

**Supplemental Information
for
NASA/TM—2013–217492**

**Generalized Fluid System Simulation Program,
Version 6.0**

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APPENDIX G—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 1
Simulation of a Flow System Consisting of a Pump, Valve, and Pipe Line

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INODE	UPNODE	NUMBER	NAMEBR	DESCRIPTION	PUMP CONST1	PUMP CONST2	PUMP CONST3	AREA
2		2	12 23					
3		2	23 34					
BRANCH			OPTION					
12	1	2	14	"Pump 12"				
23	2	3	13	"Valve 23"				
34	3	4	1	"Pipe 34"				
BRANCH			OPTION -14					
12			30888	0	-0.0008067		201.06	
BRANCH			DIA	K1	K2		AREA	
23			6	1000	0.1		28.274	
BRANCH			OPTION -1	DIA	EPSPD		ANGLE	
			34	18000	6		0.005	
							95.74	28.27431
								AREA

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

RUN DATE:09/12/2012 14:51

TITLE :Simulation of a Flow System Consisting of a Pump, Valve and Pipe Line
 ANALYST :ALOK MAJUMDAR
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX1\Ex1.dat
 FILEOUT :Ex1.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	COND	F	CONJUG	F	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	F	HCOEF	F	HEX	F	HRATE	T	IFRMIX	F	INERTIA	F	INSUC	F
INVAL	F	MIXTURE	F	MOVBN	F	MSORCE	F	NORMAL	F	NRSOLVT	F	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRINTI	T	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	F	SHEAR	T	SIMULA	T	SIUNITS	F	STEADY	T	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	F	TRANSV	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F														

NNODES = 4
 NINT = 2
 NBR = 3
 NF = 1
 NVAR = 5
 Nhref = 2

FLUIDS: H2O

BOUNDARY NODES

NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)
1	0.1470E+02	0.6000E+02	0.6237E+02	0.0000E+00
4	0.1470E+02	0.6000E+02	0.6237E+02	0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)	UPNODE	DNNODE	OPTION	PUMP CONS1	PUMP CONS2	PUMP CONS3	AREA	
2	0.0000E+00	0.0000E+00	0.0000E+00	1	2	14	0.309E+05	0.000E+00	-0.807E-03	0.201E+03	
3	0.0000E+00	0.0000E+00	0.0000E+00	2	3	13					
34	0.0000E+00	0.0000E+00	0.0000E+00	3	4	1					
BRANCH OPTION -14: PUMP CONS1 PUMP CONS2 PUMP CONS3 AREA											
12											
BRANCH OPTION -13: DIA K1 K2 AREA											
23							0.600E+01	0.100E+04	0.100E+00	0.283E+02	
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA											
34							0.180E+05	0.600E+01	0.500E-02	0.957E+02	0.283E+02

INITIAL GUESS FOR INTERNAL NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
2	0.1470E+02	0.6000E+02	0.7616E-03	0.6237E+02	0.0000E+00
3	0.1470E+02	0.6000E+02	0.7616E-03	0.6237E+02	0.0000E+00

TRIAL SOLUTION

BRANCH	DELP (PSI)	FLOWRATE (LBM/SEC)
12	0.0000	0.0100
23	0.0000	0.0100
34	0.0000	0.0100

SOLUTION

INTERNAL NODES	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.2290E+03	0.6003E+02	0.1185E-01	0.6241E+02	0.0000E+00	0.0000E+00
3	0.2288E+03	0.6003E+02	0.1184E-01	0.6241E+02	0.0000E+00	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU	COND BTU/FT-S-R	CP	GAMA

2 0.2876E+02 0.5555E-01 0.7534E-03 0.9524E-04 0.1000E+01 0.1003E+01
 3 0.2876E+02 0.5555E-01 0.7534E-03 0.9524E-04 0.1000E+01 0.1003E+01

BRANCHES

BRANCH	KFACTOR	DELTA P (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.000E+00	-0.214E+03	0.191E+03	0.219E+01	0.241E+06	0.183E-02	0.000E+00	0.000E+00
23	0.764E-03	0.193E+00	0.191E+03	0.156E+02	0.644E+06	0.130E-01	0.210E-03	0.848E+02
34	0.591E+00	0.214E+03	0.191E+03	0.156E+02	0.644E+06	0.130E-01	0.162E+00	0.657E+05

***** TOTAL ENTROPY GENERATION = 0.163E+00 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.120E+03 HP *****

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 5 ITERATIONS

TAU = 10000000.00000 ISTEP = 1 DTAU = 10000000.00000

TIME OF ANALYSIS WAS 1.562500000000000E-002 SECS

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APPENDIX H—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 2

