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**PRESBC: Pressure Boundary
Conditions for the K-FIX Code**

University of California

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PRESBC: PRESSURE BOUNDARY CONDITIONS FOR THE K-FIX CODE

by

J. R. Travis and W. C. Rivard

ABSTRACT

Recommended pressure boundary condition modifications are described for the computer code K-FIX, which has been published in the report LA-NUREG-6623 and released to the National Energy Software Center in April 1977.

I. INTRODUCTION

In many instances, the experimental investigation of questions relating to nuclear reactor safety involve the measurement of pressure histories in conjunction with other quantities to describe the fluid state in a reactor system or a particular reactor component. For example, in the Semiscale MOD-1 apparatus used for blowdown heat transfer tests,¹ measurements of pressure, temperature, and mixture density were made upstream of a nozzle test section. Downstream of the nozzle, the flow expanded freely into a containment building, which was held at a pressure of approximately 0.1 MPa (1 bar). In analyzing these critical flow experiments, it was necessary to modify the computer codes² to permit the boundary data to be specified through the measured quantities. This provided the most accurate and direct description of the physical system.

This report describes the modifications that were made to the transient, two-dimensional, two-fluid computer code K-FIX.³ The purpose of each modification is discussed in Sec. II.

Section III lists the modifications in the notation of the CDC-7600 UPDATE system. In that notation *D,KFIXCC.A,B indicates that the statements KFIXCC A through KFIXCC B should be deleted. Statements immediately following this command (if any) should be inserted at location KFIXCC B. Similarly, *I,KFIXCC.A and *B,KFIXCC.D indicates that the statements following these commands should be

inserted after statement KFIXCC A and before statement KFIXCC D, respectively. The KFIXCC identifiers refer to those in App. B of Ref. 3.

II. DESCRIPTION OF MODIFICATIONS

The modifications listed below affect the K-FIX main program and the sub-routines BDRY, BETAS, FLIC, INDEX SETUP, SETXTRA, and TILDE. A labeled COMMON data storage block has been added to all routines in the code to accommodate additional input data.

A. Input Data

The input data has been modified slightly to simplify specification of the new boundary conditions. Card No. 8 has been replaced by 4 new input cards:

Card No. 8a: (KFLIN(M), M = 1,4) (Format 4I12)

KFLIN(M) = 5, a specified influx opening
 = 6, a specified pressure opening

These are the flags that define the type of flow openings along the computing mesh bottom and left boundaries, respectively. A maximum of two openings may be specified along each boundary. KFLIN(1)-KFLIN(2) define the bottom boundary left and right openings, respectively, while KFLIN(3)-KFLIN(4) define the left boundary bottom and top openings, respectively.

Card No. 8b: (FLO(M), M = 1,8) (Format 4F12.4)

FLO(M) = the coordinates of the flow openings along the computing mesh bottom and left boundaries, respectively. See Card No. 8 in Ref. 3 for a detailed explanation.

Card No. 8c: (KFLOUT(M), M = 1,4) (Format 4I12)

KFLOUT(M) = 4, a gradient-free outflow opening
 = 6, a specified pressure opening

These are the flags that define the type of flow openings along the computing mesh top and right boundaries, respectively. A maximum of two openings may be specified along each boundary. KFLOUT(1)-KFLOUT(2) define the top boundary left and right openings, respectively, while KFLOUT(3)-KFLOUT(4) define the right boundary bottom and top openings, respectively.

Card No. 8d: (FLO(M), M = 9,16) (Format 4F12.4)

FLO(M) = the coordinates of the flow openings along the computing mesh top and right boundaries, respectively. See Card No. 8 in Ref. 3 for a detailed explanation.

Following Card No. 16, four input cards are required to specify the pressure, void fraction, and temperature for the flow openings along the top and right computing mesh boundaries. Note that for symmetry with input Cards 13-16 in Ref. 3 and to simplify the eventual extension to specified influx along the top and left boundaries, space is provided on these four additional cards to specify velocity components. These velocity values are not used with the pressure boundary conditions. The void fraction and temperature are used to specify the state of fluid initially entering the mesh. Only the pressure is used if the fluid is leaving the mesh. In this case, the void fraction and temperature are set in the boundary cells each cycle by a zero gradient condition. If the outflow should reverse, the values of void fraction and temperatures are held fixed during the inflow period at the values they had when the reversal occurred.

Card No. 16a: UOUTL, VOUTL, POUTL, THOUTL, TEMPOTL (Format 5F12.4)

UOUTL = no value needed for the pressure boundary condition treatment.

VOUTL = no value needed for the pressure boundary condition treatment.

POUTL = the pressure of the fluid entering or leaving the left opening along the top of the computing mesh.

THOUTL = the void fraction of fluid initially entering through the same opening.

TEMPOTL = the temperature of the liquid and gas initially entering through the same opening.

Card No. 16b: UOUTR, VOUTR, POUTR, THOUTR, TEMPOTR (Format 5F12.4)

UOUTR = no value needed for the pressure boundary condition treatment.

VOUTR = no value needed for the pressure boundary condition treatment.

POUTR = the pressure of the fluid entering or leaving the right opening along the top of the computing mesh.

THOUTR = the void fraction of fluid initially entering through the same opening.

TEMPOTR = the temperature of the liquid and gas initially entering through the same opening.

Card No. 16c: UOUTB, VOUTB, POUTB, THOUTB, TEMPOTB (Format 5F12.4)

UOUTB = no value needed for the pressure boundary condition treatment.

VOUTB = no value needed for the pressure boundary condition treatment.

POUTB = the pressure of the fluid entering or leaving the bottom opening along the right of the computing mesh.

THOUTB = the void fraction of fluid initially entering through the same opening.

TEMPOTL = the temperature of the liquid and gas initially entering through the same opening.

Card No. 16d: UOUTT, VOUTT, POUTT, THOUTT, TEMPOTT (Format 5F12.4)

UOUTT = no value needed for the pressure boundary condition treatment.

VOUTT = no value needed for the pressure boundary condition treatment.

POUTT = the pressure of the fluid entering or leaving the top opening along the right of the computing mesh.

THOUTT = the void fraction of fluid initially entering through the same opening.

TEMPOTT = the temperature of the liquid and gas initially entering through the same opening.

