500e+02e
578 * p      * f      1.0000e+06e
579 * pa      * f      0.0000e+00e
580 *
581 *****      type          num          id          ctitle
582 pipe          11          11 outlet pipe for vessel 9
583 *          ncells          nodes          jun1          jun2          epsw
584           1              0              13              15      1.0000e-05
585 *          ichf          iconc          iacc          ipow
586           0              0              0              0
587 *          radin          th          hout1          houtv          tout1
588      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
589 *          toutv
590      4.5500e+02
591 *
592 * dx      * f      1.0000e+00e
593 * vol      * f      1.0000e+00e
594 * fa      *      1.0000e+00      5.0000e-01e
595 * fric      * f      0.0000e+00e
596 * grav      * f      1.0000e+00e
597 * hd      * f      1.0000e+00e
598 * nff      *      1      -1e
599 * alp      * f      5.0000e-01e
600 * vl      * f      0.0000e+00e
601 * vv      * f      0.0000e+00e
602 * tl      * f      4.5500e+02e
603 * tv      * f      4.5500e+02e
604 * p      * f      1.0000e+06e
605 * pa      * f      0.0000e+00e
606 *
607 *****      type          num          id          ctitle
608 vessel          12          12 third vessel component
609 *          nasx          nrsx          ntsx          ncsr          ivssbf
610           3              1              1              3              0
611 *          idcu          idcl          idcr          icru          icrl
612           0              0              0              0              0
613 *          icrr          ilcsp          iucsp          iuhp          iconc
614           0              0              0              0              0
615 *          igeom          nvent          nvvtb
616           1              0              0
617 *          shelv          epsw
618      7.5000e+00      1.0000e-05

```

```

619 *
620 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
621 * rad    *      1.0000e+00e
622 * th     *      1.0000e+00e
623 *
624 *          gc          gytc          gxrc          gzc
625      9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
626 *
627 *          lisrl          lisrc          lisrf          ljuns
628      1              1              -2              14
629      1              1              -2              15
630      3              1              2              16
631 *
632 * level  1
633 *
634 * cfzl-t*      0.0000e+00e
635 * cfzl-z*      0.0000e+00e
636 * cfzl-r*      0.0000e+00e
637 * cfzv-t*      0.0000e+00e
638 * cfzv-z*      0.0000e+00e
639 * cfzv-r*      0.0000e+00e
640 * vol   *      1.0000e+00e
641 * fa-t   *      0.0000e+00e
642 * fa-z   *      1.0000e+00e
643 * fa-r   *      0.0000e+00e
644 * hd-t   *      0.0000e+00e
645 * hd-z   *      1.0000e+00e
646 * hd-r   *      0.0000e+00e
647 * alpn   *      5.0000e-01e
648 * vvn-t   *      0.0000e+00e
649 * vvn-z   *      0.0000e+00e
650 * vvn-r   *      0.0000e+00e
651 * vln-t   *      0.0000e+00e
652 * vln-z   *      0.0000e+00e
653 * vln-r   *      0.0000e+00e
654 * tvn     *      4.5500e+02e
655 * tln     *      4.5500e+02e
656 * pn      *      1.0000e+06e
657 * pan     *      0.0000e+00e
658 *
659 * level  2
660 *
661 * cfzl-t*      0.0000e+00e
662 * cfzl-z*      0.0000e+00e
663 * cfzl-r*      0.0000e+00e
664 * cfzv-t*      0.0000e+00e
665 * cfzv-z*      0.0000e+00e
666 * cfzv-r*      0.0000e+00e
667 * vol   *      1.0000e+00e
668 * fa-t   *      0.0000e+00e
669 * fa-z   *      1.0000e+00e
670 * fa-r   *      0.0000e+00e
671 * hd-t   *      0.0000e+00e
672 * hd-z   *      1.0000e+00e
673 * hd-r   *      0.0000e+00e
674 * alpn   *      5.0000e-01e
675 * vvn-t   *      0.0000e+00e
676 * vvn-z   *      0.0000e+00e
677 * vvn-r   *      0.0000e+00e
678 * vln-t   *      0.0000e+00e
679 * vln-z   *      0.0000e+00e
680 * vln-r   *      0.0000e+00e

```

```

681 * tvn * 4.5500e+02e
682 * tln * 4.5500e+02e
683 * pn * 1.0000e+06e
684 * pan * 0.0000e+00e
685 *
686 * level 3
687 *
688 * cfzl-t* 0.0000e+00e
689 * cfzl-z* 0.0000e+00e
690 * cfzl-r* 0.0000e+00e
691 * cfzv-t* 0.0000e+00e
692 * cfzv-z* 0.0000e+00e
693 * cfzv-r* 0.0000e+00e
694 * vol * 1.0000e+00e
695 * fa-t * 0.0000e+00e
696 * fa-z * 1.0000e+00e
697 * fa-r * 0.0000e+00e
698 * hd-t * 0.0000e+00e
699 * hd-z * 1.0000e+00e
700 * hd-r * 0.0000e+00e
701 * alpn * 5.0000e-01e
702 * vvn-t * 0.0000e+00e
703 * vvn-z * 0.0000e+00e
704 * vvn-r * 0.0000e+00e
705 * vln-t * 0.0000e+00e
706 * vln-z * 0.0000e+00e
707 * vln-r * 0.0000e+00e
708 * tvn * 4.5500e+02e
709 * tln * 4.5500e+02e
710 * pn * 1.0000e+06e
711 * pan * 0.0000e+00e
712 *

```

```

713 ***** type num id ctitle
714 pipe 13 13 outlet pipe for vessel 12
715 * ncells nodes jun1 jun2 epsw
716 1 0 16 17 1.0000e-05
717 * ichf iconc iacc ipow
718 0 0 0 0
719 * radin th houtl houtv toutl
720 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
721 * toutv
722 4.5500e+02
723 *

```

```

724 * dx * f 1.0000e+00e
725 * vol * f 1.0000e+00e
726 * fa * f 1.0000e+00e
727 * fric * f 0.0000e+00e
728 * grav * f 1.0000e+00e
729 * hd * f 1.0000e+00e
730 * nff * f 1e
731 * alp * f 5.0000e-01e
732 * vl * f 0.0000e+00e
733 * vv * f 0.0000e+00e
734 * tl * f 4.5500e+02e
735 * tv * f 4.5500e+02e
736 * p * f 1.0000e+06e
737 * pa * f 0.0000e+00e
738 *

```

```

739 ***** type num id ctitle
740 pipe 14 14 inlet pipe for vessel 15
741 * ncells nodes jun1 jun2 epsw
742 1 0 18 17 1.0000e-05

```

```

743 *      ichf      iconc      iacc      ipow
744      0          0          0          0
745 *      radin      th      houtl      houtv      toutl
746      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
747 *      toutv
748      4.5500e+02
749 *
750 * dx      * f      1.0000e+00e
751 * vol      * f      1.0000e+00e
752 * fa      * f      1.0000e+00e
753 * fric      * f      0.0000e+00e
754 * grav      * f      -1.0000e+00e
755 * hd      * f      1.0000e+00e
756 * nff      * f      1e
757 * alp      * f      5.0000e-01e
758 * vl      * f      0.0000e+00e
759 * vv      * f      0.0000e+00e
760 * tl      * f      4.5500e+02e
761 * tv      * f      4.5500e+02e
762 * p      * f      1.0000e+06e
763 * pa      * f      0.0000e+00e
764 *
765 * type      num      id      ctitle
766 vessel      15      15      fourth vessel component
767 *      nasx      nrsx      ntsx      ncsr      ivssbf
768      3          1          1          3          0
769 *      idcu      idcl      idcr      icru      icrl
770      0          0          0          0          0
771 *      icrr      ilcsp      iucsp      iuhp      iconc
772      0          0          0          0          0
773 *      igeom      nvent      nvvtb
774      1          0          0
775 *      shelv      epsw
776      1.5500e+01      1.0000e-05
777 *
778 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
779 * rad      *      1.0000e+00e
780 * th      *      1.0000e+00e
781 *
782 *      gc      gytc      gxrc      gzc
783      9.8066e+00      0.0000e+00      0.0000e+00      1.0000e+00
784 *
785 *      lisrl      lisrc      lisrf      ljuns
786      1          1          -2          19
787      1          1          -2          20
788      3          1          2          18
789 *
790 * level      1
791 *
792 * cfzl-t*      0.0000e+00e
793 * cfzl-z*      0.0000e+00e
794 * cfzl-r*      0.0000e+00e
795 * cfzv-t*      0.0000e+00e
796 * cfzv-z*      0.0000e+00e
797 * cfzv-r*      0.0000e+00e
798 * vol      *      1.0000e+00e
799 * fa-t      *      0.0000e+00e
800 * fa-z      *      1.0000e+00e
801 * fa-r      *      0.0000e+00e
802 * hd-t      *      0.0000e+00e
803 * hd-z      *      1.0000e+00e
804 * hd-r      *      0.0000e+00e

```

805	*	alpn	*	5.0000e-01e
806	*	vvv-t	*	0.0000e+00e
807	*	vvv-z	*	0.0000e+00e
808	*	vvv-r	*	0.0000e+00e
809	*	vln-t	*	0.0000e+00e
810	*	vln-z	*	0.0000e+00e
811	*	vln-r	*	0.0000e+00e
812	*	tvn	*	4.5500e+02e
813	*	tln	*	4.5500e+02e
814	*	pn	*	1.0000e+06e
815	*	pan	*	0.0000e+00e
816	*			
817	*	level	2	
818	*			
819	*	cfzl-t*		0.0000e+00e
820	*	cfzl-z*		0.0000e+00e
821	*	cfzl-r*		0.0000e+00e
822	*	cfzv-t*		0.0000e+00e
823	*	cfzv-z*		0.0000e+00e
824	*	cfzv-r*		0.0000e+00e
825	*	vol	*	1.0000e+00e
826	*	fa-t	*	0.0000e+00e
827	*	fa-z	*	1.0000e+00e
828	*	fa-r	*	0.0000e+00e
829	*	hd-t	*	0.0000e+00e
830	*	hd-z	*	1.0000e+00e
831	*	hd-r	*	0.0000e+00e
832	*	alpn	*	5.0000e-01e
833	*	vvv-t	*	0.0000e+00e
834	*	vvv-z	*	0.0000e+00e
835	*	vvv-r	*	0.0000e+00e
836	*	vln-t	*	0.0000e+00e
837	*	vln-z	*	0.0000e+00e
838	*	vln-r	*	0.0000e+00e
839	*	tvn	*	4.5500e+02e
840	*	tln	*	4.5500e+02e
841	*	pn	*	1.0000e+06e
842	*	pan	*	0.0000e+00e
843	*			
844	*	level	3	
845	*			
846	*	cfzl-t*		0.0000e+00e
847	*	cfzl-z*		0.0000e+00e
848	*	cfzl-r*		0.0000e+00e
849	*	cfzv-t*		0.0000e+00e
850	*	cfzv-z*		0.0000e+00e
851	*	cfzv-r*		0.0000e+00e
852	*	vol	*	1.0000e+00e
853	*	fa-t	*	0.0000e+00e
854	*	fa-z	*	1.0000e+00e
855	*	fa-r	*	0.0000e+00e
856	*	hd-t	*	0.0000e+00e
857	*	hd-z	*	1.0000e+00e
858	*	hd-r	*	0.0000e+00e
859	*	alpn	*	5.0000e-01e
860	*	vvv-t	*	0.0000e+00e
861	*	vvv-z	*	0.0000e+00e
862	*	vvv-r	*	0.0000e+00e
863	*	vln-t	*	0.0000e+00e
864	*	vln-z	*	0.0000e+00e
865	*	vln-r	*	0.0000e+00e
866	*	tvn	*	4.5500e+02e

```

867 * tln      *      4.5500e+02e
868 * pn       *      1.0000e+06e
869 * pan      *      0.0000e+00e
870 *
871 * type      num      id      ctitle
872 pipe      16      16 inlet pipe for vessel 18
873 * ncells   nodes   jun1     jun2     epsw
874 *      1      0      21      19      1.0000e-05
875 *      ichf   iconc   iacc     ipow
876 *      0      0      0      0
877 *      radin  th      hout1    houtv    toutl
878 *      5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  4.5500e+02
879 *      toutv
880 *      4.5500e+02
881 *
882 * dx      * f      1.0000e+00e
883 * vol     * f      1.0000e+00e
884 * fa      *      1.0000e+00      5.0000e-01e
885 * fric    * f      0.0000e+00e
886 * grav    * f      -1.0000e+00e
887 * hd      * f      1.0000e+00e
888 * nff     *      1      -1e
889 * alp     * f      5.0000e-01e
890 * vl      * f      0.0000e+00e
891 * vv      * f      0.0000e+00e
892 * tl      * f      4.5500e+02e
893 * tv      * f      4.5500e+02e
894 * p       * f      1.0000e+06e
895 * pa      * f      0.0000e+00e
896 *
897 * type      num      id      ctitle
898 pipe      17      17 inlet pipe for vessel 19
899 * ncells   nodes   jun1     jun2     epsw
900 *      1      0      22      20      1.0000e-05
901 *      ichf   iconc   iacc     ipow
902 *      0      0      0      0
903 *      radin  th      hout1    houtv    toutl
904 *      5.0000e-01  5.0000e-02  0.0000e+00  0.0000e+00  4.5500e+02
905 *      toutv
906 *      4.5500e+02
907 *
908 * dx      * f      1.0000e+00e
909 * vol     * f      1.0000e+00e
910 * fa      *      1.0000e+00      5.0000e-01e
911 * fric    * f      0.0000e+00e
912 * grav    * f      -1.0000e+00e
913 * hd      * f      1.0000e+00e
914 * nff     *      1      -1e
915 * alp     * f      5.0000e-01e
916 * vl      * f      0.0000e+00e
917 * vv      * f      0.0000e+00e
918 * tl      * f      4.5500e+02e
919 * tv      * f      4.5500e+02e
920 * p       * f      1.0000e+06e
921 * pa      * f      0.0000e+00e
922 *
923 * type      num      id      ctitle
924 vessel    18      18 fifth vessel component
925 * nasx     nrsx     ntsx     ncsr     ivssbf
926 *      3      1      1      3      0
927 *      idcu    idcl    idcr     icru     icrl
928 *      0      0      0      0      0

```

929 *	icrr	ilcsp	iucsp	iuhp	iconc
930	0	0	0	0	0
931 *	igeom	nvent	nvvtb		
932	1	0	0		
933 *	shelv	epsw			
934	1.9500e+01	1.0000e-05			
935 *					
936 * z *	1.0000e+00	2.0000e+00	3.0000e+00e		
937 * rad *	1.0000e+00e				
938 * th *	1.0000e+00e				
939 *					
940 *	gc	gytc	gxrc	gzc	
941	9.8066e+00	0.0000e+00	0.0000e+00	1.0000e+00	
942 *					
943 *	lisrl	lisrc	lisrf	ljuns	
944	1	1	-2	23	
945	1	1	-2	24	
946	3	1	2	21	
947 *					
948 * level	1				
949 *					
950 * cfzl-t*	0.0000e+00e				
951 * cfzl-z*	0.0000e+00e				
952 * cfzl-r*	0.0000e+00e				
953 * cfzv-t*	0.0000e+00e				
954 * cfzv-z*	0.0000e+00e				
955 * cfzv-r*	0.0000e+00e				
956 * vol *	1.0000e+00e				
957 * fa-t *	0.0000e+00e				
958 * fa-z *	1.0000e+00e				
959 * fa-r *	0.0000e+00e				
960 * hd-t *	0.0000e+00e				
961 * hd-z *	1.0000e+00e				
962 * hd-r *	0.0000e+00e				
963 * alpn *	5.0000e-01e				
964 * vvn-t *	0.0000e+00e				
965 * vvn-z *	0.0000e+00e				
966 * vvn-r *	0.0000e+00e				
967 * vln-t *	0.0000e+00e				
968 * vln-z *	0.0000e+00e				
969 * vln-r *	0.0000e+00e				
970 * tvn *	4.5500e+02e				
971 * tln *	4.5500e+02e				
972 * pn *	1.0000e+06e				
973 * pan *	0.0000e+00e				
974 *					
975 * level	2				
976 *					
977 * cfzl-t*	0.0000e+00e				
978 * cfzl-z*	0.0000e+00e				
979 * cfzl-r*	0.0000e+00e				
980 * cfzv-t*	0.0000e+00e				
981 * cfzv-z*	0.0000e+00e				
982 * cfzv-r*	0.0000e+00e				
983 * vol *	1.0000e+00e				
984 * fa-t *	0.0000e+00e				
985 * fa-z *	1.0000e+00e				
986 * fa-r *	0.0000e+00e				
987 * hd-t *	0.0000e+00e				
988 * hd-z *	1.0000e+00e				
989 * hd-r *	0.0000e+00e				
990 * alpn *	5.0000e-01e				


```

991 * vvn-t *      0.0000e+00e
992 * vvn-z *      0.0000e+00e
993 * vvn-r *      0.0000e+00e
994 * vln-t *      0.0000e+00e
995 * vln-z *      0.0000e+00e
996 * vln-r *      0.0000e+00e
997 * tvn  *      4.5500e+02e
998 * tln  *      4.5500e+02e
999 * pn   *      1.0000e+06e
1000 * pan *      0.0000e+00e
1001 *
1002 * level 3
1003 *
1004 * cfzl-t*      0.0000e+00e
1005 * cfzl-z*      0.0000e+00e
1006 * cfzl-r*      0.0000e+00e
1007 * cfzv-t*      0.0000e+00e
1008 * cfzv-z*      0.0000e+00e
1009 * cfzv-r*      0.0000e+00e
1010 * vol  *      1.0000e+00e
1011 * fa-t  *      0.0000e+00e
1012 * fa-z  *      1.0000e+00e
1013 * fa-r  *      0.0000e+00e
1014 * hd-t  *      0.0000e+00e
1015 * hd-z  *      1.0000e+00e
1016 * hd-r  *      0.0000e+00e
1017 * alp  *      5.0000e-01e
1018 * vvn-t *      0.0000e+00e
1019 * vvn-z *      0.0000e+00e
1020 * vvn-r *      0.0000e+00e
1021 * vln-t *      0.0000e+00e
1022 * vln-z *      0.0000e+00e
1023 * vln-r *      0.0000e+00e
1024 * tvn  *      4.5500e+02e
1025 * tln  *      4.5500e+02e
1026 * pn   *      1.0000e+06e
1027 * pan  *      0.0000e+00e
1028 *

```