B. Computational Procedure

*D,FSET8.33,34: Addition of KFLIN and KFLOUT arrays to the labeled COMMON block PARAM3.

*B,FSET8.35: Adds a labeled COMMON data storage block that contains boundary data to each routine.

*D,KFIXCC.27: Reads input data that defines cell flags and coordinates for flow openings along the computing mesh boundaries.

*I,KFIXCC.36: Reads input data that defines flow conditions at the openings.

- *D,KFIXCC.55: Writes to the output file the values of cell flags and coordinates for the openings.
- *I,KFIXCC.67: Writes to the output file the flow conditions at the openings.
- *D,KFIXCC.115,117, *D,KFIXCC.127, and *I,KFIXCC.133: Output formats for the above write statements.
- *D,KFIXCC.169,170: Checks the computing mesh boundaries for openings that have specified pressure.
- *I,KFIXCC.177: Determine if the flow is entering or leaving through a specified pressure opening along the right or left boundaries. The flow variables are then appropriately reflected or held fixed.
- *I,KFIXCC.179: The pressure is not reflected for a specified pressure opening along these boundaries.
- *I,KFIXCC.182: If flow is leaving through a specified pressure opening, the densities and internal energies are calculated from the specified pressure and reflected temperatures and void fraction through the state equations.
- *B,KFIXCC.185: Reflect axial (tangential) velocities for a specified pressure opening.
- *D,KFIXCC.187: Check the top and bottom boundaries for a specified pressure opening.
- *I,KFIXCC.193: Determine if the flow is entering or leaving through a specified pressure opening along the top or bottom boundaries. The flow variables are then appropriately reflected or held fixed.
- *I,KFIXCC.195: The pressure is not reflected for a specified pressure opening along these boundaries.
- *I,KFIXCC.198: If flow is leaving through a specified pressure opening, the densities and internal energies are calculated from the specified pressure and reflected temperatures and void fraction through the state equations.
- *B,KFIXCC.201: Reflect radial (tangential) velocities for a specified pressure opening.

- *D,KFIXCC.203, 204, 211, 217, 218, 225, 232-235, 242, 248-251, and 258:
Extend computed GO TO statement arguments to treat specified pressure cells.
- *I,KFIXCC.264: Reflect tangential velocities for a specified pressure opening.
- *D,KFIXCC.289, 291, 293, and 295: Extend computed GO TO statement arguments to treat specified pressure cells.
- *D,KFIXCC.726: Set cell flags on the left boundary.
- *D,KFIXCC.741: Set cell flags on the right boundary.
- *D,KFIXCC.756: Set cell flags on the top boundary.
- *D,KFIXCC.771: Set cell flags on the bottom boundary.
- *D,KFIXCC.773: Set cell flags on boundary corners.
- *D,KFIXCC.1105 and *D,KFIXCC.1108, 1110: Extend computed GO TO statement arguments to treat specified pressure cells.
- *D,KFIXCC.1696, 1697: Set initial conditions in specified pressure boundary cells.
- *D,KFIXCC.1699: If a cell is an obstacle, go on to the next cell.
- *B,KFIXCC.1701: Restrict the indexes of cells adjacent to a boundary cell to lie in the computing mesh.
- *B,KFIXCC.1707 and *I,KFIXCC.1707: Set input data for boundary cells that are in an opening with specified pressure.
- *I,KFIXCC.1780: Calculate additional data for these cells.
- *I,KFIXCC.1976: Calculate momentum density quantities that account for the effects of momentum convection, gravity, and viscous stresses for specified pressure openings. Calculate estimates of advanced time velocities and mass fluxes.