```

1029 ***** type          num          id          ctitle
1030 vessel          19          19 sixth vessel component
1031 *          nasx          nrsx          ntsx          ncsr          ivssbf
1032          3          1          1          3          0
1033 *          idcu          idcl          idcr          icru          icrl
1034          0          0          0          0          0
1035 *          icrr          ilcsp          iucsp          iuhp          iconc
1036          0          0          0          0          0
1037 *          igeom          nvent          nvvtb
1038          1          0          0
1039 *          shelv          epsw
1040          1.9500e+01          1.0000e-05
1041 *
1042 * z          *          1.0000e+00          2.0000e+00          3.0000e+00e
1043 * rad          *          1.0000e+00e
1044 * th          *          1.0000e+00e
1045 *
1046 *          gc          gytc          gxrc          gzc
1047          9.8066e+00          0.0000e+00          0.0000e+00          1.0000e+00
1048 *
1049 *          lisrl          lisrc          lisrf          ljuns
1050          1          1          -2          25
1051          1          1          -2          26
1052          3          1          2          22

```

```

1053 *
1054 * level 1
1055 *
1056 * cfzl-t* 0.0000e+00e
1057 * cfzl-z* 0.0000e+00e
1058 * cfzl-r* 0.0000e+00e
1059 * cfzv-t* 0.0000e+00e
1060 * cfzv-z* 0.0000e+00e
1061 * cfzv-r* 0.0000e+00e
1062 * vol * 1.0000e+00e
1063 * fa-t * 0.0000e+00e
1064 * fa-z * 1.0000e+00e
1065 * fa-r * 0.0000e+00e
1066 * hd-t * 0.0000e+00e
1067 * hd-z * 1.0000e+00e
1068 * hd-r * 0.0000e+00e
1069 * alpn * 5.0000e-01e
1070 * vvn-t * 0.0000e+00e
1071 * vvn-z * 0.0000e+00e
1072 * vvn-r * 0.0000e+00e
1073 * vln-t * 0.0000e+00e
1074 * vln-z * 0.0000e+00e
1075 * vln-r * 0.0000e+00e
1076 * tvn * 4.5500e+02e
1077 * tln * 4.5500e+02e
1078 * pn * 1.0000e+06e
1079 * pan * 0.0000e+00e
1080 *
1081 * level 2
1082 *
1083 * cfzl-t* 0.0000e+00e
1084 * cfzl-z* 0.0000e+00e
1085 * cfzl-r* 0.0000e+00e
1086 * cfzv-t* 0.0000e+00e
1087 * cfzv-z* 0.0000e+00e
1088 * cfzv-r* 0.0000e+00e
1089 * vol * 1.0000e+00e
1090 * fa-t * 0.0000e+00e
1091 * fa-z * 1.0000e+00e
1092 * fa-r * 0.0000e+00e
1093 * hd-t * 0.0000e+00e
1094 * hd-z * 1.0000e+00e
1095 * hd-r * 0.0000e+00e
1096 * alpn * 5.0000e-01e
1097 * vvn-t * 0.0000e+00e
1098 * vvn-z * 0.0000e+00e
1099 * vvn-r * 0.0000e+00e
1100 * vln-t * 0.0000e+00e
1101 * vln-z * 0.0000e+00e
1102 * vln-r * 0.0000e+00e
1103 * tvn * 4.5500e+02e
1104 * tln * 4.5500e+02e
1105 * pn * 1.0000e+06e
1106 * pan * 0.0000e+00e
1107 *
1108 * level 3
1109 *
1110 * cfzl-t* 0.0000e+00e
1111 * cfzl-z* 0.0000e+00e
1112 * cfzl-r* 0.0000e+00e
1113 * cfzv-t* 0.0000e+00e
1114 * cfzv-z* 0.0000e+00e

```

```

1115 * cfzv-r*      0.0000e+00e
1116 * vol      *      1.0000e+00e
1117 * fa-t      *      0.0000e+00e
1118 * fa-z      *      1.0000e+00e
1119 * fa-r      *      0.0000e+00e
1120 * hd-t      *      0.0000e+00e
1121 * hd-z      *      1.0000e+00e
1122 * hd-r      *      0.0000e+00e
1123 * alpn      *      5.0000e-01e
1124 * vvn-t      *      0.0000e+00e
1125 * vvn-z      *      0.0000e+00e
1126 * vvn-r      *      0.0000e+00e
1127 * vln-t      *      0.0000e+00e
1128 * vln-z      *      0.0000e+00e
1129 * vln-r      *      0.0000e+00e
1130 * tvn      *      4.5500e+02e
1131 * tln      *      4.5500e+02e
1132 * pn      *      1.0000e+06e
1133 * pan      *      0.0000e+00e
1134 *
1135 *****      type      num      id      ctitle
1136 pipe      20      20 1st outlet pipe from vessel 18
1137 *      ncells      nodes      jun1      jun2      epsw
1138      1      0      27      23      1.0000e-05
1139 *      ichf      iconc      iacc      ipow
1140      0      0      0      0
1141 *      radin      th      hout1      houtv      tout1
1142      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
1143 *      toutv
1144      4.5500e+02
1145 *
1146 * dx      * f      1.0000e+00e
1147 * vol      * f      1.0000e+00e
1148 * fa      *      1.0000e+00      5.0000e-01e
1149 * fric      * f      0.0000e+00e
1150 * grav      * f      -1.0000e+00e
1151 * hd      * f      1.0000e+00e
1152 * nff      *      1      -1e
1153 * alp      * f      5.0000e-01e
1154 * vl      * f      0.0000e+00e
1155 * vv      * f      0.0000e+00e
1156 * tl      * f      4.5500e+02e
1157 * tv      * f      4.5500e+02e
1158 * p      * f      1.0000e+06e
1159 * pa      * f      0.0000e+00e
1160 *
1161 *****      type      num      id      ctitle
1162 pipe      21      21 2nd outlet pipe from vessel 18
1163 *      ncells      nodes      jun1      jun2      epsw
1164      1      0      28      24      1.0000e-05
1165 *      ichf      iconc      iacc      ipow
1166      0      0      0      0
1167 *      radin      th      hout1      houtv      tout1
1168      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
1169 *      toutv
1170      4.5500e+02
1171 *
1172 * dx      * f      1.0000e+00e
1173 * vol      * f      1.0000e+00e
1174 * fa      *      1.0000e+00      5.0000e-01e
1175 * fric      * f      0.0000e+00e
1176 * grav      * f      -1.0000e+00e

```

```

1177 * hd      * f    1.0000e+00e
1178 * nff      *          1          -1e
1179 * alp      * f    5.0000e-01e
1180 * vl       * f    0.0000e+00e
1181 * vv       * f    0.0000e+00e
1182 * tl       * f    4.5500e+02e
1183 * tv       * f    4.5500e+02e
1184 * p        * f    1.0000e+06e
1185 * pa       * f    0.0000e+00e
1186 *
1187 *****      type          num          id          ctitle
1188 pipe          22          22 1st outlet pipe from vessel 19
1189 *          ncells      nodes          jun1          jun2          epsw
1190          1          0          29          25          1.0000e-05
1191 *          ichf      iconc          iacc          ipow
1192          0          0          0          0
1193 *          radin      th          houtl          houtv          toutl
1194          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
1195 *          toutv
1196          4.5500e+02
1197 *
1198 * dx      * f    1.0000e+00e
1199 * vol     * f    1.0000e+00e
1200 * fa      *          1.0000e+00      5.0000e-01e
1201 * fric   * f    0.0000e+00e
1202 * grav   * f    -1.0000e+00e
1203 * hd      * f    1.0000e+00e
1204 * nff      *          1          -1e
1205 * alp     * f    5.0000e-01e
1206 * vl     * f    0.0000e+00e
1207 * vv     * f    0.0000e+00e
1208 * tl     * f    4.5500e+02e
1209 * tv     * f    4.5500e+02e
1210 * p      * f    1.0000e+06e
1211 * pa     * f    0.0000e+00e
1212 *
1213 *****      type          num          id          ctitle
1214 pipe          23          23 2nd outlet pipe from vessel 19
1215 *          ncells      nodes          jun1          jun2          epsw
1216          1          0          30          26          1.0000e-05
1217 *          ichf      iconc          iacc          ipow
1218          0          0          0          0
1219 *          radin      th          houtl          houtv          toutl
1220          5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      4.5500e+02
1221 *          toutv
1222          4.5500e+02
1223 *
1224 * dx      * f    1.0000e+00e
1225 * vol     * f    1.0000e+00e
1226 * fa      *          1.0000e+00      5.0000e-01e
1227 * fric   * f    0.0000e+00e
1228 * grav   * f    -1.0000e+00e
1229 * hd      * f    1.0000e+00e
1230 * nff      *          1          -1e
1231 * alp     * f    5.0000e-01e
1232 * vl     * f    0.0000e+00e
1233 * vv     * f    0.0000e+00e
1234 * tl     * f    4.5500e+02e
1235 * tv     * f    4.5500e+02e
1236 * p      * f    1.0000e+06e
1237 * pa     * f    0.0000e+00e
1238 *

```

```

1239 ***** type num id ctitle
1240 plenum 24 24 manifold plenum 24
1241 * npljn iconc juns1 juns2
1242 5 0 1 4
1243 *
1244 * junj * 31s
1245 * junj * 27 28 29 30e
1246 * dx * f 1.0000e+00e
1247 * vol * f 4.0000e+00e
1248 * elev * f 2.1000e+01e
1249 * alp * f 5.0000e-01e
1250 * tl * f 4.5500e+02e
1251 * tv * f 4.5500e+02e
1252 * p * f 1.0000e+06e
1253 * pa * f 0.0000e+00e
1254 *
1255 ***** type num id ctitle
1256 pipe 25 25 outlet pipe from plenum 24
1257 * ncells nodes jun1 jun2 epsw
1258 1 0 32 31 1.0000e-05
1259 * ichf iconc iacc ipow
1260 0 0 0 0
1261 * radin th houtl houtv toutl
1262 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 4.5500e+02
1263 * toutv
1264 4.5500e+02
1265 *
1266 * dx * f 1.0000e+00e
1267 * vol * f 1.0000e+00e
1268 * fa * f 1.0000e+00e
1269 * fric * f 0.0000e+00e
1270 * grav * f -1.0000e+00e
1271 * hd * f 1.0000e+00e
1272 * nff * 1 -1e
1273 * alp * f 5.0000e-01e
1274 * vl * f 0.0000e+00e
1275 * vv * f 0.0000e+00e
1276 * tl * f 4.5500e+02e
1277 * tv * f 4.5500e+02e
1278 * p * f 1.0000e+06e
1279 * pa * f 0.0000e+00e
1280 *
1281 ***** type num id ctitle
1282 break 26 26 pressure b.c. for pipe 25 outlet
1283 * jun1 ibty isat ioff
1284 32 0 0 0
1285 * dxin volin alpin tin pin
1286 1.0000e+00 1.0000e+00 5.0000e-01 4.5500e+02 1.0000e+06
1287 * pain concin rbmx poff belv
1288 0.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00 2.3000e+01
1289 *
1290 end
1291 *
1292 *****
1293 * time-step data *
1294 *****
1295 *
1296 * dtmin dtmax tend rtwfp
1297 1.0000e-03 1.0000e+00 1.0000e+01 1.0000e+00
1298 * edint gfind dmpint sedint
1299 1.0000e+01 1.0000e+00 1.1000e+01 1.0000e+01
1300 *

```

1301 *	dtmin	dtmax	tend	rtwfp
1302	1.0000e-03	5.0000e+00	1.0000e+02	1.0000e+00
1303 *	edint	gfint	dmpint	sedint
1304	9.0000e+01	2.5000e+00	9.5000e+01	9.0000e+01
1305 *				
1306 *	dtmin	dtmax	tend	rtwfp
1307	1.0000e-02	3.0000e+01	1.0000e+03	1.0000e+00
1308 *	edint	gfint	dmpint	sedint
1309	9.0000e+02	1.5000e+01	9.3000e+02	9.0000e+02
1310 *				
1311 *	dtmin	dtmax	tend	rtwfp
1312	1.0000e-01	2.0000e+02	1.0000e+04	1.0000e+00
1313 *	edint	gfint	dmpint	sedint
1314	9.0000e+03	2.0000e+02	9.0000e+03	9.0000e+03
1315 *				
1316 *	endflag			
1317	-1.0000e+00			

A-4.17 MSVL Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              3              0              1              0              0
9 *--*--*TEST PROBLEM MSVL , TIME = 10000.0 s
10 mirrored parallel-flow channel with single-phase liquid
11 two pressure boundary conditions, tl = 300.0 k
12 *
13 *
14 *          #####          nff          vl          fa
15 *          # break#          (-)          (m/s)          (m2)
16 *          # 26 # p = 1.0000e+06 pa
17 *          #####
18 *          32          1          -10.0          1.0
19 *          #####
20 *          # pipe #
21 *          # 25 #
22 *          #####
23 *          31          -1          -10.0          1.0
24 *          #####
25 *          #          plenum          #
26 *          #          24          #
27 *          #####
28 *          27          28          29          30          1          -2.5          1.0x4
29 *          #####          #####          #####          #####
30 *          # pipe # # pipe # # pipe # # pipe #
31 *          # 20 # # 21 # # 22 # # 23 #
32 *          #####          #####          #####          #####
33 *          23          24          25          26          -1          -5.0          0.5x4
34 *          #####          #####
35 *          # cell #          # cell #
36 *          # 1 #          # 1 #
37 *          #-----#          #-----#          1          -5.0          1.0x2
38 *          #vessel#          #vessel#
39 *          # 18 #          # 19 #
40 *          #-----#          #-----#          1          -5.0          1.0x2
41 *          # cell #          # cell #
42 *          # 3 #          # 3 #
43 *          #####          #####
44 *          21          22          1          -5.0          1.0x2
45 *          #####          #####
46 *          # pipe # # pipe #
47 *          # 16 # # 17 #
48 *          #####          #####
49 *          19          20          -1          -10.0          0.5x2
50 *          #####
51 *          # cell #
52 *          # 1 #
53 *          #-----#          1          -10.0          1.0
54 *          #vessel#
55 *          # 15 #
56 *          #-----#          1          -10.0          1.0
57 *          # cell #
58 *          # 3 #
59 *          #####
60 *          18          1          -10.0          1.0

```

```

61 *          #####
62 *          # pipe #
63 *          # 14 #
64 *          #####
65 * -- mirror plane -- 17 -- mirror plane -- 1 10.0 1.0
66 *          #####
67 *          # pipe #
68 *          # 13 #
69 *          #####
70 *          16 1 10.0 1.0
71 *          #####
72 *          # cell #
73 *          # 3 #
74 *          #-----# 1 10.0 1.0
75 *          #vessel#
76 *          # 12 #
77 *          #-----# 1 10.0 1.0
78 *          # cell #
79 *          # 1 #
80 *          #####
81 *          14 15 -1 10.0 0.5x2
82 *          #####
83 *          # pipe # # pipe #
84 *          # 10 # # 11 #
85 *          #####
86 *          12 13 1 5.0 1.0x2
87 *          #####
88 *          # cell # # cell #
89 *          # 1 # # 3 #
90 *          #-----# #-----# 1 5.0 1.0x2
91 *          #vessel# #vessel#
92 *          # 8 # # 9 #
93 *          #-----# #-----# 1 5.0 1.0x2
94 *          # cell # # cell #
95 *          # 3 # # 1 #
96 *          #####
97 *          8 9 10 11 -1 5.0 0.5x4
98 *          #####
99 *          # pipe # # pipe # # pipe # # pipe #
100 *          # 4 # # 5 # # 6 # # 7 #
101 *          #####
102 *          4 5 6 7 1 2.5 1.0x4
103 *          #####
104 *          # plenum #
105 *          # 3 #
106 *          #####
107 *          3 -1 10.0 1.0
108 *          #####
109 *          # pipe #
110 *          # 2 #
111 *          #####
112 *          2 1 10.0 1.0
113 *          #####
114 *          # break# p = 1.4045e+06 pa
115 *          # 1 #
116 *          #####
117 *
118 *****
119 * namelist data *
120 *****
121 *
122 &inopts

```



```

123 iadded=10, ikfac=1, nvgrav=1, cpuflg=1,
124 idiag=4, nsdl=0, nsdu=5, nspl=0, nspu=5
125 &end
126 *
127 *          dstep          timet
128          0          0.0000e+00
129 *          stdyst          transi          ncomp          njun          ipak
130          0          1          26          31          0
131 *          epso          epss
132          1.0000e-04          1.0000e-04
133 *          oitmax          sitmax          isolut          ncontr          nccfl
134          10          10          0          0          0
135 *          ntsv          ntcb          ntcf          ntrp          ntcp
136          1          0          0          0          0
137 *
138 *****
139 * component-number data *
140 *****
141 *
142 * iorder * 1 s * break          pressure b.c. for pipe 2 inlet
143 * iorder * 2 s * pipe          inlet pipe for plenum 3
144 * iorder * 3 s * plenum        manifold for parallel-channel pipes
145 * iorder * 4 s * pipe          1st inlet pipe for vessel 8
146 * iorder * 5 s * pipe          2nd inlet pipe for vessel 8
147 * iorder * 6 s * pipe          1st inlet pipe for vessel 9
148 * iorder * 7 s * pipe          2nd inlet pipe for vessel 9
149 * iorder * 8 s * vessel        first vessel component
150 * iorder * 9 s * vessel        second vessel component
151 * iorder * 10 s * pipe          outlet pipe for vessel 8
152 * iorder * 11 s * pipe          outlet pipe for vessel 9
153 * iorder * 12 s * vessel        third vessel component
154 * iorder * 13 s * pipe          outlet pipe for vessel 12
155 * iorder * 14 s * pipe          inlet pipe for vessel 15
156 * iorder * 15 s * vessel        fourth vessel component
157 * iorder * 16 s * pipe          inlet pipe for vessel 18
158 * iorder * 17 s * pipe          inlet pipe for vessel 19
159 * iorder * 18 s * vessel        fifth vessel component
160 * iorder * 19 s * vessel        sixth vessel component
161 * iorder * 20 s * pipe          1st outlet pipe for vessel 18
162 * iorder * 21 s * pipe          2nd outlet pipe for vessel 18
163 * iorder * 22 s * pipe          1st outlet pipe for vessel 19
164 * iorder * 23 s * pipe          2nd outlet pipe for vessel 19
165 * iorder * 24 s * plenum        manifold for parallel-channel pipes
166 * iorder * 25 s * pipe          outlet pipe for plenum 24
167 * iorder * 26 e * break          pressure b.c. for pipe 25 outlet
168 *
169 *****
170 * control parameters *
171 *****
172 *
173 * signal variable
174 *
175 *          idsv          isvn          icln          icn1          icn2
176          1          0          0          0          0
177 *
178 *****
179 * component data *
180 *****
181 *
182 *****          type          num          id          ctitle
183 break          1          1          1          pressure b.c. for pipe 2 inlet
184 *          jun1          ibty          isat          ioff

```

185		2	1	0	0	
186	*	ibtr	ibsv	nbtb	nbsv	nbrf
187		0	1	2	0	0
188	*	dxin	volin	alpin	tin	pin
189		1.0000e+00	1.0000e+00	0.0000e+00	3.0000e+02	1.0000e+06
190	*	pain	concin	rbmx	poff	belv
191		0.0000e+00	0.0000e+00	4.0450e+05	0.0000e+00	0.0000e+00
192	*	pscl	tlscl	tvsc1	pascl	conscl
193		1.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
194	*					
195	* ptb	*	0.0000e+00	1.0000e+06	1.0000e+00	1.4045e+06e
196	*					
197	*****	type	num	id	ctitle	
198	pipe		2	2	inlet pipe for plenum 3	
199	*	ncells	nodes	jun1	jun2	epsw
200		1	0	2	3	1.0000e-05
201	*	ichf	iconc	iacc	ipow	
202		0	0	0	0	
203	*	radin	th	hout1	houtv	tout1
204		5.0000e-01	5.0000e-02	0.0000e+00	0.0000e+00	3.0000e+02
205	*	toutv				
206		3.0000e+02				
207	*					
208	* dx	* f	1.0000e+00e			
209	* vol	* f	1.0000e+00e			
210	* fa	* f	1.0000e+00e			
211	* fric	* f	0.0000e+00e			
212	* grav	* f	1.0000e+00e			
213	* hd	* f	1.0000e+00e			
214	* nff	*	1	-1e		
215	* alp	* f	0.0000e+00e			
216	* vl	* f	0.0000e+00e			
217	* vv	* f	0.0000e+00e			
218	* tl	* f	3.0000e+02e			
219	* tv	* f	3.0000e+02e			
220	* p	* f	1.0000e+06e			
221	* pa	* f	0.0000e+00e			
222	*					
223	*****	type	num	id	ctitle	
224	plenum		3	3	manifold plenum 3	
225	*	npljn	iconc	juns1	juns2	
226		5	0	1	4	
227	*					
228	* junj	*	3s			
229	* junj	*	4	5	6	7e
230	* dx	* f	1.0000e+00e			
231	* vol	* f	4.0000e+00e			
232	* elev	* f	2.0000e+00e			
233	* alp	* f	0.0000e+00e			
234	* tl	* f	3.0000e+02e			
235	* tv	* f	3.0000e+02e			
236	* p	* f	1.0000e+06e			
237	* pa	* f	0.0000e+00e			
238	*					
239	*****	type	num	id	ctitle	
240	pipe		4	4	1st inlet pipe for vessel 8	
241	*	ncells	nodes	jun1	jun2	epsw
242		1	0	4	8	1.0000e-05
243	*	ichf	iconc	iacc	ipow	
244		0	0	0	0	
245	*	radin	th	hout1	houtv	tout1
246		5.0000e-01	5.0000e-02	0.0000e+00	0.0000e+00	3.0000e+02

```

247 *      toutv
248      3.0000e+02
249 *
250 * dx      * f      1.0000e+00e
251 * vol      * f      1.0000e+00e
252 * fa      *      1.0000e+00      5.0000e-01e
253 * fric      * f      0.0000e+00e
254 * grav      * f      1.0000e+00e
255 * hd      * f      1.0000e+00e
256 * nff      *      1      -1e
257 * alp      * f      0.0000e+00e
258 * vl      * f      0.0000e+00e
259 * vv      * f      0.0000e+00e
260 * tl      * f      3.0000e+02e
261 * tv      * f      3.0000e+02e
262 * p      * f      1.0000e+06e
263 * pa      * f      0.0000e+00e
264 *
265 *****      type      num      id      ctitle
266 pipe      5      5 2nd inlet pipe for vessel 8
267 *      ncells      nodes      jun1      jun2      epsw
268      1      0      5      9      1.0000e-05
269 *      ichf      iconc      iacc      ipow
270      0      0      0      0
271 *      radin      th      hout1      houtv      tout1
272      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
273 *      toutv
274      3.0000e+02
275 *
276 * dx      * f      1.0000e+00e
277 * vol      * f      1.0000e+00e
278 * fa      *      1.0000e+00      5.0000e-01e
279 * fric      * f      0.0000e+00e
280 * grav      * f      1.0000e+00e
281 * hd      * f      1.0000e+00e
282 * nff      *      1      -1e
283 * alp      * f      0.0000e+00e
284 * vl      * f      0.0000e+00e
285 * vv      * f      0.0000e+00e
286 * tl      * f      3.0000e+02e
287 * tv      * f      3.0000e+02e
288 * p      * f      1.0000e+06e
289 * pa      * f      0.0000e+00e
290 *
291 *****      type      num      id      ctitle
292 pipe      6      6 1st inlet pipe for vessel 9
293 *      ncells      nodes      jun1      jun2      epsw
294      1      0      6      10      1.0000e-05
295 *      ichf      iconc      iacc      ipow
296      0      0      0      0
297 *      radin      th      hout1      houtv      tout1
298      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
299 *      toutv
300      3.0000e+02
301 *
302 * dx      * f      1.0000e+00e
303 * vol      * f      1.0000e+00e
304 * fa      *      1.0000e+00      5.0000e-01e
305 * fric      * f      0.0000e+00e
306 * grav      * f      1.0000e+00e
307 * hd      * f      1.0000e+00e
308 * nff      *      1      -1e

```

```

309 * alp * f 0.0000e+00e
310 * vl * f 0.0000e+00e
311 * vv * f 0.0000e+00e
312 * tl * f 3.0000e+02e
313 * tv * f 3.0000e+02e
314 * p * f 1.0000e+06e
315 * pa * f 0.0000e+00e
316 *
317 ***** type num id ctitle
318 pipe 7 7 2nd inlet pipe for vessel 9
319 * ncells nodes jun1 jun2 epsw
320 1 0 7 11 1.0000e-05
321 * ichf iconc iacc ipow
322 0 0 0 0
323 * radin th hout1 houtv tout1
324 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
325 * toutv
326 3.0000e+02
327 *
328 * dx * f 1.0000e+00e
329 * vol * f 1.0000e+00e
330 * fa * 1.0000e+00 5.0000e-01e
331 * fric * f 0.0000e+00e
332 * grav * f 1.0000e+00e
333 * hd * f 1.0000e+00e
334 * nff * 1 -1e
335 * alp * f 0.0000e+00e
336 * vl * f 0.0000e+00e
337 * vv * f 0.0000e+00e
338 * tl * f 3.0000e+02e
339 * tv * f 3.0000e+02e
340 * p * f 1.0000e+06e
341 * pa * f 0.0000e+00e
342 *
343 ***** type num id ctitle
344 vessel 8 8 first vessel component
345 * nasx nrxx ntsx ncsr ivssbf
346 3 1 1 3 0
347 * idcu idcl idcr icru icrl
348 0 0 0 0 0
349 * icrr ilcsp iucsp iuhp iconc
350 0 0 0 0 0
351 * igeom nvent nvvtb
352 1 0 0
353 * shelv epsw
354 3.5000e+00 1.0000e-05
355 *
356 * z * 1.0000e+00 2.0000e+00 3.0000e+00e
357 * rad * 1.0000e+00e
358 * th * 1.0000e+00e
359 *
360 * gc gytc gxrc gzc
361 9.8066e+00 0.0000e+00 0.0000e+00 -1.0000e+00
362 *
363 * lisrl lisrc lisrf ljuns
364 1 1 -2 8
365 1 1 -2 9
366 3 1 2 12
367 *
368 * level 1
369 *
370 * cfzl-t* 0.0000e+00e

```

```

371 * cfzl-z*      0.0000e+00e
372 * cfzl-r*      0.0000e+00e
373 * cfzv-t*      0.0000e+00e
374 * cfzv-z*      0.0000e+00e
375 * cfzv-r*      0.0000e+00e
376 * vol      *      1.0000e+00e
377 * fa-t      *      0.0000e+00e
378 * fa-z      *      1.0000e+00e
379 * fa-r      *      0.0000e+00e
380 * hd-t      *      0.0000e+00e
381 * hd-z      *      1.0000e+00e
382 * hd-r      *      0.0000e+00e
383 * alpn      *      0.0000e+00e
384 * vvn-t      *      0.0000e+00e
385 * vvn-z      *      0.0000e+00e
386 * vvn-r      *      0.0000e+00e
387 * vln-t      *      0.0000e+00e
388 * vln-z      *      0.0000e+00e
389 * vln-r      *      0.0000e+00e
390 * tvn      *      3.0000e+02e
391 * tln      *      3.0000e+02e
392 * pn      *      1.0000e+06e
393 * pan      *      0.0000e+00e
394 *
395 * level      2
396 *
397 * cfzl-t*      0.0000e+00e
398 * cfzl-z*      0.0000e+00e
399 * cfzl-r*      0.0000e+00e
400 * cfzv-t*      0.0000e+00e
401 * cfzv-z*      0.0000e+00e
402 * cfzv-r*      0.0000e+00e
403 * vol      *      1.0000e+00e
404 * fa-t      *      0.0000e+00e
405 * fa-z      *      1.0000e+00e
406 * fa-r      *      0.0000e+00e
407 * hd-t      *      0.0000e+00e
408 * hd-z      *      1.0000e+00e
409 * hd-r      *      0.0000e+00e
410 * alpn      *      0.0000e+00e
411 * vvn-t      *      0.0000e+00e
412 * vvn-z      *      0.0000e+00e
413 * vvn-r      *      0.0000e+00e
414 * vln-t      *      0.0000e+00e
415 * vln-z      *      0.0000e+00e
416 * vln-r      *      0.0000e+00e
417 * tvn      *      3.0000e+02e
418 * tln      *      3.0000e+02e
419 * pn      *      1.0000e+06e
420 * pan      *      0.0000e+00e
421 *
422 * level      3
423 *
424 * cfzl-t*      0.0000e+00e
425 * cfzl-z*      0.0000e+00e
426 * cfzl-r*      0.0000e+00e
427 * cfzv-t*      0.0000e+00e
428 * cfzv-z*      0.0000e+00e
429 * cfzv-r*      0.0000e+00e
430 * vol      *      1.0000e+00e
431 * fa-t      *      0.0000e+00e
432 * fa-z      *      1.0000e+00e

```

```

433 * fa-r *      0.0000e+00e
434 * hd-t *      0.0000e+00e
435 * hd-z *      1.0000e+00e
436 * hd-r *      0.0000e+00e
437 * alpn *      0.0000e+00e
438 * vvn-t *      0.0000e+00e
439 * vvn-z *      0.0000e+00e
440 * vvn-r *      0.0000e+00e
441 * vln-t *      0.0000e+00e
442 * vln-z *      0.0000e+00e
443 * vln-r *      0.0000e+00e
444 * tvn *        3.0000e+02e
445 * tln *        3.0000e+02e
446 * pn *         1.0000e+06e
447 * pan *        0.0000e+00e
448 *
449 *****      type          num          id          ctitle
450 vessel                9          9 second vessel component
451 *          nasx          nrsx          ntsx          ncsr          ivssbf
452 *          3            1            1            3            0
453 *          idcu          idcl          idcr          icru          icrl
454 *          0            0            0            0            0
455 *          icrr          ilcsp          iucsp          iuhp          iconc
456 *          0            0            0            0            0
457 *          igeom          nvent          nvvtb
458 *          1            0            0
459 *          shelv          epsw
460 *          3.5000e+00    1.0000e-05
461 *
462 * z *          1.0000e+00    2.0000e+00    3.0000e+00e
463 * rad *          1.0000e+00e
464 * th *          1.0000e+00e
465 *
466 *          gc          gytc          gxrc          gzc
467 *          9.8066e+00    0.0000e+00    0.0000e+00    -1.0000e+00
468 *
469 *          lisrl          lisrc          lisrf          ljuns
470 *          1            1            -2            10
471 *          1            1            -2            11
472 *          3            1            2            13
473 *
474 * level 1
475 *
476 * cfzl-t*      0.0000e+00e
477 * cfzl-z*      0.0000e+00e
478 * cfzl-r*      0.0000e+00e
479 * cfzv-t*      0.0000e+00e
480 * cfzv-z*      0.0000e+00e
481 * cfzv-r*      0.0000e+00e
482 * vol *        1.0000e+00e
483 * fa-t *        0.0000e+00e
484 * fa-z *        1.0000e+00e
485 * fa-r *        0.0000e+00e
486 * hd-t *        0.0000e+00e
487 * hd-z *        1.0000e+00e
488 * hd-r *        0.0000e+00e
489 * alpn *        0.0000e+00e
490 * vvn-t *        0.0000e+00e
491 * vvn-z *        0.0000e+00e
492 * vvn-r *        0.0000e+00e
493 * vln-t *        0.0000e+00e
494 * vln-z *        0.0000e+00e

```

```

495 * vln-r *      0.0000e+00e
496 * tvn   *      3.0000e+02e
497 * tln   *      3.0000e+02e
498 * pn    *      1.0000e+06e
499 * pan   *      0.0000e+00e
500 *
501 * level   2
502 *
503 * cfzl-t*      0.0000e+00e
504 * cfzl-z*      0.0000e+00e
505 * cfzl-r*      0.0000e+00e
506 * cfzv-t*      0.0000e+00e
507 * cfzv-z*      0.0000e+00e
508 * cfzv-r*      0.0000e+00e
509 * vol    *      1.0000e+00e
510 * fa-t   *      0.0000e+00e
511 * fa-z   *      1.0000e+00e
512 * fa-r   *      0.0000e+00e
513 * hd-t   *      0.0000e+00e
514 * hd-z   *      1.0000e+00e
515 * hd-r   *      0.0000e+00e
516 * alpn   *      0.0000e+00e
517 * vvn-t   *      0.0000e+00e
518 * vvn-z   *      0.0000e+00e
519 * vvn-r   *      0.0000e+00e
520 * vln-t   *      0.0000e+00e
521 * vln-z   *      0.0000e+00e
522 * vln-r   *      0.0000e+00e
523 * tvn    *      3.0000e+02e
524 * tln    *      3.0000e+02e
525 * pn     *      1.0000e+06e
526 * pan    *      0.0000e+00e
527 *
528 * level   3
529 *
530 * cfzl-t*      0.0000e+00e
531 * cfzl-z*      0.0000e+00e
532 * cfzl-r*      0.0000e+00e
533 * cfzv-t*      0.0000e+00e
534 * cfzv-z*      0.0000e+00e
535 * cfzv-r*      0.0000e+00e
536 * vol    *      1.0000e+00e
537 * fa-t   *      0.0000e+00e
538 * fa-z   *      1.0000e+00e
539 * fa-r   *      0.0000e+00e
540 * hd-t   *      0.0000e+00e
541 * hd-z   *      1.0000e+00e
542 * hd-r   *      0.0000e+00e
543 * alpn   *      0.0000e+00e
544 * vvn-t   *      0.0000e+00e
545 * vvn-z   *      0.0000e+00e
546 * vvn-r   *      0.0000e+00e
547 * vln-t   *      0.0000e+00e
548 * vln-z   *      0.0000e+00e
549 * vln-r   *      0.0000e+00e
550 * tvn    *      3.0000e+02e
551 * tln    *      3.0000e+02e
552 * pn     *      1.0000e+06e
553 * pan    *      0.0000e+00e
554 *
555 *****      type      num      id      ctitle
556 pipe              10

```

```

10 outlet pipe for vessel 8

```

```

557 *      ncells      nodes      jun1      jun2      epsw
558      1      0      12      14      1.0000e-05
559 *      ichf      iconc      iacc      ipow
560      0      0      0      0
561 *      radin      th      houtl      houtv      toutl
562      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
563 *      toutv
564      3.0000e+02
565 *
566 * dx      * f      1.0000e+00e
567 * vol      * f      1.0000e+00e
568 * fa      *      1.0000e+00      5.0000e-01e
569 * fric      * f      0.0000e+00e
570 * grav      * f      1.0000e+00e
571 * hd      * f      1.0000e+00e
572 * nff      *      1      -1e
573 * alp      * f      0.0000e+00e
574 * vl      * f      0.0000e+00e
575 * vv      * f      0.0000e+00e
576 * tl      * f      3.0000e+02e
577 * tv      * f      3.0000e+02e
578 * p      * f      1.0000e+06e
579 * pa      * f      0.0000e+00e
580 *
581 * type      num      id      ctitle
582 pipe      11      11      outlet pipe for vessel 9
583 *      ncells      nodes      jun1      jun2      epsw
584      1      0      13      15      1.0000e-05
585 *      ichf      iconc      iacc      ipow
586      0      0      0      0
587 *      radin      th      houtl      houtv      toutl
588      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
589 *      toutv
590      3.0000e+02
591 *
592 * dx      * f      1.0000e+00e
593 * vol      * f      1.0000e+00e
594 * fa      *      1.0000e+00      5.0000e-01e
595 * fric      * f      0.0000e+00e
596 * grav      * f      1.0000e+00e
597 * hd      * f      1.0000e+00e
598 * nff      *      1      -1e
599 * alp      * f      0.0000e+00e
600 * vl      * f      0.0000e+00e
601 * vv      * f      0.0000e+00e
602 * tl      * f      3.0000e+02e
603 * tv      * f      3.0000e+02e
604 * p      * f      1.0000e+06e
605 * pa      * f      0.0000e+00e
606 *
607 * type      num      id      ctitle
608 vessel      12      12      third vessel component
609 *      nasx      nrsx      ntsx      ncsr      ivssbf
610      3      1      1      3      0
611 *      idcu      idcl      idcr      icru      icrl
612      0      0      0      0      0
613 *      icrr      ilcsp      iucsp      iuhp      iconc
614      0      0      0      0      0
615 *      igeom      nvent      nvvtb
616      1      0      0
617 *      shelv      epsw
618      7.5000e+00      1.0000e-05