III. LISTING OF MODIFICATIONS

LASL Identification

No. LP-2084

*IDENT PRESB		
*D,FSETB.33,34		
1 C(100), FLO(16), JPL0T(12), KFLIN(4), KFLOUT(4),	PBC0580	1
1 NAME(10), NSL(4), NSO(20), OB(4,20), SCALE(4)	PBC0580	2
*B,FSETB.35		
C	PBC0580	3
C ADDITION OF A LABELED COMMON BLOCK FOR THE CONSTANT	PBC0580	4
C PRESSURE BOUNDARY CONDITION	PBC0580	5
C	PBC0580	6
COMMON / PRESBC / UOUTL,VOUTL,POUTL,THOUTL,TEMPOTL,	PBC0580	7
1 UOUTR,VOUTR,POUTR,THOUTR,TEMPOTR,	PBC0580	8
2 UOUTB,VOUTB,POUTB,THOUTB,TEMPOTB,	PBC0580	9
3 UOUTT,VOUTT,POUTT,THOUTT,TEMPOTT	PBC0580	10
*D,KFIXCC.27		
C	PBC0580	11
C ADDITIONS TO PROGRAM KFIX TO ACCOMMODATE THE CONSTANT	PBC0580	12
C PRESSURE BOUNDARY INPUT AND OUTPUT	PBC0580	13
C	PBC0580	14
READ(10,140) (KFLIN(M),M=1,4)	PBC0580	15
READ(10,110) (FLO(M),M=1,8)	PBC0580	16
READ(10,140) (KFLOUT(M),M=1,4)	PBC0580	17
READ(10,110) (FLO(M),M=9,16)	PBC0580	18
*I,KFIXCC.36		
READ 160, UOUTL,VOUTL,POUTL,THOUTL,TEMPOTL,	PBC0580	19
1 UOUTR,VOUTR,POUTR,THOUTR,TEMPOTR,	PBC0580	20
2 UOUTB,VOUTB,POUTB,THOUTB,TEMPOTB,	PBC0580	21
3 UOUTT,VOUTT,POUTT,THOUTT,TEMPOTT	PBC0580	22
*D,KFIXCC.55		
WRITE(KTAPE,230) (KFLIN(1),I=1,4), (FLO(M),M=1,8), (KFLOUT(1),I=1,4),	PBC0580	23
1 (FLO(M),M=9,16)	PBC0580	24
*I,KFIXCC.67		
WRITE(KTAPE,275) UOUTL,VOUTL,POUTL,THOUTL,TEMPOTL,	PBC0580	25
1 UOUTR,VOUTR,POUTR,THOUTR,TEMPOTR,	PBC0580	26
2 UOUTB,VOUTB,POUTB,THOUTB,TEMPOTB,	PBC0580	27
3 UOUTT,VOUTT,POUTT,THOUTT,TEMPOTT	PBC0580	28
*D,KFIXCC.115,117		
230 FORMAT(54H0 4. INFLOW OPENINGS CELL FLAGS BOTTOM-L=,	PBC0580	29
113,11H BOTTOM-R=,13,9H LEFT-B=,13,9H LEFT-T=,13/1H0,12X,	PBC0580	30
29HA. BOTTOM,10X,1P4E11.4/1H0,12X,7HB. LEFT,12X,1P4E11.4/	PBC0580	31
351H0 5. OUTFLOW OPENINGS CELL FLAGS TOP-L=,13,	PBC0580	32
48H TOP-R=,13,10H RIGHT-B=,13,10H RIGHT-T=,13/1H0,12X,	PBC0580	33
56HA. TOP,13X,1P4E11.4/1H0,12X,8HB. RIGHT,11X,1P4E11.4)	PBC0580	34
*D,KFIXCC.127		
270 FORMAT(*0BOUNDARY DATA*/*0 1. BOTTOM*/*0 UINL=*	PBC0580	35
*I,KFIXCC.133		
275 FORMAT(13H0 3. TOP,/,	PBC0580	36
1 11X, 7H UOUTL=,1PE11.4, 8H VOUTL=,1PE11.4, 8H POUTL=,1PE11.4,	PBC0580	37
2 9H THOUTL=,1PE11.4, 9H TEMPOTL=,1PE11.4,/,	PBC0580	38
3 11X, 7H UOUTR=,1PE11.4, 8H VOUTR=,1PE11.4, 8H POUTR=,1PE11.4,	PBC0580	39
4 9H THOUTR=,1PE11.4, 9H TEMPOTR=,1PE11.4,/,	PBC0580	40
5 15H0 4. RIGHT,/,	PBC0580	41
6 11X, 7H UOUTB=,1PE11.4, 8H VOUTB=,1PE11.4, 8H POUTB=,1PE11.4,	PBC0580	42
7 9H THOUTB=,1PE11.4, 9H TEMPOTB=,1PE11.4,/,	PBC0580	43
8 11X, 7H UOUTT=,1PE11.4, 8H VOUTT=,1PE11.4, 8H POUTT=,1PE11.4,	PBC0580	44
9 9H THOUTT=,1PE11.4, 9H TEMPOTT=,1PE11.4)	PBC0580	45
*D,KFIXCC.169,170		
C	PBC0580	46
C CHANGES TO SUBROUTINE BDRY FOR THE CONSTANT PRESSURE BOUNDARY	PBC0580	47

C		PBC0580	48
	NFLI=FL(IJ)	PBC0580	49
	NFLB=FL(IJ)	PBC0580	50
	NFLT=FL(IJ)	PBC0580	51
	NFLR=FL(IJ)	PBC0580	52
	IF((NFLR.EQ.4).OR.(NFLR.EQ.6).OR.(NFLI.EQ.6))GO TO 10	PBC0580	53
	IF((NFLT.EQ.4).OR.(NFLT.EQ.6).OR.(NFLB.EQ.6))GO TO 20	PBC0580	54
*I,KFIXCC.177			
	IF(NFLI.EQ.6)N2=IJ	PBC0580	55
	UMIX=RGP(N1)*UG(N1) + RLP(N1)*UL(N1)	PBC0580	56
	IF(NFLI.EQ.6)UMIX=RGP(N2)*UG(N2) + RLP(N2)*UL(N2)	PBC0580	57
	IF(NFLI.EQ.6.AND.UMIX.GE.0.)GO TO 19	PBC0580	58
	IF(NFLR.EQ.6.AND.UMIX.LE.0.)GO TO 19	PBC0580	59
*I,KFIXCC.179			
	IF((NFLR.EQ.6.OR.NFLI.EQ.6).AND.N.EQ.NPRES) GO TO 15	PBC0580	60
*I,KFIXCC.182			
	IF(NFLR.NE.6.AND.NFLI.NE.6)GO TO 16	PBC0580	61
	IJ=N2	PBC0580	62
	CALL CONVERT	PBC0580	63
	IJ=N1	PBC0580	64
	16 CONTINUE	PBC0580	65
	IF(NFLI.EQ.6) GO TO 17	PBC0580	66
*B,KFIXCC.185			
	GO TO 18	PBC0580	67
	17 IF(NFLT.GE.5)VG(N2)=VG(N1)	PBC0580	68
	IF(NFLT.GE.5)VL(N2)=VL(N1)	PBC0580	69
	GO TO 19	PBC0580	70
	18 CONTINUE	PBC0580	71
*D,KFIXCC.187			
	19 IF((NFLI.NE.4).AND.(NFLT.NE.6).AND.(NFLB.NE.6))GO TO 30	PBC0580	72
*I,KFIXCC.193			
	IF(NFLB.EQ.6)N2=IJ	PBC0580	73
	VMIX=RGP(N1)*VG(N1) + RLP(N1)*VL(N1)	PBC0580	74
	IF(NFLB.EQ.6)VMIX=RGP(N2)*VG(N2) + RLP(N2)*VL(N2)	PBC0580	75
	IF(NFLB.EQ.6.AND.VMIX.GE.0.)GO TO 30	PBC0580	76
	IF(NFLT.EQ.6.AND.VMIX.LE.0.)GO TO 30	PBC0580	77
*I,KFIXCC.195			
	IF((NFLT.EQ.6.OR.NFLB.EQ.6).AND.N.EQ.NPRES) GO TO 25	PBC0580	78
*I,KFIXCC.198			
	IF(NFLT.NE.6.AND.NFLB.NE.6)GO TO 26	PBC0580	79
	IJ=N2	PBC0580	80
	CALL CONVERT	PBC0580	81
	IJ=N1	PBC0580	82
	26 CONTINUE	PBC0580	83
	IF(NFLB.EQ.6) GO TO 27	PBC0580	84
*B,KFIXCC.201			
	GO TO 28	PBC0580	85
	27 IF(NFLB.GE.5)UG(N2)=UG(N1)	PBC0580	86
	IF(NFLB.GE.5)UL(N2)=UL(N1)	PBC0580	87
	GO TO 30	PBC0580	88
	28 CONTINUE	PBC0580	89
*D,KFIXCC.203,204			
	30 GO TO (60,35,45,60,60,60),NFLR	PBC0580	90
	35 GO TO (60,40,40,60,60,60),NFLTR	PBC0580	91
*D,KFIXCC.211			
	45 GO TO (60,50,50,60,60,60),NFLTR	PBC0580	92
*D,KFIXCC.217,218			
	60 GO TO (90,65,75,90,90,90),NFLT	PBC0580	93