```



```

619 *
620 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
621 * rad    *      1.0000e+00e
622 * th      *      1.0000e+00e
623 *
624 *          gc          gytc          gxrc          gzc
625      9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
626 *
627 *          lisrl          lisrc          lisrf          ljuns
628      1              1              -2              14
629      1              1              -2              15
630      3              1              2              16
631 *
632 * level  1
633 *
634 * cfzl-t*      0.0000e+00e
635 * cfzl-z*      0.0000e+00e
636 * cfzl-r*      0.0000e+00e
637 * cfzv-t*      0.0000e+00e
638 * cfzv-z*      0.0000e+00e
639 * cfzv-r*      0.0000e+00e
640 * vol      *      1.0000e+00e
641 * fa-t      *      0.0000e+00e
642 * fa-z      *      1.0000e+00e
643 * fa-r      *      0.0000e+00e
644 * hd-t      *      0.0000e+00e
645 * hd-z      *      1.0000e+00e
646 * hd-r      *      0.0000e+00e
647 * alpn      *      0.0000e+00e
648 * vvn-t      *      0.0000e+00e
649 * vvn-z      *      0.0000e+00e
650 * vvn-r      *      0.0000e+00e
651 * vln-t      *      0.0000e+00e
652 * vln-z      *      0.0000e+00e
653 * vln-r      *      0.0000e+00e
654 * tvn      *      3.0000e+02e
655 * tln      *      3.0000e+02e
656 * pn      *      1.0000e+06e
657 * pan      *      0.0000e+00e
658 *
659 * level  2
660 *
661 * cfzl-t*      0.0000e+00e
662 * cfzl-z*      0.0000e+00e
663 * cfzl-r*      0.0000e+00e
664 * cfzv-t*      0.0000e+00e
665 * cfzv-z*      0.0000e+00e
666 * cfzv-r*      0.0000e+00e
667 * vol      *      1.0000e+00e
668 * fa-t      *      0.0000e+00e
669 * fa-z      *      1.0000e+00e
670 * fa-r      *      0.0000e+00e
671 * hd-t      *      0.0000e+00e
672 * hd-z      *      1.0000e+00e
673 * hd-r      *      0.0000e+00e
674 * alpn      *      0.0000e+00e
675 * vvn-t      *      0.0000e+00e
676 * vvn-z      *      0.0000e+00e
677 * vvn-r      *      0.0000e+00e
678 * vln-t      *      0.0000e+00e
679 * vln-z      *      0.0000e+00e
680 * vln-r      *      0.0000e+00e

```

```

681 * tvn      *      3.0000e+02e
682 * tln      *      3.0000e+02e
683 * pn       *      1.0000e+06e
684 * pan      *      0.0000e+00e
685 *
686 * level    3
687 *
688 * cfzl-t*    0.0000e+00e
689 * cfzl-z*    0.0000e+00e
690 * cfzl-r*    0.0000e+00e
691 * cfzv-t*    0.0000e+00e
692 * cfzv-z*    0.0000e+00e
693 * cfzv-r*    0.0000e+00e
694 * vol       *      1.0000e+00e
695 * fa-t       *      0.0000e+00e
696 * fa-z       *      1.0000e+00e
697 * fa-r       *      0.0000e+00e
698 * hd-t       *      0.0000e+00e
699 * hd-z       *      1.0000e+00e
700 * hd-r       *      0.0000e+00e
701 * alpn      *      0.0000e+00e
702 * vvn-t      *      0.0000e+00e
703 * vvn-z      *      0.0000e+00e
704 * vvn-r      *      0.0000e+00e
705 * vln-t      *      0.0000e+00e
706 * vln-z      *      0.0000e+00e
707 * vln-r      *      0.0000e+00e
708 * tvn       *      3.0000e+02e
709 * tln       *      3.0000e+02e
710 * pn        *      1.0000e+06e
711 * pan       *      0.0000e+00e
712 *

```

```

713 *****      type          num          id          ctitle
714 pipe                      13          13 outlet pipe for vessel 12
715 *          ncells          nodes        jun1          jun2          epsw
716 *          1              0            16            17          1.0000e-05
717 *          ichf            iconc        iacc            ipow
718 *          0              0            0              0
719 *          radin            th          houtl          houtv          toutl
720 *          5.0000e-01      5.0000e-02  0.0000e+00      0.0000e+00      3.0000e+02
721 *          toutv
722 *          3.0000e+02
723 *

```

```

724 * dx      * f      1.0000e+00e
725 * vol     * f      1.0000e+00e
726 * fa      * f      1.0000e+00e
727 * fric    * f      0.0000e+00e
728 * grav    * f      1.0000e+00e
729 * hd      * f      1.0000e+00e
730 * nff     * f              1e
731 * alp     * f      0.0000e+00e
732 * vl      * f      0.0000e+00e
733 * vv      * f      0.0000e+00e
734 * tl      * f      3.0000e+02e
735 * tv      * f      3.0000e+02e
736 * p       * f      1.0000e+06e
737 * pa      * f      0.0000e+00e
738 *

```

```

739 *****      type          num          id          ctitle
740 pipe                      14          14 inlet pipe for vessel 15
741 *          ncells          nodes        jun1          jun2          epsw
742 *          1              0            18            17          1.0000e-05

```

```

743 *      ichf      iconc      iacc      ipow
744      0          0          0          0
745 *      radin      th      houtl      houtv      toutl
746      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
747 *      toutv
748      3.0000e+02
749 *
750 * dx      * f      1.0000e+00e
751 * vol      * f      1.0000e+00e
752 * fa      * f      1.0000e+00e
753 * fric      * f      0.0000e+00e
754 * grav      * f      -1.0000e+00e
755 * hd      * f      1.0000e+00e
756 * nff      * f      1e
757 * alp      * f      0.0000e+00e
758 * vl      * f      0.0000e+00e
759 * vv      * f      0.0000e+00e
760 * tl      * f      3.0000e+02e
761 * tv      * f      3.0000e+02e
762 * p      * f      1.0000e+06e
763 * pa      * f      0.0000e+00e
764 *
765 *****      type      num      id      ctitle
766 vessel      15      15 fourth vessel component
767 *      nasx      nrxx      ntsx      ncsr      ivssbf
768      3      1      1      3      0
769 *      idcu      idcl      idcr      icru      icrl
770      0      0      0      0      0
771 *      icrr      ilcsp      iucsp      iuhp      iconc
772      0      0      0      0      0
773 *      igeom      nvent      nvvtb
774      1      0      0
775 *      shelv      epsw
776      1.5500e+01      1.0000e-05
777 *
778 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
779 * rad      *      1.0000e+00e
780 * th      *      1.0000e+00e
781 *
782 *      gc      gytc      gxrc      gzc
783      9.8066e+00      0.0000e+00      0.0000e+00      1.0000e+00
784 *
785 *      lisrl      lisrc      lisrf      ljuns
786      1      1      -2      19
787      1      1      -2      20
788      3      1      2      18
789 *
790 * level      1
791 *
792 * cfzl-t*      0.0000e+00e
793 * cfzl-z*      0.0000e+00e
794 * cfzl-r*      0.0000e+00e
795 * cfzv-t*      0.0000e+00e
796 * cfzv-z*      0.0000e+00e
797 * cfzv-r*      0.0000e+00e
798 * vol      *      1.0000e+00e
799 * fa-t      *      0.0000e+00e
800 * fa-z      *      1.0000e+00e
801 * fa-r      *      0.0000e+00e
802 * hd-t      *      0.0000e+00e
803 * hd-z      *      1.0000e+00e
804 * hd-r      *      0.0000e+00e

```

805	*	alpn	*	0.0000e+00e
806	*	vvv-t	*	0.0000e+00e
807	*	vvv-z	*	0.0000e+00e
808	*	vvv-r	*	0.0000e+00e
809	*	vln-t	*	0.0000e+00e
810	*	vln-z	*	0.0000e+00e
811	*	vln-r	*	0.0000e+00e
812	*	tvn	*	3.0000e+02e
813	*	tln	*	3.0000e+02e
814	*	pn	*	1.0000e+06e
815	*	pan	*	0.0000e+00e
816	*			
817	*	level	2	
818	*			
819	*	cfzl-t*		0.0000e+00e
820	*	cfzl-z*		0.0000e+00e
821	*	cfzl-r*		0.0000e+00e
822	*	cfzv-t*		0.0000e+00e
823	*	cfzv-z*		0.0000e+00e
824	*	cfzv-r*		0.0000e+00e
825	*	vol	*	1.0000e+00e
826	*	fa-t	*	0.0000e+00e
827	*	fa-z	*	1.0000e+00e
828	*	fa-r	*	0.0000e+00e
829	*	hd-t	*	0.0000e+00e
830	*	hd-z	*	1.0000e+00e
831	*	hd-r	*	0.0000e+00e
832	*	alpn	*	0.0000e+00e
833	*	vvv-t	*	0.0000e+00e
834	*	vvv-z	*	0.0000e+00e
835	*	vvv-r	*	0.0000e+00e
836	*	vln-t	*	0.0000e+00e
837	*	vln-z	*	0.0000e+00e
838	*	vln-r	*	0.0000e+00e
839	*	tvn	*	3.0000e+02e
840	*	tln	*	3.0000e+02e
841	*	pn	*	1.0000e+06e
842	*	pan	*	0.0000e+00e
843	*			
844	*	level	3	
845	*			
846	*	cfzl-t*		0.0000e+00e
847	*	cfzl-z*		0.0000e+00e
848	*	cfzl-r*		0.0000e+00e
849	*	cfzv-t*		0.0000e+00e
850	*	cfzv-z*		0.0000e+00e
851	*	cfzv-r*		0.0000e+00e
852	*	vol	*	1.0000e+00e
853	*	fa-t	*	0.0000e+00e
854	*	fa-z	*	1.0000e+00e
855	*	fa-r	*	0.0000e+00e
856	*	hd-t	*	0.0000e+00e
857	*	hd-z	*	1.0000e+00e
858	*	hd-r	*	0.0000e+00e
859	*	alpn	*	0.0000e+00e
860	*	vvv-t	*	0.0000e+00e
861	*	vvv-z	*	0.0000e+00e
862	*	vvv-r	*	0.0000e+00e
863	*	vln-t	*	0.0000e+00e
864	*	vln-z	*	0.0000e+00e
865	*	vln-r	*	0.0000e+00e
866	*	tvn	*	3.0000e+02e

```

867 * tln * 3.0000e+02e
868 * pn * 1.0000e+06e
869 * pan * 0.0000e+00e
870 *
871 ***** type num id ctitle
872 pipe 16 16 inlet pipe for vessel 18
873 * ncells nodes jun1 jun2 epsw
874 * 1 0 21 19 1.0000e-05
875 * ichf iconc iacc ipow
876 * 0 0 0 0
877 * radin th hout1 houtv tout1
878 * 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
879 * toutv
880 * 3.0000e+02
881 *
882 * dx * f 1.0000e+00e
883 * vol * f 1.0000e+00e
884 * fa * 1.0000e+00 5.0000e-01e
885 * fric * f 0.0000e+00e
886 * grav * f -1.0000e+00e
887 * hd * f 1.0000e+00e
888 * nff * 1 -1e
889 * alp * f 0.0000e+00e
890 * vl * f 0.0000e+00e
891 * vv * f 0.0000e+00e
892 * tl * f 3.0000e+02e
893 * tv * f 3.0000e+02e
894 * p * f 1.0000e+06e
895 * pa * f 0.0000e+00e
896 *
897 ***** type num id ctitle
898 pipe 17 17 inlet pipe for vessel 19
899 * ncells nodes jun1 jun2 epsw
900 * 1 0 22 20 1.0000e-05
901 * ichf iconc iacc ipow
902 * 0 0 0 0
903 * radin th hout1 houtv tout1
904 * 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
905 * toutv
906 * 3.0000e+02
907 *
908 * dx * f 1.0000e+00e
909 * vol * f 1.0000e+00e
910 * fa * 1.0000e+00 5.0000e-01e
911 * fric * f 0.0000e+00e
912 * grav * f -1.0000e+00e
913 * hd * f 1.0000e+00e
914 * nff * 1 -1e
915 * alp * f 0.0000e+00e
916 * vl * f 0.0000e+00e
917 * vv * f 0.0000e+00e
918 * tl * f 3.0000e+02e
919 * tv * f 3.0000e+02e
920 * p * f 1.0000e+06e
921 * pa * f 0.0000e+00e
922 *
923 ***** type num id ctitle
924 vessel 18 18 fifth vessel component
925 * nasx nrxx ntsx ncsr ivssbf
926 * 3 1 1 3 0
927 * idcu idcl idcr icru icrl
928 * 0 0 0 0 0

```

929 *	icrr	ilcsp	iucsp	iuhp	iconc
930	0	0	0	0	0
931 *	igeom	nvent	nvvtb		
932	1	0	0		
933 *	shelv	epsw			
934	1.9500e+01	1.0000e-05			
935 *					
936 * z *	1.0000e+00	2.0000e+00	3.0000e+00e		
937 * rad *	1.0000e+00e				
938 * th *	1.0000e+00e				
939 *					
940 *	gc	gytc	gxrc	gzc	
941	9.8066e+00	0.0000e+00	0.0000e+00	1.0000e+00	
942 *					
943 *	lisrl	lisrc	lisrf	ljuns	
944	1	1	-2	23	
945	1	1	-2	24	
946	3	1	2	21	
947 *					
948 * level	1				
949 *					
950 * cfzl-t*	0.0000e+00e				
951 * cfzl-z*	0.0000e+00e				
952 * cfzl-r*	0.0000e+00e				
953 * cfzv-t*	0.0000e+00e				
954 * cfzv-z*	0.0000e+00e				
955 * cfzv-r*	0.0000e+00e				
956 * vol *	1.0000e+00e				
957 * fa-t *	0.0000e+00e				
958 * fa-z *	1.0000e+00e				
959 * fa-r *	0.0000e+00e				
960 * hd-t *	0.0000e+00e				
961 * hd-z *	1.0000e+00e				
962 * hd-r *	0.0000e+00e				
963 * alp*	0.0000e+00e				
964 * vvn-t *	0.0000e+00e				
965 * vvn-z *	0.0000e+00e				
966 * vvn-r *	0.0000e+00e				
967 * vln-t *	0.0000e+00e				
968 * vln-z *	0.0000e+00e				
969 * vln-r *	0.0000e+00e				
970 * tvn *	3.0000e+02e				
971 * tln *	3.0000e+02e				
972 * pn *	1.0000e+06e				
973 * pan *	0.0000e+00e				
974 *					
975 * level	2				
976 *					
977 * cfzl-t*	0.0000e+00e				
978 * cfzl-z*	0.0000e+00e				
979 * cfzl-r*	0.0000e+00e				
980 * cfzv-t*	0.0000e+00e				
981 * cfzv-z*	0.0000e+00e				
982 * cfzv-r*	0.0000e+00e				
983 * vol *	1.0000e+00e				
984 * fa-t *	0.0000e+00e				
985 * fa-z *	1.0000e+00e				
986 * fa-r *	0.0000e+00e				
987 * hd-t *	0.0000e+00e				
988 * hd-z *	1.0000e+00e				
989 * hd-r *	0.0000e+00e				
990 * alp*	0.0000e+00e				

```

991 * vvn-t *      0.0000e+00e
992 * vvn-z *      0.0000e+00e
993 * vvn-r *      0.0000e+00e
994 * vln-t *      0.0000e+00e
995 * vln-z *      0.0000e+00e
996 * vln-r *      0.0000e+00e
997 * tvn *        3.0000e+02e
998 * tln *        3.0000e+02e
999 * pn *         1.0000e+06e
1000 * pan *       0.0000e+00e
1001 *
1002 * level 3
1003 *
1004 * cfzl-t*      0.0000e+00e
1005 * cfzl-z*      0.0000e+00e
1006 * cfzl-r*      0.0000e+00e
1007 * cfzv-t*      0.0000e+00e
1008 * cfzv-z*      0.0000e+00e
1009 * cfzv-r*      0.0000e+00e
1010 * vol *       1.0000e+00e
1011 * fa-t *      0.0000e+00e
1012 * fa-z *      1.0000e+00e
1013 * fa-r *      0.0000e+00e
1014 * hd-t *      0.0000e+00e
1015 * hd-z *      1.0000e+00e
1016 * hd-r *      0.0000e+00e
1017 * alpn *      0.0000e+00e
1018 * vvn-t *      0.0000e+00e
1019 * vvn-z *      0.0000e+00e
1020 * vvn-r *      0.0000e+00e
1021 * vln-t *      0.0000e+00e
1022 * vln-z *      0.0000e+00e
1023 * vln-r *      0.0000e+00e
1024 * tvn *        3.0000e+02e
1025 * tln *        3.0000e+02e
1026 * pn *         1.0000e+06e
1027 * pan *       0.0000e+00e
1028 *

```

```

1029 *****      type          num          id          ctitle
1030 vessel          19          19 sixth vessel component
1031 *              nasx          nrsx          ntsx          ncsr          ivssbf
1032              3              1              1              3              0
1033 *              idcu          idcl          idcr          icru          icrl
1034              0              0              0              0              0
1035 *              icrr          ilcsp          iucsp          iuhp          iconc
1036              0              0              0              0              0
1037 *              igeom          nvent          nvvtb
1038              1              0              0
1039 *              shelv          epsw
1040              1.9500e+01      1.0000e-05
1041 *
1042 * z *          1.0000e+00      2.0000e+00      3.0000e+00e
1043 * rad *       1.0000e+00e
1044 * th *       1.0000e+00e
1045 *
1046 *              gc          gycr          gxrc          gzc
1047              9.8066e+00      0.0000e+00      0.0000e+00      1.0000e+00
1048 *
1049 *              lisrl          lisrc          lisrf          ljuns
1050              1              1              -2              25
1051              1              1              -2              26
1052              3              1              2              22

```

```

1053 *
1054 * level 1
1055 *
1056 * cfzl-t* 0.0000e+00e
1057 * cfzl-z* 0.0000e+00e
1058 * cfzl-r* 0.0000e+00e
1059 * cfzv-t* 0.0000e+00e
1060 * cfzv-z* 0.0000e+00e
1061 * cfzv-r* 0.0000e+00e
1062 * vol * 1.0000e+00e
1063 * fa-t * 0.0000e+00e
1064 * fa-z * 1.0000e+00e
1065 * fa-r * 0.0000e+00e
1066 * hd-t * 0.0000e+00e
1067 * hd-z * 1.0000e+00e
1068 * hd-r * 0.0000e+00e
1069 * alpn * 0.0000e+00e
1070 * vvn-t * 0.0000e+00e
1071 * vvn-z * 0.0000e+00e
1072 * vvn-r * 0.0000e+00e
1073 * vln-t * 0.0000e+00e
1074 * vln-z * 0.0000e+00e
1075 * vln-r * 0.0000e+00e
1076 * tvn * 3.0000e+02e
1077 * tln * 3.0000e+02e
1078 * pn * 1.0000e+06e
1079 * pan * 0.0000e+00e
1080 *
1081 * level 2
1082 *
1083 * cfzl-t* 0.0000e+00e
1084 * cfzl-z* 0.0000e+00e
1085 * cfzl-r* 0.0000e+00e
1086 * cfzv-t* 0.0000e+00e
1087 * cfzv-z* 0.0000e+00e
1088 * cfzv-r* 0.0000e+00e
1089 * vol * 1.0000e+00e
1090 * fa-t * 0.0000e+00e
1091 * fa-z * 1.0000e+00e
1092 * fa-r * 0.0000e+00e
1093 * hd-t * 0.0000e+00e
1094 * hd-z * 1.0000e+00e
1095 * hd-r * 0.0000e+00e
1096 * alpn * 0.0000e+00e
1097 * vvn-t * 0.0000e+00e
1098 * vvn-z * 0.0000e+00e
1099 * vvn-r * 0.0000e+00e
1100 * vln-t * 0.0000e+00e
1101 * vln-z * 0.0000e+00e
1102 * vln-r * 0.0000e+00e
1103 * tvn * 3.0000e+02e
1104 * tln * 3.0000e+02e
1105 * pn * 1.0000e+06e
1106 * pan * 0.0000e+00e
1107 *
1108 * level 3
1109 *
1110 * cfzl-t* 0.0000e+00e
1111 * cfzl-z* 0.0000e+00e
1112 * cfzl-r* 0.0000e+00e
1113 * cfzv-t* 0.0000e+00e
1114 * cfzv-z* 0.0000e+00e

```



```

1115 * cfzv-r*      0.0000e+00e
1116 * vol      *      1.0000e+00e
1117 * fa-t      *      0.0000e+00e
1118 * fa-z      *      1.0000e+00e
1119 * fa-r      *      0.0000e+00e
1120 * hd-t      *      0.0000e+00e
1121 * hd-z      *      1.0000e+00e
1122 * hd-r      *      0.0000e+00e
1123 * alpn      *      0.0000e+00e
1124 * vvn-t      *      0.0000e+00e
1125 * vvn-z      *      0.0000e+00e
1126 * vvn-r      *      0.0000e+00e
1127 * vln-t      *      0.0000e+00e
1128 * vln-z      *      0.0000e+00e
1129 * vln-r      *      0.0000e+00e
1130 * tvn      *      3.0000e+02e
1131 * tln      *      3.0000e+02e
1132 * pn      *      1.0000e+06e
1133 * pan      *      0.0000e+00e
1134 *
1135 *****      type      num      id      ctitle
1136 pipe      20      20 1st outlet pipe from vessel 18
1137 *      ncells      nodes      jun1      jun2      epsw
1138      1      0      27      23      1.0000e-05
1139 *      ichf      iconc      iacc      ipow
1140      0      0      0      0
1141 *      radin      th      hout1      houtv      tout1
1142      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
1143 *      toutv
1144      3.0000e+02
1145 *
1146 * dx      * f      1.0000e+00e
1147 * vol      * f      1.0000e+00e
1148 * fa      *      1.0000e+00      5.0000e-01e
1149 * fric      * f      0.0000e+00e
1150 * grav      * f      -1.0000e+00e
1151 * hd      * f      1.0000e+00e
1152 * nff      *      1      -1e
1153 * alp      * f      0.0000e+00e
1154 * vl      * f      0.0000e+00e
1155 * vv      * f      0.0000e+00e
1156 * tl      * f      3.0000e+02e
1157 * tv      * f      3.0000e+02e
1158 * p      * f      1.0000e+06e
1159 * pa      * f      0.0000e+00e
1160 *
1161 *****      type      num      id      ctitle
1162 pipe      21      21 2nd outlet pipe from vessel 18
1163 *      ncells      nodes      jun1      jun2      epsw
1164      1      0      28      24      1.0000e-05
1165 *      ichf      iconc      iacc      ipow
1166      0      0      0      0
1167 *      radin      th      hout1      houtv      tout1
1168      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      3.0000e+02
1169 *      toutv
1170      3.0000e+02
1171 *
1172 * dx      * f      1.0000e+00e
1173 * vol      * f      1.0000e+00e
1174 * fa      *      1.0000e+00      5.0000e-01e
1175 * fric      * f      0.0000e+00e
1176 * grav      * f      -1.0000e+00e

```

```

1177 * hd      * f      1.0000e+00e
1178 * nff      *          1          -1e
1179 * alp      * f      0.0000e+00e
1180 * vl      * f      0.0000e+00e
1181 * vv      * f      0.0000e+00e
1182 * tl      * f      3.0000e+02e
1183 * tv      * f      3.0000e+02e
1184 * p       * f      1.0000e+06e
1185 * pa      * f      0.0000e+00e
1186 *
1187 *****      type          num          id          ctitle
1188 pipe          22          22 1st outlet pipe from vessel 19
1189 *          ncells          nodes          jun1          jun2          epsw
1190 *          1          0          29          25          1.0000e-05
1191 *          ichf          iconc          iacc          ipow
1192 *          0          0          0          0
1193 *          radin          th          hout1          houtv          tout1
1194 *          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          3.0000e+02
1195 *          toutv
1196 *          3.0000e+02
1197 *
1198 * dx      * f      1.0000e+00e
1199 * vol      * f      1.0000e+00e
1200 * fa      *          1.0000e+00          5.0000e-01e
1201 * fric      * f      0.0000e+00e
1202 * grav      * f      -1.0000e+00e
1203 * hd      * f      1.0000e+00e
1204 * nff      *          1          -1e
1205 * alp      * f      0.0000e+00e
1206 * vl      * f      0.0000e+00e
1207 * vv      * f      0.0000e+00e
1208 * tl      * f      3.0000e+02e
1209 * tv      * f      3.0000e+02e
1210 * p       * f      1.0000e+06e
1211 * pa      * f      0.0000e+00e
1212 *
1213 *****      type          num          id          ctitle
1214 pipe          23          23 2nd outlet pipe from vessel 19
1215 *          ncells          nodes          jun1          jun2          epsw
1216 *          1          0          30          26          1.0000e-05
1217 *          ichf          iconc          iacc          ipow
1218 *          0          0          0          0
1219 *          radin          th          hout1          houtv          tout1
1220 *          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          3.0000e+02
1221 *          toutv
1222 *          3.0000e+02
1223 *
1224 * dx      * f      1.0000e+00e
1225 * vol      * f      1.0000e+00e
1226 * fa      *          1.0000e+00          5.0000e-01e
1227 * fric      * f      0.0000e+00e
1228 * grav      * f      -1.0000e+00e
1229 * hd      * f      1.0000e+00e
1230 * nff      *          1          -1e
1231 * alp      * f      0.0000e+00e
1232 * vl      * f      0.0000e+00e
1233 * vv      * f      0.0000e+00e
1234 * tl      * f      3.0000e+02e
1235 * tv      * f      3.0000e+02e
1236 * p       * f      1.0000e+06e
1237 * pa      * f      0.0000e+00e
1238 *

```

```

1239 ***** type num id ctitle
1240 plenum 24 24 manifold plenum 24
1241 * npljn iconc juns1 juns2
1242 5 0 1 4
1243 *
1244 * junj * 31s
1245 * junj * 27 28 29 30e
1246 * dx * f 1.0000e+00e
1247 * vol * f 4.0000e+00e
1248 * elev * f 2.1000e+01e
1249 * alp * f 0.0000e+00e
1250 * tl * f 3.0000e+02e
1251 * tv * f 3.0000e+02e
1252 * p * f 1.0000e+06e
1253 * pa * f 0.0000e+00e
1254 *
1255 ***** type num id ctitle
1256 pipe 25 25 outlet pipe from plenum 24
1257 * ncells nodes jun1 jun2 epsw
1258 1 0 32 31 1.0000e-05
1259 * ichf iconc iacc ipow
1260 0 0 0 0
1261 * radin th houtl houtv toutl
1262 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 3.0000e+02
1263 * toutv
1264 3.0000e+02
1265 *
1266 * dx * f 1.0000e+00e
1267 * vol * f 1.0000e+00e
1268 * fa * f 1.0000e+00e
1269 * fric * f 0.0000e+00e
1270 * grav * f -1.0000e+00e
1271 * hd * f 1.0000e+00e
1272 * nff * 1 -1e
1273 * alp * f 0.0000e+00e
1274 * vl * f 0.0000e+00e
1275 * vv * f 0.0000e+00e
1276 * tl * f 3.0000e+02e
1277 * tv * f 3.0000e+02e
1278 * p * f 1.0000e+06e
1279 * pa * f 0.0000e+00e
1280 *
1281 ***** type num id ctitle
1282 break 26 26 pressure b.c. for pipe 25 outlet
1283 * jun1 ibty isat ioiff
1284 32 0 0 0
1285 * dxin volin alpin tin pin
1286 1.0000e+00 1.0000e+00 0.0000e+00 3.0000e+02 1.0000e+06
1287 * pain concin rbmx poff belv
1288 0.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00 2.3000e+01
1289 *
1290 end
1291 *
1292 *****
1293 * time-step data *
1294 *****
1295 *
1296 * dtmin dtmax tend rtwfp
1297 1.0000e-03 1.0000e+00 1.0000e+01 1.0000e+00
1298 * edint gfint dmpint sedint
1299 1.0000e+01 1.0000e+00 1.1000e+01 1.0000e+01
1300 *

```

1301 *	dtmin	dtmax	tend	rtwfp
1302	1.0000e-03	5.0000e+00	1.0000e+02	1.0000e+00
1303 *	edint	gfint	dmpint	sedint
1304	9.0000e+01	2.5000e+00	9.5000e+01	9.0000e+01
1305 *				
1306 *	dtmin	dtmax	tend	rtwfp
1307	1.0000e-02	3.0000e+01	1.0000e+03	1.0000e+00
1308 *	edint	gfint	dmpint	sedint
1309	9.0000e+02	1.5000e+01	9.3000e+02	9.0000e+02
1310 *				
1311 *	dtmin	dtmax	tend	rtwfp
1312	1.0000e-01	2.0000e+02	1.0000e+04	1.0000e+00
1313 *	edint	gfint	dmpint	sedint
1314	9.0000e+03	2.0000e+02	9.0000e+03	9.0000e+03
1315 *				
1316 *	endflag			
1317	-1.0000e+00			

A-4.18 MSVLR Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *          4              0              1              0              0
9 *--*--*TEST PROBLEM MSVLR , TIME = 10000.0 s to 20000.0 s
10 mirrored parallel-flow channel with single-phase liquid
11 two pressure boundary conditions, t1 = 300.0 k
12 transient restart calculation
13 *
14 *
15 *          nff          vl          fa
16 *          (-)        (m/s)      (m2)
17 *          *****
18 *          # break#
19 *          # 26 # p = 1.0000e+06 pa
20 *          *****
21 *          32          1      -10.0      1.0
22 *          *****
23 *          # pipe #
24 *          # 25 #
25 *          *****
26 *          31          -1      -10.0      1.0
27 *          *****
28 *          # plenum #
29 *          # 24 #
30 *          *****
31 *          27          28          29          30          1      -2.5      1.0x4
32 *          *****
33 *          # pipe # # pipe # # pipe # # pipe #
34 *          # 20 # # 21 # # 22 # # 23 #
35 *          *****
36 *          23          24          25          26          -1      -5.0      0.5x4
37 *          *****
38 *          # cell # # cell #
39 *          # 1 # # 1 #
40 *          #-----# #-----#
41 *          #vessel# #vessel#
42 *          # 18 # # 19 #
43 *          #-----# #-----#
44 *          # cell # # cell #
45 *          # 3 # # 3 #
46 *          *****
47 *          21          22          1      -5.0      1.0x2
48 *          *****
49 *          # pipe # # pipe #
50 *          # 16 # # 17 #
51 *          *****
52 *          19          20          -1      -10.0      0.5x2
53 *          *****
54 *          # cell #
55 *          # 1 #
56 *          #-----#
57 *          #vessel#
58 *          # 15 #
59 *          #-----#
60 *          # cell #
61 *          # 3 #
62 *          *****

```

```

61 *          18          1 -10.0  1.0
62 *          #####
63 *          # pipe #
64 *          # 14 #
65 *          #####
66 * -- mirror plane -- 17 -- mirror plane -- 1 10.0  1.0
67 *          #####
68 *          # pipe #
69 *          # 13 #
70 *          #####
71 *          16          1 10.0  1.0
72 *          #####
73 *          # cell #
74 *          # 3 #
75 *          #-----#          1 10.0  1.0
76 *          #vessel#
77 *          # 12 #
78 *          #-----#          1 10.0  1.0
79 *          # cell #
80 *          # 1 #
81 *          #####
82 *          14 15          -1 10.0  0.5x2
83 *          #####
84 *          # pipe # # pipe #
85 *          # 10 # # 11 #
86 *          #####
87 *          12 13          1 5.0  1.0x2
88 *          #####
89 *          # cell # # cell #
90 *          # 1 # # 3 #
91 *          #-----#          1 5.0  1.0x2
92 *          #vessel# #vessel#
93 *          # 8 # # 9 #
94 *          #-----#          1 5.0  1.0x2
95 *          # cell # # cell #
96 *          # 3 # # 1 #
97 *          #####
98 *          8 9 10 11          -1 5.0  0.5x4
99 *          #####
100 *          # pipe # # pipe # # pipe # # pipe #
101 *          # 4 # # 5 # # 6 # # 7 #
102 *          #####
103 *          4 5 6 7          1 2.5  1.0x4
104 *          #####
105 *          # plenum #
106 *          # 3 #
107 *          #####
108 *          3          -1 10.0  1.0
109 *          #####
110 *          # pipe #
111 *          # 2 #
112 *          #####
113 *          2          1 10.0  1.0
114 *          #####
115 *          # break# p = 1.4045e+06 pa
116 *          # 1 #
117 *          #####
118 *
119 * *****
120 * namelist data *
121 * *****
122 *

```

```

123 &inopts
124   dtstrt=10.0, iadded=10, ikfac=1, nvgrav=1, cpuflg=1,
125   idiag=4, nsdl=0, nsdu=5, nspl=0, nspl=0, nspl=0, nspl=0
126 &end
127 *
128 *           dstep           timet
129           -1           0.0000e+00
130 *           stdyst           transi           ncomp           njun           ipak
131           0           1           26           31           0
132 *           epso           epss
133           1.0000e-04           1.0000e-04
134 *           oitmax           sitmax           isolut           ncontr           nccfl
135           10           10           0           0           0
136 *           ntsv           ntcb           ntcf           ntrp           ntcp
137           1           0           0           0           0
138 *
139 *****
140 * component-number data *
141 *****
142 *
143 * iorder * 1 s * break           pressure b.c. for pipe 2 inlet
144 * iorder * 2 s * pipe           inlet pipe for plenum 3
145 * iorder * 3 s * plenum        manifold for parallel-channel pipes
146 * iorder * 4 s * pipe           1st inlet pipe for vessel 8
147 * iorder * 5 s * pipe           2nd inlet pipe for vessel 8
148 * iorder * 6 s * pipe           1st inlet pipe for vessel 9
149 * iorder * 7 s * pipe           2nd inlet pipe for vessel 9
150 * iorder * 8 s * vessel        first vessel component
151 * iorder * 9 s * vessel        second vessel component
152 * iorder * 10 s * pipe          outlet pipe for vessel 8
153 * iorder * 11 s * pipe          outlet pipe for vessel 9
154 * iorder * 12 s * vessel        third vessel component
155 * iorder * 13 s * pipe          outlet pipe for vessel 12
156 * iorder * 14 s * pipe          inlet pipe for vessel 15
157 * iorder * 15 s * vessel        fourth vessel component
158 * iorder * 16 s * pipe          inlet pipe for vessel 18
159 * iorder * 17 s * pipe          inlet pipe for vessel 19
160 * iorder * 18 s * vessel        fifth vessel component
161 * iorder * 19 s * vessel        sixth vessel component
162 * iorder * 20 s * pipe          1st outlet pipe for vessel 18
163 * iorder * 21 s * pipe          2nd outlet pipe for vessel 18
164 * iorder * 22 s * pipe          1st outlet pipe for vessel 19
165 * iorder * 23 s * pipe          2nd outlet pipe for vessel 19
166 * iorder * 24 s * plenum        manifold for parallel-channel pipes
167 * iorder * 25 s * pipe          outlet pipe for plenum 24
168 * iorder * 26 e * break         pressure b.c. for pipe 25 outlet
169 *
170 *****
171 * control parameters *
172 *****
173 *
174 * signal variable
175 *
176 *           idsv           isvn           icln           icn1           icn2
177           0           0           0           0           0
178 *
179 *****
180 * component data *
181 *****
182 *
183 end
184 *

```

```

185 *****
186 * time-step data *
187 *****
188 *
189 *      dtmin      dtmax      tend      rtwfp
190      1.0000e-01    3.0000e+01    1.1000e+04    1.0000e+03
191 *      edint      gfint      dmpint      sedint
192      9.0000e+02    3.0000e+01    1.1000e+03    9.0000e+02
193 *
194 *      dtmin      dtmax      tend      rtwfp
195      1.0000e+00    2.0000e+02    2.0000e+04    1.0000e+03
196 *      edint      gfint      dmpint      sedint
197      9.0000e+03    2.0000e+02    9.0000e+03    9.0000e+03
198 *
199 *      endflag
200      -1.0000e+00

```


A-4.19 MSVV Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *              3              0              1              0              0
9 *---*TEST PROBLEM MSVV , TIME = 10000.0 s
10 mirrored parallel-flow channel with single-phase vapor
11 two pressure boundary conditions, tv = 500.0 k
12 *
13 *
14 *          nff          vv          fa
15 *          (-)        (m/s)      (m2)
16 *          *****
17 *          # break#
18 *          # 26 # p = 1.0000e+06 pa
19 *          *****
20 *          32          1      -10.0      1.0
21 *          *****
22 *          # pipe #
23 *          # 25 #
24 *          *****
25 *          31          -1      -10.0      1.0
26 *          *****
27 *          # plenum #
28 *          # 24 #
29 *          *****
30 *          27          28          29          30          1      -2.5      1.0x4
31 *          *****
32 *          # pipe # # pipe # # pipe # # pipe #
33 *          # 20 # # 21 # # 22 # # 23 #
34 *          *****
35 *          23          24          25          26          -1      -5.0      0.5x4
36 *          *****
37 *          # cell # # cell #
38 *          # 1 # # 1 #
39 *          #-----# #-----#
40 *          #vessel# #vessel#
41 *          # 18 # # 19 #
42 *          #-----# #-----#
43 *          # cell # # cell #
44 *          # 3 # # 3 #
45 *          *****
46 *          21          22          1      -5.0      1.0x2
47 *          *****
48 *          # pipe # # pipe #
49 *          # 16 # # 17 #
50 *          *****
51 *          19          20          -1      -10.0      0.5x2
52 *          *****
53 *          # cell #
54 *          # 1 #
55 *          #-----#
56 *          #vessel#
57 *          # 15 #
58 *          #-----#
59 *          # cell #
60 *          # 3 #
        *****
        18          1      -10.0      1.0