65 GO TO (90,70,70,90,90,90),NFLTR	PBC0580	94
*D,KFIXCC.225		
75 GO TO (90,80,80,90,90,90),NFLTR	PBC0580	95
*D,KFIXCC.232,235		
GO TO (130,105,115,130,130,130),NFLL	PBC0580	96
105 GO TO (130,110,110,130,130,130),NFLTL	PBC0580	97
*D,KFIXCC.242		
115 GO TO (130,120,120,130,130,130),NFLTL	PBC0580	98
*D,KFIXCC.248,251		
130 GO TO (200,135,145,200,200,200),NFLB	PBC0580	99
135 GO TO (200,140,140,200,200,200),NFLBR	PBC0580	100
*D,KFIXCC.258		
145 GO TO (200,150,150,200,200,200),NFLBR	PBC0580	101
*I,KFIXCC.264		
J=1	PBC0580	102
IUPLIM=1B-1	PBC0580	103
DO 300 I=2,1B1,IUPLIM	PBC0580	104
IJ=1	PBC0580	105
IF (FL(IJ),NE.6) GO TO 300	PBC0580	106
IMJ=IJ-1	PBC0580	107
NFLL=FL(IMJ)	PBC0580	108
GO TO (250,230,240,250,250,250),NFLL	PBC0580	109
230 VG(IMJ)=VG(IJ)	PBC0580	110
VL(IMJ)=VL(IJ)	PBC0580	111
GO TO 250	PBC0580	112
240 VG(IMJ)=-VG(IJ)	PBC0580	113
VL(IMJ)=-VL(IJ)	PBC0580	114
250 IPJ=IJ+1	PBC0580	115
NFLR=FL(IPJ)	PBC0580	116
GO TO (300,260,270,300,300,300),NFLR	PBC0580	117
260 VG(IPJ)=VG(IJ)	PBC0580	118
VL(IPJ)=VL(IJ)	PBC0580	119
GO TO 300	PBC0580	120
270 VG(IPJ)=-VG(IJ)	PBC0580	121
VL(IPJ)=-VL(IJ)	PBC0580	122
300 CONTINUE	PBC0580	123
I=1	PBC0580	124
JUPLIM=JB-1	PBC0580	125
DO 400 J=2,JB1,JUPLIM	PBC0580	126
IJ=1+(J-1)*1B2	PBC0580	127
IF (FL(IJ),NE.6) GO TO 400	PBC0580	128
IJM=IJ-1B2	PBC0580	129
NFLB=FL(IJM)	PBC0580	130
GO TO (350,330,340,350,350,350),NFLB	PBC0580	131
330 UG(IJM)=UG(IJ)	PBC0580	132
UL(IJM)=UL(IJ)	PBC0580	133
GO TO 350	PBC0580	134
340 UG(IJM)=-UG(IJ)	PBC0580	135
UL(IJM)=-UL(IJ)	PBC0580	136
350 IJP=IJ+1B2	PBC0580	137
NFLT=FL(IJP)	PBC0580	138
GO TO (400,360,370,400,400,400),NFLT	PBC0580	139
360 UG(IJP)=UG(IJ)	PBC0580	140
UL(IJP)=UL(IJ)	PBC0580	141
GO TO 400	PBC0580	142
370 UG(IJP)=-UG(IJ)	PBC0580	143
UL(IJP)=-UL(IJ)	PBC0580	144
400 CONTINUE	PBC0580	145

*D,KFIXCC.289		
C	PBC0580	146
C	PBC0580	147
C	PBC0580	148
GO TO (2,1,1,2,1,2),NFLR	PBC0580	149
*D,KFIXCC.291		
2 GO TO (4,3,3,4,3,4),NFLR	PBC0580	150
*D,KFIXCC.293		
4 GO TO (6,5,5,6,5,6),NFLT	PBC0580	151
*D,KFIXCC.295		
6 GO TO (8,7,7,8,7,8),NFLB	PBC0580	152
*D,KFIXCC.726		
C	PBC0580	153
C	PBC0580	154
C	PBC0580	155
C	PBC0580	156
16 IF (J2.EQ.5) FL(1,J)=KFLIN(3)	PBC0580	157
IF (J2.EQ.7) FL(1,J)=KFLIN(4)	PBC0580	158
*D,KFIXCC.741		
60 IF (J4.EQ.13) FL(1,J)=KFLOUT(3)	PBC0580	159
IF (J4.EQ.15) FL(1,J)=KFLOUT(4)	PBC0580	160
*D,KFIXCC.756		
100 IF (J3.EQ.9) FL(1,J)=KFLOUT(1)	PBC0580	161
IF (J3.EQ.11) FL(1,J)=KFLOUT(2)	PBC0580	162
*D,KFIXCC.771		
140 IF (J1.EQ.1) FL(1,J)=KFLIN(1)	PBC0580	163
IF (J1.EQ.3) FL(1,J)=KFLIN(2)	PBC0580	164
*I,KFIXCC.773		
IF (FL(1B1,JB2).EQ.6.AND.FL(1B2,JB1).EQ.6) FL(1B2,JB2)=6	PBC0580	165
IF (FL(2,JB2).EQ.6.AND.FL(1,JB1).EQ.6) FL(1,JB2)=6	PBC0580	166
IF (FL(2,1).EQ.6.AND.FL(1,2).EQ.6) FL(1,1)=6	PBC0580	167
IF (FL(1B1,1).EQ.6.AND.FL(1B2,2).EQ.6) FL(1B2,1)=6	PBC0580	168
*D,KFIXCC.1105		
C	PBC0580	169
C	PBC0580	170
C	PBC0580	171
GO TO (20,2,2,20,20,20),NFLTR	PBC0580	172
*D,KFIXCC.1108,1110		
GO TO (4,6,6,4,4,4),NFLT	PBC0580	173
4 GO TO (8,10,10,8,8,8),NFLR	PBC0580	174
6 GO TO (12,8,8,12,12,12),NFLR	PBC0580	175
*D,KFIXCC.1696,1697		
C	PBC0580	176
C	PBC0580	177
C	PBC0580	178
C	PBC0580	179
DO 50 J=1,JB2	PBC0580	180
DO 50 I=1,1B2	PBC0580	181
*D,KFIXCC.1699		
IF ((FL(IJ).NE.1).AND.(FL(IJ).NE.4).AND.(FL(IJ).NE.6)) GO TO 50	PBC0580	182
*B,KFIXCC.1701		
IF (I.EQ.1B2) I PJ=IJ	PBC0580	183
IF (J.EQ.JB2) I JP=IJ	PBC0580	184
*B,KFIXCC.1707		
IF (FL(IJ).NE.6) GO TO 45	PBC0580	185
IF (I.NE.1) GO TO 32	PBC0580	186
DIST=(J-1)*DZ-0.1*DZ	PBC0580	187
IF (DIST.GT.FLO(7).AND.DIST.LT.FLO(8)) GO TO 31	PBC0580	188