```

```

61 *          #####
62 *          # pipe #
63 *          # 14 #
64 *          #####
65 * -- mirror plane -- 17 -- mirror plane -- 1    10.0    1.0
66 *          #####
67 *          # pipe #
68 *          # 13 #
69 *          #####
70 *          16                                1    10.0    1.0
71 *          #####
72 *          # cell #
73 *          # 3 #
74 *          #-----#                        1    10.0    1.0
75 *          #vessel#
76 *          # 12 #
77 *          #-----#                        1    10.0    1.0
78 *          # cell #
79 *          # 1 #
80 *          #####
81 *          14    15                        -1    10.0    0.5x2
82 *          #####      #####
83 *          # pipe #    # pipe #
84 *          # 10 #    # 11 #
85 *          #####      #####
86 *          12          13                    1     5.0    1.0x2
87 *          #####      #####
88 *          # cell #    # cell #
89 *          # 3 #      # 3 #
90 *          #-----#    #-----#                1     5.0    1.0x2
91 *          #vessel#    #vessel#
92 *          # 8 #      # 9 #
93 *          #-----#    #-----#                1     5.0    1.0x2
94 *          # cell #    # cell #
95 *          # 1 #      # 1 #
96 *          #####      #####
97 *          8    9          10    11          -1     5.0    0.5x4
98 *          #####      #####      #####      #####
99 *          # pipe #    # pipe #    # pipe #    # pipe #
100 *          # 4 #    # 5 #    # 6 #    # 7 #
101 *          #####      #####      #####      #####
102 *          4          5          6          7                1     2.5    1.0x4
103 *          #####
104 *          #          plenum          #
105 *          #          3          #
106 *          #####
107 *          3                                -1    10.0    1.0
108 *          #####
109 *          # pipe #
110 *          # 2 #
111 *          #####
112 *          2                                1    10.0    1.0
113 *          #####
114 *          # break#    p = 1001758.5 pa
115 *          # 1 #
116 *          #####
117 *
118 * *****
119 * namelist data *
120 * *****
121 *
122 * &inopts

```

```

123 iadded=10, ikfac=1, nvgrav=1, cpuf1g=1,
124 idiag=4, nsdl=0, nsdu=5, nspl=0, nsps=5
125 &end
126 *
127 *          dstep          timet
128 *          0          0.0000e+00
129 *          stdyst          transi          ncomp          njun          ipak
130 *          0          1          26          31          0
131 *          epso          epss
132 *          1.0000e-04          1.0000e-04
133 *          oitmax          sitmax          isolut          ncontr          nccfl
134 *          10          10          0          0          0
135 *          ntsv          ntcbl          ntcfl          ntrp          ntcp
136 *          1          0          0          0          0
137 *
138 *****
139 * component-number data *
140 *****
141 *
142 * iorder * 1 s * break          pressure b.c. for pipe 2 inlet
143 * iorder * 2 s * pipe          inlet pipe for plenum 3
144 * iorder * 3 s * plenum          manifold for parallel-channel pipes
145 * iorder * 4 s * pipe          1st inlet pipe for vessel 8
146 * iorder * 5 s * pipe          2nd inlet pipe for vessel 8
147 * iorder * 6 s * pipe          1st inlet pipe for vessel 9
148 * iorder * 7 s * pipe          2nd inlet pipe for vessel 9
149 * iorder * 8 s * vessel          first vessel component
150 * iorder * 9 s * vessel          second vessel component
151 * iorder * 10 s * pipe          outlet pipe for vessel 8
152 * iorder * 11 s * pipe          outlet pipe for vessel 9
153 * iorder * 12 s * vessel          third vessel component
154 * iorder * 13 s * pipe          outlet pipe for vessel 12
155 * iorder * 14 s * pipe          inlet pipe for vessel 15
156 * iorder * 15 s * vessel          fourth vessel component
157 * iorder * 16 s * pipe          inlet pipe for vessel 18
158 * iorder * 17 s * pipe          inlet pipe for vessel 19
159 * iorder * 18 s * vessel          fifth vessel component
160 * iorder * 19 s * vessel          sixth vessel component
161 * iorder * 20 s * pipe          1st outlet pipe for vessel 18
162 * iorder * 21 s * pipe          2nd outlet pipe for vessel 18
163 * iorder * 22 s * pipe          1st outlet pipe for vessel 19
164 * iorder * 23 s * pipe          2nd outlet pipe for vessel 19
165 * iorder * 24 s * plenum          manifold for parallel-channel pipes
166 * iorder * 25 s * pipe          outlet pipe for plenum 24
167 * iorder * 26 e * break          pressure b.c. for pipe 25 outlet
168 *
169 *****
170 * control parameters *
171 *****
172 *
173 * signal variable
174 *
175 *          idsv          isvn          icln          icn1          icn2
176 *          1          0          0          0          0
177 *
178 *****
179 * component data *
180 *****
181 *
182 *          type          num          id          ctitle
183 break          1          1          pressure b.c. for pipe 2 inlet
184 *          jun1          ibty          isat          ioff

```

```

185      2      1      0      0
186 *      ibtr      ibsv      nbtr      nbsv      nbrf
187      0      1      2      0      0
188 *      dxin      volin      alpin      tin      pin
189      1.0000e+00      1.0000e+00      1.0000e+00      5.0000e+02      1.0000e+06
190 *      pain      concin      rbmx      poff      belv
191      0.0000e+00      0.0000e+00      1.7585e+03      0.0000e+00      0.0000e+00
192 *      pscl      tpscl      tvscl      pascl      conscl
193      1.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00      0.0000e+00
194 *
195 * ptb *      0.0000e+00      1.0000e+06      1.0000e+00      1001758.50e
196 *
197 ***** type      num      id      ctitle
198 pipe      2      2 inlet pipe for plenum 3
199 *      ncells      nodes      jun1      jun2      epsw
200      1      0      2      3      1.0000e-05
201 *      ichf      iconc      iacc      ipow
202      0      0      0      0
203 *      radin      th      hout1      houtv      tout1
204      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
205 *      toutv
206      5.0000e+02
207 *
208 * dx * f 1.0000e+00e
209 * vol * f 1.0000e+00e
210 * fa * f 1.0000e+00e
211 * fric * f 0.0000e+00e
212 * grav * f 1.0000e+00e
213 * hd * f 1.0000e+00e
214 * nff * 1
215 * alp * f 1.0000e+00e
216 * vl * f 0.0000e+00e
217 * vv * f 0.0000e+00e
218 * tl * f 5.0000e+02e
219 * tv * f 5.0000e+02e
220 * p * f 1.0000e+06e
221 * pa * f 0.0000e+00e
222 *
223 ***** type      num      id      ctitle
224 plenum      3      3 manifold plenum 3
225 *      npljn      iconc      juns1      juns2
226      5      0      1      4
227 *
228 * junj * 3s
229 * junj * 4      5      6      7e
230 * dx * f 1.0000e+00e
231 * vol * f 4.0000e+00e
232 * elev * f 2.0000e+00e
233 * alp * f 1.0000e+00e
234 * tl * f 5.0000e+02e
235 * tv * f 5.0000e+02e
236 * p * f 1.0000e+06e
237 * pa * f 0.0000e+00e
238 *
239 ***** type      num      id      ctitle
240 pipe      4      4 1st inlet pipe for vessel 8
241 *      ncells      nodes      jun1      jun2      epsw
242      1      0      4      8      1.0000e-05
243 *      ichf      iconc      iacc      ipow
244      0      0      0      0
245 *      radin      th      hout1      houtv      tout1
246      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02

```

```

247 *          toutv
248      5.0000e+02
249 *
250 * dx      * f      1.0000e+00e
251 * vol     * f      1.0000e+00e
252 * fa      *      1.0000e+00      5.0000e-01e
253 * fric    * f      0.0000e+00e
254 * grav    * f      1.0000e+00e
255 * hd      * f      1.0000e+00e
256 * nff     *      1      -1e
257 * alp     * f      1.0000e+00e
258 * vl      * f      0.0000e+00e
259 * vv      * f      0.0000e+00e
260 * tl      * f      5.0000e+02e
261 * tv      * f      5.0000e+02e
262 * p       * f      1.0000e+06e
263 * pa      * f      0.0000e+00e
264 *
265 *****      type          num          id          ctitle
266 pipe          5          5 2nd inlet pipe for vessel 8
267 *          ncells      nodes      jun1      jun2      epsw
268      1          0          5          9      1.0000e-05
269 *          ichf      iconc      iacc      ipow
270      0          0          0          0
271 *          radin      th      hout1      houtv      tout1
272      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
273 *          toutv
274      5.0000e+02
275 *
276 * dx      * f      1.0000e+00e
277 * vol     * f      1.0000e+00e
278 * fa      *      1.0000e+00      5.0000e-01e
279 * fric    * f      0.0000e+00e
280 * grav    * f      1.0000e+00e
281 * hd      * f      1.0000e+00e
282 * nff     *      1      -1e
283 * alp     * f      1.0000e+00e
284 * vl      * f      0.0000e+00e
285 * vv      * f      0.0000e+00e
286 * tl      * f      5.0000e+02e
287 * tv      * f      5.0000e+02e
288 * p       * f      1.0000e+06e
289 * pa      * f      0.0000e+00e
290 *
291 *****      type          num          id          ctitle
292 pipe          6          6 1st inlet pipe for vessel 9
293 *          ncells      nodes      jun1      jun2      epsw
294      1          0          6          10      1.0000e-05
295 *          ichf      iconc      iacc      ipow
296      0          0          0          0
297 *          radin      th      hout1      houtv      tout1
298      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
299 *          toutv
300      5.0000e+02
301 *
302 * dx      * f      1.0000e+00e
303 * vol     * f      1.0000e+00e
304 * fa      *      1.0000e+00      5.0000e-01e
305 * fric    * f      0.0000e+00e
306 * grav    * f      1.0000e+00e
307 * hd      * f      1.0000e+00e
308 * nff     *      1      -1e

```

```

309 * alp      * f      1.0000e+00e
310 * vl       * f      0.0000e+00e
311 * vv       * f      0.0000e+00e
312 * tl       * f      5.0000e+02e
313 * tv       * f      5.0000e+02e
314 * p        * f      1.0000e+06e
315 * pa       * f      0.0000e+00e
316 *
317 *****      type              num              id              ctitle
318 pipe              7              7 2nd inlet pipe for vessel 9
319 *              ncells          nodes          jun1          jun2          epsw
320 *              1              0              7              11          1.0000e-05
321 *              ichf            iconc          iacc          ipow
322 *              0              0              0              0
323 *              radin          th              hout1          houtv          tout1
324 *              5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
325 *              toutv
326 *              5.0000e+02
327 *
328 * dx         * f      1.0000e+00e
329 * vol        * f      1.0000e+00e
330 * fa         *      1.0000e+00      5.0000e-01e
331 * fric       * f      0.0000e+00e
332 * grav       * f      1.0000e+00e
333 * hd         * f      1.0000e+00e
334 * nff        *      1              -1e
335 * alp        * f      1.0000e+00e
336 * vl         * f      0.0000e+00e
337 * vv         * f      0.0000e+00e
338 * tl         * f      5.0000e+02e
339 * tv         * f      5.0000e+02e
340 * p          * f      1.0000e+06e
341 * pa         * f      0.0000e+00e
342 *
343 *****      type              num              id              ctitle
344 vessel              8              8 first vessel component
345 *              nasx          nrsx          ntsx          ncsr          ivssbf
346 *              3              1              1              3              0
347 *              idcu          idcl          idcr          icru          icrl
348 *              0              0              0              0              0
349 *              icrr          ilcsp          iucsp          iuhp          iconc
350 *              0              0              0              0              0
351 *              igeom          nvent          nvvtb
352 *              1              0              0
353 *              shelv          epsw
354 *              3.5000e+00      1.0000e-05
355 *
356 * z           *      1.0000e+00      2.0000e+00      3.0000e+00e
357 * rad         *      1.0000e+00e
358 * th          *      1.0000e+00e
359 *
360 *              gc              gytc              gxrc              gzc
361 *              9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
362 *
363 *              lisrl          lisrc          lisrf          ljuns
364 *              1              1              -2              8
365 *              1              1              -2              9
366 *              3              1              2              12
367 *
368 * level      1
369 *
370 * cfz1-t*      0.0000e+00e

```

```

371 * cfzl-z*      0.0000e+00e
372 * cfzl-r*      0.0000e+00e
373 * cfzv-t*      0.0000e+00e
374 * cfzv-z*      0.0000e+00e
375 * cfzv-r*      0.0000e+00e
376 * vol   *      1.0000e+00e
377 * fa-t   *      0.0000e+00e
378 * fa-z   *      1.0000e+00e
379 * fa-r   *      0.0000e+00e
380 * hd-t   *      0.0000e+00e
381 * hd-z   *      1.0000e+00e
382 * hd-r   *      0.0000e+00e
383 * alpn   *      1.0000e+00e
384 * vvn-t   *      0.0000e+00e
385 * vvn-z   *      0.0000e+00e
386 * vvn-r   *      0.0000e+00e
387 * vln-t   *      0.0000e+00e
388 * vln-z   *      0.0000e+00e
389 * vln-r   *      0.0000e+00e
390 * tvn     *      5.0000e+02e
391 * tln     *      5.0000e+02e
392 * pn      *      1.0000e+06e
393 * pan     *      0.0000e+00e
394 *
395 * level   2
396 *
397 * cfzl-t*      0.0000e+00e
398 * cfzl-z*      0.0000e+00e
399 * cfzl-r*      0.0000e+00e
400 * cfzv-t*      0.0000e+00e
401 * cfzv-z*      0.0000e+00e
402 * cfzv-r*      0.0000e+00e
403 * vol   *      1.0000e+00e
404 * fa-t   *      0.0000e+00e
405 * fa-z   *      1.0000e+00e
406 * fa-r   *      0.0000e+00e
407 * hd-t   *      0.0000e+00e
408 * hd-z   *      1.0000e+00e
409 * hd-r   *      0.0000e+00e
410 * alpn   *      1.0000e+00e
411 * vvn-t   *      0.0000e+00e
412 * vvn-z   *      0.0000e+00e
413 * vvn-r   *      0.0000e+00e
414 * vln-t   *      0.0000e+00e
415 * vln-z   *      0.0000e+00e
416 * vln-r   *      0.0000e+00e
417 * tvn     *      5.0000e+02e
418 * tln     *      5.0000e+02e
419 * pn      *      1.0000e+06e
420 * pan     *      0.0000e+00e
421 *
422 * level   3
423 *
424 * cfzl-t*      0.0000e+00e
425 * cfzl-z*      0.0000e+00e
426 * cfzl-r*      0.0000e+00e
427 * cfzv-t*      0.0000e+00e
428 * cfzv-z*      0.0000e+00e
429 * cfzv-r*      0.0000e+00e
430 * vol   *      1.0000e+00e
431 * fa-t   *      0.0000e+00e
432 * fa-z   *      1.0000e+00e

```

```

433 * fa-r *      0.0000e+00e
434 * hd-t *      0.0000e+00e
435 * hd-z *      1.0000e+00e
436 * hd-r *      0.0000e+00e
437 * alpn *      1.0000e+00e
438 * vvn-t *      0.0000e+00e
439 * vvn-z *      0.0000e+00e
440 * vvn-r *      0.0000e+00e
441 * vln-t *      0.0000e+00e
442 * vln-z *      0.0000e+00e
443 * vln-r *      0.0000e+00e
444 * tvn *        5.0000e+02e
445 * tln *        5.0000e+02e
446 * pn *         1.0000e+06e
447 * pan *        0.0000e+00e
448 *
449 *****      type          num          id          ctitle
450 vessel          9          9 second vessel component
451 *          nasx          nr sx          ntsx          ncsr          ivssbf
452          3          1          1          3          0
453 *          idcu          idcl          idcr          icru          icrl
454          0          0          0          0          0
455 *          icrr          ilcsp          iucsp          iuhp          iconc
456          0          0          0          0          0
457 *          igeom          nvent          nvvtb
458          1          0          0
459 *          shelv          epsw
460          3.5000e+00      1.0000e-05
461 *
462 * z *          1.0000e+00      2.0000e+00      3.0000e+00e
463 * rad *          1.0000e+00e
464 * th *          1.0000e+00e
465 *
466 *          gc          gytc          gxrc          gzc
467          9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
468 *
469 *          lisrl          lisrc          lisrf          ljuns
470          1          1          -2          10
471          1          1          -2          11
472          3          1          2          13
473 *
474 * level 1
475 *
476 * cfzl-t*      0.0000e+00e
477 * cfzl-z*      0.0000e+00e
478 * cfzl-r*      0.0000e+00e
479 * cfzv-t*      0.0000e+00e
480 * cfzv-z*      0.0000e+00e
481 * cfzv-r*      0.0000e+00e
482 * vol *        1.0000e+00e
483 * fa-t *        0.0000e+00e
484 * fa-z *        1.0000e+00e
485 * fa-r *        0.0000e+00e
486 * hd-t *        0.0000e+00e
487 * hd-z *        1.0000e+00e
488 * hd-r *        0.0000e+00e
489 * alpn *        1.0000e+00e
490 * vvn-t *        0.0000e+00e
491 * vvn-z *        0.0000e+00e
492 * vvn-r *        0.0000e+00e
493 * vln-t *        0.0000e+00e
494 * vln-z *        0.0000e+00e

```



```

495 * vln-r *      0.0000e+00e
496 * tvn   *      5.0000e+02e
497 * tln   *      5.0000e+02e
498 * pn    *      1.0000e+06e
499 * pan   *      0.0000e+00e
500 *
501 * level   2
502 *
503 * cfzl-t*      0.0000e+00e
504 * cfzl-z*      0.0000e+00e
505 * cfzl-r*      0.0000e+00e
506 * cfzv-t*      0.0000e+00e
507 * cfzv-z*      0.0000e+00e
508 * cfzv-r*      0.0000e+00e
509 * vol    *      1.0000e+00e
510 * fa-t   *      0.0000e+00e
511 * fa-z   *      1.0000e+00e
512 * fa-r   *      0.0000e+00e
513 * hd-t   *      0.0000e+00e
514 * hd-z   *      1.0000e+00e
515 * hd-r   *      0.0000e+00e
516 * alpn   *      1.0000e+00e
517 * vvn-t   *      0.0000e+00e
518 * vvn-z   *      0.0000e+00e
519 * vvn-r   *      0.0000e+00e
520 * vln-t   *      0.0000e+00e
521 * vln-z   *      0.0000e+00e
522 * vln-r   *      0.0000e+00e
523 * tvn    *      5.0000e+02e
524 * tln    *      5.0000e+02e
525 * pn     *      1.0000e+06e
526 * pan    *      0.0000e+00e
527 *
528 * level   3
529 *
530 * cfzl-t*      0.0000e+00e
531 * cfzl-z*      0.0000e+00e
532 * cfzl-r*      0.0000e+00e
533 * cfzv-t*      0.0000e+00e
534 * cfzv-z*      0.0000e+00e
535 * cfzv-r*      0.0000e+00e
536 * vol    *      1.0000e+00e
537 * fa-t   *      0.0000e+00e
538 * fa-z   *      1.0000e+00e
539 * fa-r   *      0.0000e+00e
540 * hd-t   *      0.0000e+00e
541 * hd-z   *      1.0000e+00e
542 * hd-r   *      0.0000e+00e
543 * alpn   *      1.0000e+00e
544 * vvn-t   *      0.0000e+00e
545 * vvn-z   *      0.0000e+00e
546 * vvn-r   *      0.0000e+00e
547 * vln-t   *      0.0000e+00e
548 * vln-z   *      0.0000e+00e
549 * vln-r   *      0.0000e+00e
550 * tvn    *      5.0000e+02e
551 * tln    *      5.0000e+02e
552 * pn     *      1.0000e+06e
553 * pan    *      0.0000e+00e
554 *
555 *****      type          num          id          ctitle
556 pipe                10          10 outlet pipe for vessel 8

```

```

557 *          ncells          nodes          jun1          jun2          epsw
558          1              0              12              14      1.0000e-05
559 *          ichf          iconc          iacc          ipow
560          0              0              0              0
561 *          radin          th          hout1          houtv          tout1
562      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
563 *          toutv
564      5.0000e+02
565 *
566 * dx      * f      1.0000e+00e
567 * vol      * f      1.0000e+00e
568 * fa      *      1.0000e+00      5.0000e-01e
569 * fric      * f      0.0000e+00e
570 * grav      * f      1.0000e+00e
571 * hd      * f      1.0000e+00e
572 * nff      *      1          -1e
573 * alp      * f      1.0000e+00e
574 * vl      * f      0.0000e+00e
575 * vv      * f      0.0000e+00e
576 * tl      * f      5.0000e+02e
577 * tv      * f      5.0000e+02e
578 * p      * f      1.0000e+06e
579 * pa      * f      0.0000e+00e
580 *
581 * type          num          id          ctitle
582 pipe          11          11 outlet pipe for vessel 9
583 *          ncells          nodes          jun1          jun2          epsw
584          1              0              13              15      1.0000e-05
585 *          ichf          iconc          iacc          ipow
586          0              0              0              0
587 *          radin          th          hout1          houtv          tout1
588      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
589 *          toutv
590      5.0000e+02
591 *
592 * dx      * f      1.0000e+00e
593 * vol      * f      1.0000e+00e
594 * fa      *      1.0000e+00      5.0000e-01e
595 * fric      * f      0.0000e+00e
596 * grav      * f      1.0000e+00e
597 * hd      * f      1.0000e+00e
598 * nff      *      1          -1e
599 * alp      * f      1.0000e+00e
600 * vl      * f      0.0000e+00e
601 * vv      * f      0.0000e+00e
602 * tl      * f      5.0000e+02e
603 * tv      * f      5.0000e+02e
604 * p      * f      1.0000e+06e
605 * pa      * f      0.0000e+00e
606 *
607 * type          num          id          ctitle
608 vessel          12          12 third vessel component
609 *          nasx          nrsx          ntsx          ncsr          ivssbf
610          3              1              1              3              0
611 *          idcu          idcl          idcr          icru          icrl
612          0              0              0              0              0
613 *          icrr          ilcsp          iucsp          iuhp          iconc
614          0              0              0              0              0
615 *          igeom          nvent          nvvtb
616          1              0              0
617 *          shelv          epsw
618      7.5000e+00      1.0000e-05

```

```

619 *
620 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
621 * rad    *      1.0000e+00e
622 * th     *      1.0000e+00e
623 *
624 *          gc          gytc          gxrc          gzc
625      9.8066e+00      0.0000e+00      0.0000e+00      -1.0000e+00
626 *
627 *          lisrl          lisrc          lisrf          ljuns
628      1              1              -2              14
629      1              1              -2              15
630      3              1              2              16
631 *
632 * level   1
633 *
634 * cfzl-t*      0.0000e+00e
635 * cfzl-z*      0.0000e+00e
636 * cfzl-r*      0.0000e+00e
637 * cfzv-t*      0.0000e+00e
638 * cfzv-z*      0.0000e+00e
639 * cfzv-r*      0.0000e+00e
640 * vol   *      1.0000e+00e
641 * fa-t   *      0.0000e+00e
642 * fa-z   *      1.0000e+00e
643 * fa-r   *      0.0000e+00e
644 * hd-t   *      0.0000e+00e
645 * hd-z   *      1.0000e+00e
646 * hd-r   *      0.0000e+00e
647 * alpn   *      1.0000e+00e
648 * vvn-t   *      0.0000e+00e
649 * vvn-z   *      0.0000e+00e
650 * vvn-r   *      0.0000e+00e
651 * vln-t   *      0.0000e+00e
652 * vln-z   *      0.0000e+00e
653 * vln-r   *      0.0000e+00e
654 * tvn     *      5.0000e+02e
655 * tln     *      5.0000e+02e
656 * pn      *      1.0000e+06e
657 * pan     *      0.0000e+00e
658 *
659 * level   2
660 *
661 * cfzl-t*      0.0000e+00e
662 * cfzl-z*      0.0000e+00e
663 * cfzl-r*      0.0000e+00e
664 * cfzv-t*      0.0000e+00e
665 * cfzv-z*      0.0000e+00e
666 * cfzv-r*      0.0000e+00e
667 * vol   *      1.0000e+00e
668 * fa-t   *      0.0000e+00e
669 * fa-z   *      1.0000e+00e
670 * fa-r   *      0.0000e+00e
671 * hd-t   *      0.0000e+00e
672 * hd-z   *      1.0000e+00e
673 * hd-r   *      0.0000e+00e
674 * alpn   *      1.0000e+00e
675 * vvn-t   *      0.0000e+00e
676 * vvn-z   *      0.0000e+00e
677 * vvn-r   *      0.0000e+00e
678 * vln-t   *      0.0000e+00e
679 * vln-z   *      0.0000e+00e
680 * vln-r   *      0.0000e+00e

```

```

681 * tvn      *      5.0000e+02e
682 * tln      *      5.0000e+02e
683 * pn       *      1.0000e+06e
684 * pan      *      0.0000e+00e
685 *
686 * level    3
687 *
688 * cfzl-t*    0.0000e+00e
689 * cfzl-z*    0.0000e+00e
690 * cfzl-r*    0.0000e+00e
691 * cfzv-t*    0.0000e+00e
692 * cfzv-z*    0.0000e+00e
693 * cfzv-r*    0.0000e+00e
694 * vol       *      1.0000e+00e
695 * fa-t      *      0.0000e+00e
696 * fa-z      *      1.0000e+00e
697 * fa-r      *      0.0000e+00e
698 * hd-t      *      0.0000e+00e
699 * hd-z      *      1.0000e+00e
700 * hd-r      *      0.0000e+00e
701 * alpn      *      1.0000e+00e
702 * vvn-t     *      0.0000e+00e
703 * vvn-z     *      0.0000e+00e
704 * vvn-r     *      0.0000e+00e
705 * vln-t     *      0.0000e+00e
706 * vln-z     *      0.0000e+00e
707 * vln-r     *      0.0000e+00e
708 * tvn       *      5.0000e+02e
709 * tln       *      5.0000e+02e
710 * pn        *      1.0000e+06e
711 * pan       *      0.0000e+00e
712 *

```

```

713 *****      type          num          id          ctitle
714 pipe                      13          13 outlet pipe for vessel 12
715 *          ncells          nodes          jun1          jun2          epsw
716 *              1              0              16              17          1.0000e-05
717 *          ichf          iconc          iacc          ipow
718 *              0              0              0              0
719 *          radin          th          houtl          houtv          toutl
720 *      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
721 *          toutv
722 *      5.0000e+02
723 *

```

```

724 * dx      * f      1.0000e+00e
725 * vol     * f      1.0000e+00e
726 * fa      * f      1.0000e+00e
727 * fric    * f      0.0000e+00e
728 * grav    * f      1.0000e+00e
729 * hd      * f      1.0000e+00e
730 * nff     * f              1e
731 * alp     * f      1.0000e+00e
732 * vl      * f      0.0000e+00e
733 * vv      * f      0.0000e+00e
734 * tl      * f      5.0000e+02e
735 * tv      * f      5.0000e+02e
736 * p       * f      1.0000e+06e
737 * pa      * f      0.0000e+00e
738 *

```

```

739 *****      type          num          id          ctitle
740 pipe                      14          14 inlet pipe for vessel 15
741 *          ncells          nodes          jun1          jun2          epsw
742 *              1              0              18              17          1.0000e-05

```

```

743 *      ichf      iconc      iacc      ipow
744 *      0          0          0          0
745 *      radin      th      houtl      houtv      toutl
746 *      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
747 *      toutv
748 *      5.0000e+02
749 *
750 * dx      * f      1.0000e+00e
751 * vol      * f      1.0000e+00e
752 * fa      * f      1.0000e+00e
753 * fric      * f      0.0000e+00e
754 * grav      * f      -1.0000e+00e
755 * hd      * f      1.0000e+00e
756 * nff      * f      1e
757 * alp      * f      1.0000e+00e
758 * vl      * f      0.0000e+00e
759 * vv      * f      0.0000e+00e
760 * tl      * f      5.0000e+02e
761 * tv      * f      5.0000e+02e
762 * p      * f      1.0000e+06e
763 * pa      * f      0.0000e+00e
764 *
765 * *****      type      num      id      ctitle
766 * vessel      15      15 fourth vessel component
767 *      nasx      nrxx      ntsx      ncsr      ivssbf
768 *      3      1      1      3      0
769 *      idcu      idcl      idcr      icru      icrl
770 *      0      0      0      0      0
771 *      icrr      ilcsp      iucsp      iuhp      iconc
772 *      0      0      0      0      0
773 *      igeom      nvent      nvvtb
774 *      1      0      0
775 *      shelv      epsw
776 *      1.5500e+01      1.0000e-05
777 *
778 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
779 * rad      *      1.0000e+00e
780 * th      *      1.0000e+00e
781 *
782 *      gc      gytc      gxrc      gzc
783 *      9.8066e+00      0.0000e+00      0.0000e+00      1.0000e+00
784 *
785 *      lisrl      lisrc      lisrf      ljuns
786 *      1      1      -2      19
787 *      1      1      -2      20
788 *      3      1      2      18
789 *
790 * level      1
791 *
792 * cfzl-t*      0.0000e+00e
793 * cfzl-z*      0.0000e+00e
794 * cfzl-r*      0.0000e+00e
795 * cfzv-t*      0.0000e+00e
796 * cfzv-z*      0.0000e+00e
797 * cfzv-r*      0.0000e+00e
798 * vol      *      1.0000e+00e
799 * fa-t      *      0.0000e+00e
800 * fa-z      *      1.0000e+00e
801 * fa-r      *      0.0000e+00e
802 * hd-t      *      0.0000e+00e
803 * hd-z      *      1.0000e+00e
804 * hd-r      *      0.0000e+00e

```

805	*	alpn	*	1.0000e+00e
806	*	vvv-t	*	0.0000e+00e
807	*	vvv-z	*	0.0000e+00e
808	*	vvv-r	*	0.0000e+00e
809	*	vln-t	*	0.0000e+00e
810	*	vln-z	*	0.0000e+00e
811	*	vln-r	*	0.0000e+00e
812	*	tvn	*	5.0000e+02e
813	*	tln	*	5.0000e+02e
814	*	pn	*	1.0000e+06e
815	*	pan	*	0.0000e+00e
816	*			
817	*	level	2	
818	*			
819	*	cfzl-t*		0.0000e+00e
820	*	cfzl-z*		0.0000e+00e
821	*	cfzl-r*		0.0000e+00e
822	*	cfzv-t*		0.0000e+00e
823	*	cfzv-z*		0.0000e+00e
824	*	cfzv-r*		0.0000e+00e
825	*	vol	*	1.0000e+00e
826	*	fa-t	*	0.0000e+00e
827	*	fa-z	*	1.0000e+00e
828	*	fa-r	*	0.0000e+00e
829	*	hd-t	*	0.0000e+00e
830	*	hd-z	*	1.0000e+00e
831	*	hd-r	*	0.0000e+00e
832	*	alpn	*	1.0000e+00e
833	*	vvv-t	*	0.0000e+00e
834	*	vvv-z	*	0.0000e+00e
835	*	vvv-r	*	0.0000e+00e
836	*	vln-t	*	0.0000e+00e
837	*	vln-z	*	0.0000e+00e
838	*	vln-r	*	0.0000e+00e
839	*	tvn	*	5.0000e+02e
840	*	tln	*	5.0000e+02e
841	*	pn	*	1.0000e+06e
842	*	pan	*	0.0000e+00e
843	*			
844	*	level	3	
845	*			
846	*	cfzl-t*		0.0000e+00e
847	*	cfzl-z*		0.0000e+00e
848	*	cfzl-r*		0.0000e+00e
849	*	cfzv-t*		0.0000e+00e
850	*	cfzv-z*		0.0000e+00e
851	*	cfzv-r*		0.0000e+00e
852	*	vol	*	1.0000e+00e
853	*	fa-t	*	0.0000e+00e
854	*	fa-z	*	1.0000e+00e
855	*	fa-r	*	0.0000e+00e
856	*	hd-t	*	0.0000e+00e
857	*	hd-z	*	1.0000e+00e
858	*	hd-r	*	0.0000e+00e
859	*	alpn	*	1.0000e+00e
860	*	vvv-t	*	0.0000e+00e
861	*	vvv-z	*	0.0000e+00e
862	*	vvv-r	*	0.0000e+00e
863	*	vln-t	*	0.0000e+00e
864	*	vln-z	*	0.0000e+00e
865	*	vln-r	*	0.0000e+00e
866	*	tvn	*	5.0000e+02e

```

867 * tln * 5.0000e+02e
868 * pn * 1.0000e+06e
869 * pan * 0.0000e+00e
870 *
871 ***** type num id ctitle
872 pipe 16 16 inlet pipe for vessel 18
873 * ncells nodes jun1 jun2 epsw
874 * 1 0 21 19 1.0000e-05
875 * ichf iconc iacc ipow
876 * 0 0 0 0
877 * radin th hout1 houtv tout1
878 * 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
879 * toutv
880 * 5.0000e+02
881 *
882 * dx * f 1.0000e+00e
883 * vol * f 1.0000e+00e
884 * fa * 1.0000e+00 5.0000e-01e
885 * fric * f 0.0000e+00e
886 * grav * f -1.0000e+00e
887 * hd * f 1.0000e+00e
888 * nff * 1 -1e
889 * alp * f 1.0000e+00e
890 * vl * f 0.0000e+00e
891 * vv * f 0.0000e+00e
892 * tl * f 5.0000e+02e
893 * tv * f 5.0000e+02e
894 * p * f 1.0000e+06e
895 * pa * f 0.0000e+00e
896 *
897 ***** type num id ctitle
898 pipe 17 17 inlet pipe for vessel 19
899 * ncells nodes jun1 jun2 epsw
900 * 1 0 22 20 1.0000e-05
901 * ichf iconc iacc ipow
902 * 0 0 0 0
903 * radin th hout1 houtv tout1
904 * 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
905 * toutv
906 * 5.0000e+02
907 *
908 * dx * f 1.0000e+00e
909 * vol * f 1.0000e+00e
910 * fa * 1.0000e+00 5.0000e-01e
911 * fric * f 0.0000e+00e
912 * grav * f -1.0000e+00e
913 * hd * f 1.0000e+00e
914 * nff * 1 -1e
915 * alp * f 1.0000e+00e
916 * vl * f 0.0000e+00e
917 * vv * f 0.0000e+00e
918 * tl * f 5.0000e+02e
919 * tv * f 5.0000e+02e
920 * p * f 1.0000e+06e
921 * pa * f 0.0000e+00e
922 *
923 ***** type num id ctitle
924 vessel 18 18 fifth vessel component
925 * nasx nrsx ntsx ncsr ivssbf
926 * 3 1 1 3 0
927 * idcu idcl idcr icru icrl
928 * 0 0 0 0 0

```

929 *	icrr	ilcsp	iucsp	iuhp	iconc
930	0	0	0	0	0
931 *	igeom	nvent	nvvtb		
932	1	0	0		
933 *	shelv	epsw			
934	1.9500e+01	1.0000e-05			
935 *					
936 * z *	1.0000e+00	2.0000e+00	3.0000e+00e		
937 * rad *	1.0000e+00e				
938 * th *	1.0000e+00e				
939 *					
940 *	gc	gytc	gxrc	gzc	
941	9.8066e+00	0.0000e+00	0.0000e+00	1.0000e+00	
942 *					
943 *	lisrl	lisrc	lisrf	ljuns	
944	1	1	-2	23	
945	1	1	-2	24	
946	3	1	2	21	
947 *					
948 * level	1				
949 *					
950 * cfzl-t*	0.0000e+00e				
951 * cfzl-z*	0.0000e+00e				
952 * cfzl-r*	0.0000e+00e				
953 * cfzv-t*	0.0000e+00e				
954 * cfzv-z*	0.0000e+00e				
955 * cfzv-r*	0.0000e+00e				
956 * vol *	1.0000e+00e				
957 * fa-t *	0.0000e+00e				
958 * fa-z *	1.0000e+00e				
959 * fa-r *	0.0000e+00e				
960 * hd-t *	0.0000e+00e				
961 * hd-z *	1.0000e+00e				
962 * hd-r *	0.0000e+00e				
963 * alpn *	1.0000e+00e				
964 * vvn-t *	0.0000e+00e				
965 * vvn-z *	0.0000e+00e				
966 * vvn-r *	0.0000e+00e				
967 * vln-t *	0.0000e+00e				
968 * vln-z *	0.0000e+00e				
969 * vln-r *	0.0000e+00e				
970 * tvn *	5.0000e+02e				
971 * tln *	5.0000e+02e				
972 * pn *	1.0000e+06e				
973 * pan *	0.0000e+00e				
974 *					
975 * level	2				
976 *					
977 * cfzl-t*	0.0000e+00e				
978 * cfzl-z*	0.0000e+00e				
979 * cfzl-r*	0.0000e+00e				
980 * cfzv-t*	0.0000e+00e				
981 * cfzv-z*	0.0000e+00e				
982 * cfzv-r*	0.0000e+00e				
983 * vol *	1.0000e+00e				
984 * fa-t *	0.0000e+00e				
985 * fa-z *	1.0000e+00e				
986 * fa-r *	0.0000e+00e				
987 * hd-t *	0.0000e+00e				
988 * hd-z *	1.0000e+00e				
989 * hd-r *	0.0000e+00e				
990 * alpn *	1.0000e+00e				


```

991 * vvn-t *      0.0000e+00e
992 * vvn-z *      0.0000e+00e
993 * vvn-r *      0.0000e+00e
994 * vln-t *      0.0000e+00e
995 * vln-z *      0.0000e+00e
996 * vln-r *      0.0000e+00e
997 * tvn  *      5.0000e+02e
998 * tln  *      5.0000e+02e
999 * pn   *      1.0000e+06e
1000 * pan  *      0.0000e+00e
1001 *
1002 * level  3
1003 *
1004 * cfzl-t*      0.0000e+00e
1005 * cfzl-z*      0.0000e+00e
1006 * cfzl-r*      0.0000e+00e
1007 * cfzv-t*      0.0000e+00e
1008 * cfzv-z*      0.0000e+00e
1009 * cfzv-r*      0.0000e+00e
1010 * vol   *      1.0000e+00e
1011 * fa-t  *      0.0000e+00e
1012 * fa-z  *      1.0000e+00e
1013 * fa-r  *      0.0000e+00e
1014 * hd-t  *      0.0000e+00e
1015 * hd-z  *      1.0000e+00e
1016 * hd-r  *      0.0000e+00e
1017 * alpn  *      1.0000e+00e
1018 * vvn-t *      0.0000e+00e
1019 * vvn-z *      0.0000e+00e
1020 * vvn-r *      0.0000e+00e
1021 * vln-t *      0.0000e+00e
1022 * vln-z *      0.0000e+00e
1023 * vln-r *      0.0000e+00e
1024 * tvn   *      5.0000e+02e
1025 * tln   *      5.0000e+02e
1026 * pn    *      1.0000e+06e
1027 * pan   *      0.0000e+00e
1028 *