P(IJ)=PINB	PBC0580	189
TH(IJ)=THINB	PBC0580	190
TG(IJ)=TL(IJ)=TEMPINB	PBC0580	191
GO TO 45	PBC0580	192
31 CONTINUE	PBC0580	193
P(IJ)=PINT	PBC0580	194
TH(IJ)=THINT	PBC0580	195
TG(IJ)=TL(IJ)=TEMPINT	PBC0580	196
GO TO 45	PBC0580	197
32 IF(J.NE.1) GO TO 35	PBC0580	198
DIST=(I-1)*DR-0.1*DR	PBC0580	199
IF(DIST.GT.FLO(3).AND.DIST.LT.FLO(4)) GO TO 33	PBC0580	200
P(IJ)=PINL	PBC0580	201
TH(IJ)=THINL	PBC0580	202
TG(IJ)=TL(IJ)=TEMPINL	PBC0580	203
GO TO 45	PBC0580	204
33 CONTINUE	PBC0580	205
P(IJ)=PINR	PBC0580	206
TH(IJ)=THINR	PBC0580	207
TG(IJ)=TL(IJ)=TEMPINR	PBC0580	208
GO TO 45	PBC0580	209
35 IF(I.NE.1B2) GO TO 37	PBC0580	210
DIST=(J-1)*DZ-0.1*DZ	PBC0580	211
IF(DIST.GT.FLO(15).AND.DIST.LT.FLO(16)) GO TO 36	PBC0580	212
P(IJ)=POUTB	PBC0580	213
TH(IJ)=THOUTB	PBC0580	214
TG(IJ)=TL(IJ)=TEMPOTB	PBC0580	215
GO TO 45	PBC0580	216
36 CONTINUE	PBC0580	217
P(IJ)=POUTT	PBC0580	218
TH(IJ)=THOUTT	PBC0580	219
TG(IJ)=TL(IJ)=TEMPOTT	PBC0580	220
GO TO 45	PBC0580	221
37 IF(J.NE.1B2) GO TO 45	PBC0580	222
DIST=(I-1)*DR-0.1*DR	PBC0580	223
IF(DIST.GT.FLO(11).AND.DIST.LT.FLO(12)) GO TO 38	PBC0580	224
P(IJ)=POUTL	PBC0580	225
TH(IJ)=THOUTL	PBC0580	226
TG(IJ)=TL(IJ)=TEMPOTL	PBC0580	227
GO TO 45	PBC0580	228
38 CONTINUE	PBC0580	229
P(IJ)=POUTR	PBC0580	230
TH(IJ)=THOUTR	PBC0580	231
TG(IJ)=TL(IJ)=TEMPOTR	PBC0580	232
*I,KFIXCC.1707		
IF(FL(IJ).EQ.6) CALL SETXTRA	PBC0580	233
*I,KFIXCC.1780		
C	PBC0580	234
C ADDITIONS TO SUBROUTINE SETXTRA TO SET SURFACE AREA AND	PBC0580	235
C BOILING AND CONDENSATION RATES ON THE CONSTANT PRESSURE BOUNDARY	PBC0580	236
C	PBC0580	237
CALL ASURFS	PBC0580	238
CALL BOIL	PBC0580	239
CALL COND	PBC0580	240
*I,KFIXCC.1976		
C	PBC0580	241
C ADDITIONS TO SUBROUTINE TILDE FOR CALCULATING THE MOMENTUM	PBC0580	242
C DENSITY QUANTITIES ON THE CONSTANT PRESSURE BOUNDARY	PBC0580	243

C

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J=2
DO 30 I=2,181
  IJ=I+182
  IJM=IJ-182
  IF (FL(IJM).NE.6) GO TO 25
  IJB=IJM
  IF (FL(IJM).EQ.2.OR.FL(IJM).EQ.3) IJB=IJ
  IJP=IJ+182
  IJT=IJP
  IF (FL(IJP).EQ.2.OR.FL(IJP).EQ.3) IJT=IJ
  IPJM=IJM+1
  IJBR=IPJM
  IF (FL(IPJM).EQ.2.OR.FL(IPJM).EQ.3) IJBR=IJM
  IMJ=IJ-1
  IJL=IMJ
  IF (FL(IMJ).EQ.2.OR.FL(IMJ).EQ.3) IJL=IJ
  IMJM=IJM-1
  IJBL=IMJM
  IF (FL(IMJM).EQ.2.OR.FL(IMJM).EQ.3) IJBL=IJM
  IPJ=IJ+1
  IJR=IPJ
  IF (FL(IPJ).EQ.2.OR.FL(IPJ).EQ.3) IJR=IJ
  CS(1)=0.5*(VG(IJM)+VG(IJ))
  IF (CS(1).LT.0.0) GO TO 21
  RVG(IJM)=0.5*(RGP(IJ)+RGP(IJB))*(VG(IJM)+GRAV*DT)
  GO TO 22
21 VGF=0.5*(RGP(IJ)+RGP(IJT))*VG(IJ)*CS(1)
  SVGT=MUG(IJ)*(2.0*RDZ*(VG(IJ)-VG(IJM))-0.667*(RRIDR(I))*
1 (RB(I)*UG(IJ)-RB(I-1)*UG(IMJ))+RDZ*(VG(IJ)-VG(IJM))))*TH(IJ)
  VGFT=VGF-SVGT
  VGB=2.0*VG(IJM)-VG(IJ)
  CS(3)=0.5*(VG(IJM)+VGB)
  VGFB(1)=0.5*(RGP(IJB)+RGP(IJ))*VG(IJM)*CS(3)
  SVGB=MUG(IJB)*(2.0*RDZ*(VG(IJM)-VGB)-0.667*(RRIDR(I))*
1 (RB(I)*UG(IJM)-RB(I-1)*UG(IMJM))+RDZ*(VG(IJM)-VGB))))*TH(IJB)
  VGFB(1)=VGFB(1)-SVGB
  CS(2)=0.5*(UG(IJ)+UG(IJM))
  IF (CS(2).GE.0.0) VGFR=0.5*(RGP(IJB)+RGP(IJ))*VG(IJM)*CS(2)*RB(1)
  IF (CS(2).LT.0.0) VGFR=0.5*(RGP(IJBR)+RGP(IJR))*VG(IPJM)*CS(2)*RB
1 (1)
  SVGR=0.25*(MUG(IJ)+MUG(IJB)+MUG(IJR)+MUG(IJBR))*(RDR*(VG(IPJM)
1 -VG(IJM))+RDZ*(UG(IJ)-UG(IJM)))*RB(1)*(0.25*
2 (TH(IJ)+TH(IJB)+TH(IJR)+TH(IJBR)))
  VGFR=VGFR-SVGR
  CS(3)=0.5*(UG(IMJM)+UG(IMJ))
  IF (CS(3).GE.0.0) VGFL=0.5*(RGP(IJBL)+RGP(IJL))*VG(IMJM)*CS(3)*RB
1 (I-1)
  IF (CS(3).LT.0.0) VGFL=0.5*(RGP(IJB)+RGP(IJ))*VG(IJM)*CS(3)*RB(I-1)
  SVGL=0.25*(MUG(IJ)+MUG(IJB)+MUG(IJL)+MUG(IJBL))*(RDR*(VG(IJM)
1 -VG(IMJM))+RDZ*(UG(IMJ)-UG(IMJM)))*RB(I-1)*(0.25*
2 (TH(IJ)+TH(IJB)+TH(IJL)+TH(IJBL)))
  VGFL=VGFL-SVGL
  RVG(IJM)=0.5*(RGP(IJ)+RGP(IJB))*(VG(IJM)+GRAV*DT)
1 -DTODR(1)*(VGFR-VGFL)-DTODZ*(VGFT-VGFB(1))
22 CS(1)=0.5*(VL(IJM)+VL(IJ))
  IF (CS(1).LT.0.0) GO TO 23
  RVL(IJM)=0.5*(RLP(IJ)+RLP(IJB))*(VL(IJM)+GRAV*DT)

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PBC0580	301

GO TO 30	PBC0580	302
23 VLFT=0.5*(RLP(IJ)+RLP(IJT))*VL(IJ)*CS(1)	PBC0580	303
SVLT=MUL(IJ)*(2.0*RDZ*(VL(IJ)-VL(IJM))-0.667*(RRIDR(I)*	PBC0580	304
1(RB(I)*UL(IJ)-RB(I-1)*UL(IMJ))+RDZ*(VL(IJ)-VL(IJM)))*(1.0-TH(IJ))	PBC0580	305
VLFT=VLFT-SVLT	PBC0580	306
VLB=2.0*VL(IJM)-VL(IJ)	PBC0580	307
CS(3)=0.5*(VL(IJM)-VLB)	PBC0580	308
VLFB(I)=0.5*(RLP(IJB)+RLP(IJ))*VL(IJM)*CS(3)	PBC0580	309
SVLB=MUL(IJB)*(2.0*RDZ*(VL(IJM)-VLB)-0.667*(RRIDR(I)*	PBC0580	310
1(RB(I)*UL(IJM)-RB(I-1)*UL(IMJ))+RDZ*(VL(IJM)-VLB)))*(1.0-TH(IJB))	PBC0580	311
VLFB(I)=VLFB(I)-SVLB	PBC0580	312
CS(2)=0.5*(UL(IJ)+UL(IJM))	PBC0580	313
IF(CS(2).GE.0.0) VLFR=0.5*(RLP(IJB)+RLP(IJ))*VL(IJM)*CS(2)*RB(I)	PBC0580	314
IF(CS(2).LT.0.0) VLFR=0.5*(RLP(IJB)+RLP(IJ))*VL(IPJM)*CS(2)*RB	PBC0580	315
1(I)	PBC0580	316
SVLR=0.25*(MUL(IJ)+MUL(IJB)+MUL(IJR)+MUL(IJBR))*(RDR*(VL(IPJM)	PBC0580	317
1-VL(IJM))+RDZ*(UL(IJ)-UL(IJM))*RB(I)*(1.0-0.25*	PBC0580	318
2(TH(IJ)+TH(IJB)+TH(IJR)+TH(IJBR)))	PBC0580	319
VLFR=VLFR-SVLR	PBC0580	320
CS(3)=0.5*(UL(IMJ)+UL(IMJ))	PBC0580	321
IF(CS(3).GE.0.0) VLFL=0.5*(RLP(IJB)+RLP(IJ))*VL(IMJ)*CS(3)*RB	PBC0580	322
1(I-1)	PBC0580	323
IF(CS(3).LT.0.0) VLFL=0.5*(RLP(IJB)+RLP(IJ))*VL(IJM)*CS(3)*RB(I-1)	PBC0580	324
SVLL=0.25*(MUL(IJ)+MUL(IJB)+MUL(IJL)+MUL(IJBL))*(RDR*(VL(IJM)	PBC0580	325
1-VL(IMJ))+RDZ*(UL(IMJ)-UL(IMJ))*RB(I-1)*(1.0-0.25*	PBC0580	326
2(TH(IJ)+TH(IJB)+TH(IJL)+TH(IJBL)))	PBC0580	327
VLFL=VLFL-SVLL	PBC0580	328
RVL(IJM)=0.5*(RLP(IJ)+RLP(IJB))*(VL(IJM)+GRAV*DT)	PBC0580	329
1-DTORDR(I)*(VLFR-VLFL)-DTODZ*(VLFT-VLFB(I))	PBC0580	330
25 IJ=IJ+JB*182	PBC0580	331
IJP=IJ+182	PBC0580	332
IF(FL(IJP).NE.6)GO TO 30	PBC0580	333
IF(VG(IJ).GT.0.0) GO TO 26	PBC0580	334
RVG(IJ)=0.5*(RGP(IJ)+RGP(IJP))*(VG(IJ)+GRAV*DT)	PBC0580	335
26 IF(VL(IJ).GT.0.0) GO TO 30	PBC0580	336
RVL(IJ)=0.5*(RLP(IJ)+RLP(IJP))*(VL(IJ)+GRAV*DT)	PBC0580	337
30 CONTINUE	PBC0580	338
I=2	PBC0580	339
DO 40 J=2,JB1	PBC0580	340
IJ=2+(J-1)*182	PBC0580	341
IMJ=IJ-1	PBC0580	342
IF(FL(IMJ).NE.6)GO TO 35	PBC0580	343
IJL=IMJ	PBC0580	344
IF(FL(IMJ).EQ.2.OR.FL(IMJ).EQ.3) IJL=IJ	PBC0580	345
IPJ=IJ+1	PBC0580	346
IJR=IPJ	PBC0580	347
IF(FL(IPJ).EQ.2.OR.FL(IPJ).EQ.3) IJR=IJ	PBC0580	348
IMJM=IMJ-182	PBC0580	349
IJBL=IMJM	PBC0580	350
IF(FL(IMJM).EQ.2.OR.FL(IMJM).EQ.3) IJBL=IMJ	PBC0580	351
IJP=IJ+182	PBC0580	352
IJT=IJP	PBC0580	353
IF(FL(IJP).EQ.2.OR.FL(IJP).EQ.3) IJT=IJ	PBC0580	354
IMJP=IJP-1	PBC0580	355
IJTL=IMJP	PBC0580	356
IF(FL(IMJP).EQ.2.OR.FL(IMJP).EQ.3) IJTL=IMJ	PBC0580	357
IJM=IJ-182	PBC0580	358
IJB=IJM	PBC0580	359