```

```

1029 *****      type              num              id              ctitle
1030 vessel              19              19 sixth vessel component
1031 *              nasx              nrsx              ntsx              ncsr              ivssbf
1032              3              1              1              3              0
1033 *              idcu              idcl              idcr              icru              icrl
1034              0              0              0              0              0
1035 *              icrr              ilcsp              iucsp              iuhp              iconc
1036              0              0              0              0              0
1037 *              igeom              nvent              nvvtb
1038              1              0              0
1039 *              shelv              epsw
1040              1.9500e+01      1.0000e-05
1041 *
1042 * z      *      1.0000e+00      2.0000e+00      3.0000e+00e
1043 * rad   *      1.0000e+00e
1044 * th    *      1.0000e+00e
1045 *
1046 *              gc              gytc              gxrc              gzc
1047              9.8066e+00      0.0000e+00      0.0000e+00      1.0000e+00
1048 *
1049 *              lisrl              lisrc              lisrf              ljuns
1050              1              1              -2              25
1051              1              1              -2              26
1052              3              1              2              22

```

```

1053 *
1054 * level 1
1055 *
1056 * cfzl-t* 0.0000e+00e
1057 * cfzl-z* 0.0000e+00e
1058 * cfzl-r* 0.0000e+00e
1059 * cfzv-t* 0.0000e+00e
1060 * cfzv-z* 0.0000e+00e
1061 * cfzv-r* 0.0000e+00e
1062 * vol * 1.0000e+00e
1063 * fa-t * 0.0000e+00e
1064 * fa-z * 1.0000e+00e
1065 * fa-r * 0.0000e+00e
1066 * hd-t * 0.0000e+00e
1067 * hd-z * 1.0000e+00e
1068 * hd-r * 0.0000e+00e
1069 * alpn * 1.0000e+00e
1070 * vvn-t * 0.0000e+00e
1071 * vvn-z * 0.0000e+00e
1072 * vvn-r * 0.0000e+00e
1073 * vln-t * 0.0000e+00e
1074 * vln-z * 0.0000e+00e
1075 * vln-r * 0.0000e+00e
1076 * tvn * 5.0000e+02e
1077 * tln * 5.0000e+02e
1078 * pn * 1.0000e+06e
1079 * pan * 0.0000e+00e
1080 *
1081 * level 2
1082 *
1083 * cfzl-t* 0.0000e+00e
1084 * cfzl-z* 0.0000e+00e
1085 * cfzl-r* 0.0000e+00e
1086 * cfzv-t* 0.0000e+00e
1087 * cfzv-z* 0.0000e+00e
1088 * cfzv-r* 0.0000e+00e
1089 * vol * 1.0000e+00e
1090 * fa-t * 0.0000e+00e
1091 * fa-z * 1.0000e+00e
1092 * fa-r * 0.0000e+00e
1093 * hd-t * 0.0000e+00e
1094 * hd-z * 1.0000e+00e
1095 * hd-r * 0.0000e+00e
1096 * alpn * 1.0000e+00e
1097 * vvn-t * 0.0000e+00e
1098 * vvn-z * 0.0000e+00e
1099 * vvn-r * 0.0000e+00e
1100 * vln-t * 0.0000e+00e
1101 * vln-z * 0.0000e+00e
1102 * vln-r * 0.0000e+00e
1103 * tvn * 5.0000e+02e
1104 * tln * 5.0000e+02e
1105 * pn * 1.0000e+06e
1106 * pan * 0.0000e+00e
1107 *
1108 * level 3
1109 *
1110 * cfzl-t* 0.0000e+00e
1111 * cfzl-z* 0.0000e+00e
1112 * cfzl-r* 0.0000e+00e
1113 * cfzv-t* 0.0000e+00e
1114 * cfzv-z* 0.0000e+00e

```

```

1115 * cfzv-r*      0.0000e+00e
1116 * vol      *      1.0000e+00e
1117 * fa-t      *      0.0000e+00e
1118 * fa-z      *      1.0000e+00e
1119 * fa-r      *      0.0000e+00e
1120 * hd-t      *      0.0000e+00e
1121 * hd-z      *      1.0000e+00e
1122 * hd-r      *      0.0000e+00e
1123 * alpn      *      1.0000e+00e
1124 * vvn-t      *      0.0000e+00e
1125 * vvn-z      *      0.0000e+00e
1126 * vvn-r      *      0.0000e+00e
1127 * vln-t      *      0.0000e+00e
1128 * vln-z      *      0.0000e+00e
1129 * vln-r      *      0.0000e+00e
1130 * tvn      *      5.0000e+02e
1131 * tln      *      5.0000e+02e
1132 * pn      *      1.0000e+06e
1133 * pan      *      0.0000e+00e
1134 *
1135 *****      type      num      id      ctitle
1136 pipe      20      20 1st outlet pipe from vessel 18
1137 *      ncells      nodes      jun1      jun2      epsw
1138      1      0      27      23      1.0000e-05
1139 *      ichf      iconc      iacc      ipow
1140      0      0      0      0
1141 *      radin      th      hout1      houtv      tout1
1142      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
1143 *      toutv
1144      5.0000e+02
1145 *
1146 * dx      * f      1.0000e+00e
1147 * vol      * f      1.0000e+00e
1148 * fa      *      1.0000e+00      5.0000e-01e
1149 * fric      * f      0.0000e+00e
1150 * grav      * f      -1.0000e+00e
1151 * hd      * f      1.0000e+00e
1152 * nff      *      1      -1e
1153 * alp      * f      1.0000e+00e
1154 * vl      * f      0.0000e+00e
1155 * vv      * f      0.0000e+00e
1156 * tl      * f      5.0000e+02e
1157 * tv      * f      5.0000e+02e
1158 * p      * f      1.0000e+06e
1159 * pa      * f      0.0000e+00e
1160 *
1161 *****      type      num      id      ctitle
1162 pipe      21      21 2nd outlet pipe from vessel 18
1163 *      ncells      nodes      jun1      jun2      epsw
1164      1      0      28      24      1.0000e-05
1165 *      ichf      iconc      iacc      ipow
1166      0      0      0      0
1167 *      radin      th      hout1      houtv      tout1
1168      5.0000e-01      5.0000e-02      0.0000e+00      0.0000e+00      5.0000e+02
1169 *      toutv
1170      5.0000e+02
1171 *
1172 * dx      * f      1.0000e+00e
1173 * vol      * f      1.0000e+00e
1174 * fa      *      1.0000e+00      5.0000e-01e
1175 * fric      * f      0.0000e+00e
1176 * grav      * f      -1.0000e+00e

```

```

1177 * hd      * f    1.0000e+00e
1178 * nff      *          1          -1e
1179 * alp      * f    1.0000e+00e
1180 * vl       * f    0.0000e+00e
1181 * vv       * f    0.0000e+00e
1182 * tl       * f    5.0000e+02e
1183 * tv       * f    5.0000e+02e
1184 * p        * f    1.0000e+06e
1185 * pa       * f    0.0000e+00e
1186 *
1187 *****      type          num          id          ctitle
1188 pipe          22          22 1st outlet pipe from vessel 19
1189 *          ncells          nodes          jun1          jun2          epsw
1190          1          0          29          25          1.0000e-05
1191 *          ichf          iconc          iacc          ipow
1192          0          0          0          0
1193 *          radin          th          houtl          houtv          toutl
1194          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
1195 *          toutv
1196          5.0000e+02
1197 *
1198 * dx      * f    1.0000e+00e
1199 * vol     * f    1.0000e+00e
1200 * fa      *          1.0000e+00          5.0000e-01e
1201 * fric   * f    0.0000e+00e
1202 * grav   * f    -1.0000e+00e
1203 * hd      * f    1.0000e+00e
1204 * nff      *          1          -1e
1205 * alp     * f    1.0000e+00e
1206 * vl      * f    0.0000e+00e
1207 * vv      * f    0.0000e+00e
1208 * tl      * f    5.0000e+02e
1209 * tv      * f    5.0000e+02e
1210 * p       * f    1.0000e+06e
1211 * pa      * f    0.0000e+00e
1212 *
1213 *****      type          num          id          ctitle
1214 pipe          23          23 2nd outlet pipe from vessel 19
1215 *          ncells          nodes          jun1          jun2          epsw
1216          1          0          30          26          1.0000e-05
1217 *          ichf          iconc          iacc          ipow
1218          0          0          0          0
1219 *          radin          th          houtl          houtv          toutl
1220          5.0000e-01          5.0000e-02          0.0000e+00          0.0000e+00          5.0000e+02
1221 *          toutv
1222          5.0000e+02
1223 *
1224 * dx      * f    1.0000e+00e
1225 * vol     * f    1.0000e+00e
1226 * fa      *          1.0000e+00          5.0000e-01e
1227 * fric   * f    0.0000e+00e
1228 * grav   * f    -1.0000e+00e
1229 * hd      * f    1.0000e+00e
1230 * nff      *          1          -1e
1231 * alp     * f    1.0000e+00e
1232 * vl      * f    0.0000e+00e
1233 * vv      * f    0.0000e+00e
1234 * tl      * f    5.0000e+02e
1235 * tv      * f    5.0000e+02e
1236 * p       * f    1.0000e+06e
1237 * pa      * f    0.0000e+00e
1238 *

```

```

1239 ***** type num id ctitle
1240 plenum 24 24 manifold plenum 24
1241 * npljn iconc juns1 juns2
1242 5 0 1 4
1243 *
1244 * junj * 31s
1245 * junj * 27 28 29 30e
1246 * dx * f 1.0000e+00e
1247 * vol * f 4.0000e+00e
1248 * elev * f 2.1000e+01e
1249 * alp * f 1.0000e+00e
1250 * tl * f 5.0000e+02e
1251 * tv * f 5.0000e+02e
1252 * p * f 1.0000e+06e
1253 * pa * f 0.0000e+00e
1254 *
1255 ***** type num id ctitle
1256 pipe 25 25 outlet pipe from plenum 24
1257 * ncells nodes jun1 jun2 epsw
1258 1 0 32 31 1.0000e-05
1259 * ichf iconc iacc ipow
1260 0 0 0 0
1261 * radin th houtl houtv toutl
1262 5.0000e-01 5.0000e-02 0.0000e+00 0.0000e+00 5.0000e+02
1263 * toutv
1264 5.0000e+02
1265 *
1266 * dx * f 1.0000e+00e
1267 * vol * f 1.0000e+00e
1268 * fa * f 1.0000e+00e
1269 * fric * f 0.0000e+00e
1270 * grav * f -1.0000e+00e
1271 * hd * f 1.0000e+00e
1272 * nff * 1 -1e
1273 * alp * f 1.0000e+00e
1274 * vl * f 0.0000e+00e
1275 * vv * f 0.0000e+00e
1276 * tl * f 5.0000e+02e
1277 * tv * f 5.0000e+02e
1278 * p * f 1.0000e+06e
1279 * pa * f 0.0000e+00e
1280 *
1281 ***** type num id ctitle
1282 break 26 26 pressure b.c. for pipe 25 outlet
1283 * jun1 ibty isat ioff
1284 32 0 0 0
1285 * dxin volin alpin tin pin
1286 1.0000e+00 1.0000e+00 1.0000e+00 5.0000e+02 1.0000e+06
1287 * pain concin rbmx poff belv
1288 0.0000e+00 0.0000e+00 0.0000e+00 0.0000e+00 2.3000e+01
1289 *
1290 end
1291 *
1292 *****
1293 * time-step data *
1294 *****
1295 *
1296 * dtmin dtmax tend rtwfp
1297 1.0000e-03 1.0000e+00 1.0000e+01 1.0000e+00
1298 * edint gfint dmpint sedint
1299 1.0000e+01 1.0000e+00 1.1000e+01 1.0000e+01
1300 *

```

1301 *	dtmin	dtmax	tend	rtwfp
1302	1.0000e-03	5.0000e+00	1.0000e+02	1.0000e+00
1303 *	edint	gfint	dmpint	sedint
1304	9.0000e+01	2.5000e+00	9.5000e+01	9.0000e+01
1305 *				
1306 *	dtmin	dtmax	tend	rtwfp
1307	1.0000e-02	3.0000e+01	1.0000e+03	1.0000e+00
1308 *	edint	gfint	dmpint	sedint
1309	9.0000e+02	1.5000e+01	9.3000e+02	9.0000e+02
1310 *				
1311 *	dtmin	dtmax	tend	rtwfp
1312	1.0000e-01	2.0000e+02	1.0000e+04	1.0000e+00
1313 *	edint	gfint	dmpint	sedint
1314	9.0000e+03	2.0000e+02	9.0000e+03	9.0000e+03
1315 *				
1316 *	endflag			
1317	-1.0000e+00			

A-5 ROD2 Test Problem

```

1 free format
2 *
3 *****
4 * main data *
5 *****
6 *
7 *          numtcr          ieos          inopt          nmat          id2o
8 *          11              0              1              0              0
9 *--*TEST PROBLEM ROD2 , Time = 0.3 s
10 transient-calculation heat-structure test problem
11 heat structure in cylindrical geometry
12 heat structure has one average and one supplemental rod
13 constant power in 6136 rod fuel elements with zr clad
14 heat transfer through rod between two pipe coolant channels
15 superheated vapor contacting rod inner surface
16 subcooled liquid contacting rod outer surface
17 there is no coolant mass flow across pipe mesh-cell interfaces
18 fill and break boundary conditions at pipe ends
19 boron is dissolved in the coolant
20 *
21 *          #####          #####
22 *          p = 2.7 mpa      # break#      # break#      p = 2.7 mpa
23 *          tv = 600.0 k     #  4  #        #  6  #        t1 = 500.0 k
24 *          alpha = 1.0     #####          #####          alpha = 0.0
25 *                          4              6
26 *          tw = 400.0 k     #####-----#####
27 *          tv = 600.0 k     # cell #---+      +---# cell #      t1 = 500.0 k
28 *          alpha = 1.0     #  4  #---+      +---#  4  #        alpha = 0.0
29 *          tw = 400.0 k     #-----#-----#-----#
30 *          # cell #---+      +---# cell #
31 *          tv = 580.0 k     #  3  #---+      +---#  3  #        t1 = 460.0 k
32 *          alpha = 1.0     #  #---+      +---#  #        alpha = 0.0
33 *          tw = 500.0 k     #-pipe-#-----#-pipe-#
34 *          #  1  #---+      +---#  2  #
35 *          tv = 520.0 k     # cell #---+ rod +---# cell #      t1 = 440.0 k
36 *          alpha = 1.0     #  2  #---+  7 +---#  2  #        alpha = 0.0
37 *          #  #---+      +---#  #
38 *          tw = 300.0 k     #-----#-----#-----#
39 *          tv = 550.0 k     # cell #---+      +---# cell #      t1 = 380.0 k
40 *          alpha = 1.0     #  1  #---+      +---#  1  #        alpha = 0.0
41 *          tw = 400.0 k     #####-----#####
42 *          vv = 0.0 m/s     3              5          vl = 0.0 m/s
43 *          #####          #####
44 *          tv = 550.0 k     # fill #          # fill #        t1 = 380.0 k
45 *          alpha = 1.0     #  3  #          #  5  #        alpha = 0.0
46 *          #####          #####
47 *
48 *****
49 * namelist data *
50 *****
51 *
52 &inopts
53 iadded=2, nhtstr=1, nsend=20, idiag=4,
54 nsdl=0, nsdu=5, nspl=0, nspu=5, cpuflg=1
55 &end
56 *
57 *          dstep          timet
58 *          0              0.0000e+00
59 *          stdyst          transi          ncomp          njun          ipak
60 *          0              1              7              4              1

```

```

61 *          epso          epss
62      1.0000e-03      0.0000e+00
63 *          oitmax      sitmax      isolut      ncontr      nccfl
64          10          10          1          0          0
65 *          ntsv      ntc b      ntc f      ntrp      ntcp
66          1          0          0          1          0
67 *
68 *****
69 * component-number data *
70 *****
71 *
72 * iorder*          1          2          3          4          5
73 * iorder*          6          7e
74 *
75 *****
76 * control-parameter data *
77 *****
78 *
79 *
80 * signal variables
81 *          idsv      isvn      ilcn      icn1      icn2
82          1          0          0          0          0
83 *
84 * trips
85 *          ntse      ntct      ntsf      ntdp      ntsd
86          0          0          0          0          0
87 *          idtp      isrt      iset      itst      idsg
88          -2          2          0          1          1
89 *          setp(1)      setp(2)
90      0.0000e+00      1.0000e-01
91 *          dtsp(1)      dtsp(2)
92      0.0000e+00      0.0000e+00
93 *          ifsp(1)      ifsp(2)
94          0          0
95 *
96 *****
97 * component data *
98 *****
99 *
100 *****      type          num          id          ctitle
101 pipe          1          1 superheated-steam channel
102 *          ncells      nodes      jun1      jun2      epsw
103          4          0          3          4      0.0000e+00
104 *          ichf      iconc      iacc      ipow
105          1          1          0          0
106 *          radin      th      hout1      houtv      tout1
107      2.0000e+00      1.0000e-01      0.0000e+00      0.0000e+00      3.0000e+02
108 *          toutv
109      3.0000e+02
110 *
111 * dx      *      4.6000e-01      9.3000e-01      7.3000e-01      4.9000e-01e
112 * vol      * f      1.0000e+01e
113 * fa      *      1.0000e-05r04 0.0000e+00e
114 * fric      * f      0.0000e+00e
115 * grav      * f      1.0000e+00e
116 * hd      * f      1.3400e-02e
117 * nff      * f      1e
118 * alp      * f      1.0000e+00e
119 * vl      * f      0.0000e+00e
120 * vv      * f      0.0000e+00e
121 * tl      * f      5.0000e+02e
122 * tv      *      5.5000e+02      5.2000e+02      5.8000e+02      6.0000e+02e

```