IF(FL(IJM).EQ.2.OR.FL(IJM).EQ.3) IJB=IJ	PBC0580	360
CS(1)=0.5*(UG(IMJ)+UG(IJ))	PBC0580	361
IF(CS(1).LT.0.0) GO TO 31	PBC0580	362
RUG(IMJ)=0.5*(RGP(IJ)+RGP(IJL))*UG(IMJ)	PBC0580	363
GO TO 32	PBC0580	364
31 UGFR=0.5*(RGP(IJ)+RGP(IJR))*UG(IJ)*CS(1)*R(2)	PBC0580	365
SUGR=MUG(IJ)*(2.0*RDR*(UG(IJ)-UG(IMJ))-0.667*(RDR*(UG(IJ)	PBC0580	366
1 -UG(IMJ))+RDZ*(VG(IJ)-VG(IJM)))*(TH(IJ))	PBC0580	367
UGFR=UGFR-SUGR	PBC0580	368
UGL=((R(1)+R(2))*RB(1)*UG(IMJ)-R(1)*RB(2)*UG(IJ))	PBC0580	369
1 *RRB(1)/R(2)	PBC0580	370
CS(3)=0.5*(UG(IMJ)+UGL)	PBC0580	371
UGFL=0.5*(RGP(IJL)+RGP(IJ))*UG(IMJ)*CS(3)*R(1)	PBC0580	372
SUGL=MUG(IJL)*(2.0*RDR*(UG(IMJ)-UGL)-0.667*(RDR*(UG(IMJ)-UGL)	PBC0580	373
1 +RDZ*(VG(IMJ)-VG(IJM)))*(TH(IJL))	PBC0580	374
UGFL=UGFL-SUGL	PBC0580	375
CS(2)=0.5*(VG(IJ)+VG(IMJ))	PBC0580	376
IF(CS(2).GE.0.0) UGFT=0.5*(RGP(IJL)+RGP(IJ))*UG(IMJ)*CS(2)	PBC0580	377
IF(CS(2).LT.0.0) UGFT=0.5*(RGP(IJTL)+RGP(IJT))*UG(IMJ)*CS(2)	PBC0580	378
SUGT=0.25*(MUG(IJ)+MUG(IJL)+MUG(IJT)+MUG(IJTL))*(RDR*(VG(IJ)	PBC0580	379
1 -VG(IMJ))+RDZ*(UG(IMJ)-UG(IMJ))*(0.25*(TH(IJ)+TH(IJL)	PBC0580	380
2 +TH(IJT)+TH(IJTL)))	PBC0580	381
UGFT=UGFT-SUGT	PBC0580	382
CS(3)=0.5*(VG(IMJ)+VG(IJM))	PBC0580	383
IF(CS(3).GE.0.0) UGFB(1)=0.5*(RGP(IJBL)+RGP(IJB))*UG(IMJ)*CS(3)	PBC0580	384
IF(CS(3).LT.0.0) UGFB(1)=0.5*(RGP(IJL)+RGP(IJ))*UG(IMJ)*CS(3)	PBC0580	385
SUGB=0.25*(MUG(IJ)+MUG(IJL)+MUG(IJB)+MUG(IJBL))*(RDR*(VG(IJM)	PBC0580	386
1 -VG(IMJ))+RDZ*(UG(IMJ)-UG(IMJ))*(0.25*(TH(IJ)+TH(IJL)	PBC0580	387
2 +TH(IJB)+TH(IJBL)))	PBC0580	388
UGFB(1)=UGFB(1)-SUGB	PBC0580	389
SUGC=0.	PBC0580	390
IF(ITC.EQ.0) GO TO 310	PBC0580	391
SUGC=0.5*(MUG(IJ)+MUG(IJL))*(2.0*UG(IMJ)-0.333*(RDR*(UG(IJ)-UGL)	PBC0580	392
1 +RDZ*(VG(IJ)+VG(IMJ)-VG(IJM)-VG(IMJ)))*(0.5*(TH(IJ)	PBC0580	393
2 +TH(IJL)))	PBC0580	394
310 CONTINUE	PBC0580	395
RUG(IMJ)=0.5*(RGP(IJ)+RGP(IJL))*UG(IMJ)-DTORBD(1)*(UGFR-UGFL)	PBC0580	396
1 -DTODZ*(UGFT-UGFB(1))	PBC0580	397
2 -DT*SUGC	PBC0580	398
32 CS(1)=0.5*(UL(IMJ)+UL(IJ))	PBC0580	399
IF(CS(1).LT.0.0) GO TO 33	PBC0580	400
RUL(IMJ)=0.5*(RLP(IJ)+RLP(IJL))*UL(IMJ)	PBC0580	401
GO TO 40	PBC0580	402
33 ULFR=0.5*(RLP(IJ)+RLP(IJR))*UL(IJ)*CS(1)*R(2)	PBC0580	403
SULR=MUL(IJ)*(2.0*RDR*(UL(IJ)-UL(IMJ))-0.667*(RDR*(UL(IJ)	PBC0580	404
1 -UL(IMJ))+RDZ*(VL(IJ)-VL(IJM)))*(1.0-TH(IJ))	PBC0580	405
ULFR=ULFR-SULR	PBC0580	406
ULL=((R(1)+R(2))*RB(1)*UL(IMJ)-R(1)*RB(2)*UL(IJ))	PBC0580	407
1 *RRB(1)/R(2)	PBC0580	408
CS(3)=0.5*(UL(IMJ)+ULL)	PBC0580	409
ULFL=0.5*(RLP(IJL)+RLP(IJ))*UL(IMJ)*CS(3)*R(1)	PBC0580	410
SULL=MUL(IJL)*(2.0*RDR*(UL(IMJ)-ULL)-0.667*(RDR*(UL(IMJ)-ULL)	PBC0580	411
1 +RDZ*(VL(IMJ)-VL(IJM)))*(1.0-TH(IJL))	PBC0580	412
ULFL=ULFL-SULL	PBC0580	413
CS(2)=0.5*(VL(IJ)+VL(IMJ))	PBC0580	414
IF(CS(2).GE.0.0) ULFT=0.5*(RLP(IJL)+RLP(IJ))*UL(IMJ)*CS(2)	PBC0580	415
IF(CS(2).LT.0.0) ULFT=0.5*(RLP(IJTL)+RLP(IJT))*UL(IMJ)*CS(2)	PBC0580	416
SULT=0.25*(MUL(IJ)+MUL(IJL)+MUL(IJT)+MUL(IJTL))*(RDR*(VL(IJ)	PBC0580	417

1 -VL(IMJ))+RDZ*(UL(IMJ)-UL(IMJ))*(1.0-0.25*(TH(IJ)+TH(IJL))	PBC0580	418
2 +TH(IJT)+TH(IJL)))	PBC0580	419
ULFT=ULFT-SULT	PBC0580	420
CS(3)=0.5*(VL(IMJ)+VL(IJM))	PBC0580	421
IF(CS(3).GE.0.0) ULFB(1)=0.5*(RLP(IJBL)+RLP(IJB))*UL(IMJ)*CS(3)	PBC0580	422
IF(CS(3).LT.0.0) ULFB(1)=0.5*(RLP(IJL)+RLP(IJ))*UL(IMJ)*CS(3)	PBC0580	423
SULB=0.25*(MUL(IJ)+MUL(IJL)+MUL(IJB)+MUL(IJBL))*(RDR*(VL(IJM)	PBC0580	424
1 -VL(IMJ))+RDZ*(UL(IMJ)-UL(IMJ))*(1.0-0.25*(TH(IJ)+TH(IJL)	PBC0580	425
2 +TH(IJB)+TH(IJBL)))	PBC0580	426
ULFB(1)=ULFB(1)-SULB	PBC0580	427
SULC=0.	PBC0580	428
IF(ITC.EQ.0) GO TO 34	PBC0580	429
SULC=0.5*(MUL(IJ)+MUL(IJL))*(2.0*UL(IMJ)-0.333*(RDR*(UL(IJ)-UL	PBC0580	430
1 +RDZ*(VL(IJ)+VL(IMJ)-VL(IJM)-VL(IMJ)))*(1.0-0.5*(TH(IJ)	PBC0580	431
2 +TH(IJL)))	PBC0580	432
34 CONTINUE	PBC0580	433
RUL(IMJ)=0.5*(RLP(IJ)+RLP(IJL))*UL(IMJ)-DTORBOR(1)*(ULFR-ULFL)	PBC0580	434
1 -DT00Z*(ULFT-ULFB(1))	PBC0580	435
2 -DT*SULC	PBC0580	436
35 IJ=IB1+(J-1)*IB2	PBC0580	437
IPJ=IJ+1	PBC0580	438
IF(FL(IPJ).NE.6) GO TO 40	PBC0580	439
IF(UG(IJ).GT.0.0) GO TO 36	PBC0580	440
RUG(IJ)=0.5*(RGP(IJ)+RGP(IPJ))*UG(IJ)	PBC0580	441
36 IF(UL(IJ).GT.0.0) GO TO 40	PBC0580	442
RUL(IJ)=0.5*(RLP(IJ)+RLP(IPJ))*UL(IJ)	PBC0580	443
40 CONTINUE	PBC0580	444
J=2	PBC0580	445
DO 50 I=2,IB1	PBC0580	446
IJ=I+IB2	PBC0580	447
IJM=IJ-IB2	PBC0580	448
IF(FL(IJM).NE.6) GO TO 50	PBC0580	449
CALL INDEXA	PBC0580	450
CALL VEL5	PBC0580	451
CALL MASFG	PBC0580	452
CALL MASFL	PBC0580	453
50 CONTINUE	PBC0580	454
I=2	PBC0580	455
DO 60 J=2,JB1	PBC0580	456
IJ=2+(J-1)*IB2	PBC0580	457
IMJ=IJ-1	PBC0580	458
IF(FL(IMJ).NE.6) GO TO 60	PBC0580	459
CALL INDEXA	PBC0580	460
CALL VEL5	PBC0580	461
CALL MASFG	PBC0580	462
CALL MASFI	PBC0580	463
60 CONTINUE	PBC0580	464

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