Simulation of a Water Distribution Network

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```

GFSSP VERSION
604
GFSSP INSTALLATION PATH

ANALYST
Alok Majumdar
INPUT DATA FILE NAME
Ex2.dat
OUTPUT FILE NAME
Ex2.out
TITLE
Simulation of a water distribution network
USERSETUP
F
DENCON          GRAVITY          ENERGY          MIXTURE          THRUST          STEADY          TRANSV          SAVER
T               F               F               F               F               T               F               F
HEX             HCOEF             REACTING         INERTIA          CONDX           ADDPROP         PRINTI         ROTATION
F               F               F               F               F               F               T               F
BUOYANCY       HRATE            INVAL           MSORCE          MOVBN          TPA            VARGEO         TVM
F               F               F               F               F               F               F               F
SHEAR          PRNTIN          PRNTADD        OPVALVE         TRANSQ         CONJUG         RADIAT         WINPLOT
F               T               T               F               F               F               F               T
PRESS          INSUC           VARROT          CYCLIC          CHKVALS        WINFILE        DALTON         NOSTATS
F               F               F               F               F               T               F               F
NORMAL         SIMUL           SECONDL        NRSOLVT         IBDF           NOPLT          PRESREG        FLOWREG
F               T               T               F               1               T               T               0
TRANS_MOM      USERVARS        PSMG           ISOLVE          PLOTADD        SIUNITS        TECPLOT        MDGEN
F               F               F               1               F               F               F               F
NUM_USER_VARS  IFR_MIX         PRINTD         SATTABL         MSORIN         PRELVLV        LAMINAR        HSTAG
1               1               F               F               F               F               T               T
NNODES         NINT            NBR            NF              0
9              5              10            0
RELAXK         RELAXD          RELAX          RELAXH          RELAXNR        RELAXHC        RELAXTS
1              0.5            1              1              500 1         1              1
RHOREF        EMUREF         0.00066
62.4          0.00066
NODE          INDEX          DESCRIPTION
1            2            " Node 1"
2            1            " Node 2"
3            2            " Node 3"
4            2            " Node 4"
5            1            " Node 5"
6            1            " Node 6"
7            1            " Node 7"
8            1            " Node 8"
9            2            " Node 9"

```

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

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A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

RUN DATE:09/12/2012 14:53

TITLE :Simulation of a water distribution network
 ANALYST :Alok Majumdar
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX2\Ex2.dat
 FILEOUT :Ex2.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	CONDX	F	CONJUG	F	CYCLIC	F	DALTON	T	DENCON	T	ENERGY	F
FLOWREG	0	GRAVITY	F	HCOEF	F	HEX	F	HRATE	F	IFRMIX	F	INERTIA	F	INSUC	F
INVAL	F	MIXTURE	F	MOVBNB	F	MSORCE	F	NORMAL	F	NRSOLVT	F	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRINTI	T	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	F	SHEAR	F	SIMULA	T	SIUNITS	F	STEADY	T	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	F	TRANSV	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F														

NNODES	=	9
NINT	=	5
NBR	=	10
NF	=	0
NVAR	=	15
NHREF	=	2
RHOREF	=	62.4000 LBM/FT**3
EMUREF	=	0.6600E-03 LEM/FT-SEC

BOUNDARY NODES

NODE	P	AREA
	(PSI)	(IN^2)
1	0.5000E+02	0.0000E+00
3	0.4800E+02	0.0000E+00
4	0.4500E+02	0.0000E+00
9	0.4600E+02	0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA	MASS	HEAT
	(IN^2)	(LBM/S)	(BTU/LBM)
2	0.0000E+00	0.0000E+00	0.0000E+00
5	0.0000E+00	0.0000E+00	0.0000E+00
6	0.0000E+00	0.0000E+00	0.0000E+00
7	0.0000E+00	0.0000E+00	0.0000E+00
8	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH

UPNODE	DNNODE	OPTION
1	2	1
2	5	1
7	1	1
3	1	1
5	7	1
7	6	1
5	8	1
6	8	1
8	4	1
9	9	1

BRANCH	OPTION	LENGTH	DIA	EPSPD	ANGLE	AREA
12	-1:	0.120E+03	0.600E+01	0.180E-02	0.000E+00	0.283E+02
25	-1:	0.240E+04	0.600E+01	0.180E-02	0.000E+00	0.283E+02
27	-1:	0.240E+04	0.500E+01	0.180E-02	0.000E+00	0.196E+02
53	-1:	0.120E+03	0.500E+01	0.180E-02	0.000E+00	0.196E+02
57	-1:	0.144E+04	0.400E+01	0.180E-02	0.000E+00	0.126E+02
56	-1:	0.240E+04	0.400E+01	0.180E-02	0.000E+00	0.126E+02
78	-1:	0.240E+04	0.400E+01	0.180E-02	0.000E+00	0.126E+02
68	-1:	0.144E+04	0.400E+01	0.180E-02	0.000E+00	0.126E+02
64	-1:	0.120E+03	0.400E+01	0.180E-02	0.000E+00	0.126E+02

BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
 89 0.120E+03 0.500E+01 0.180E-02 0.000E+00 0.196E+02

INITIAL GUESS FOR INTERNAL NODES

NODE P (PSI)
 2 0.4960E+02
 5 0.4840E+02
 6 0.4740E+02
 7 0.4920E+02
 8 0.4640E+02

TRIAL SOLUTION

BRANCH	DELP (PSI)	FLOWRATE (LBM/SEC)
12	0.0000	0.0100
25	0.0000	0.0100
27	0.0000	0.0100
53	0.0000	0.0100
57	0.0000	0.0100
56	0.0000	0.0100
78	0.0000	0.0100
68	0.0000	0.0100
64	0.0000	0.0100
89	0.0000	0.0100

SOLUTION

INTERNAL NODES
 NODE P (PSI) EM (LBM)
 2 0.4979E+02 0.0000E+00
 5 0.4810E+02 0.0000E+00
 6 0.4535E+02 0.0000E+00
 7 0.4833E+02 0.0000E+00
 8 0.4600E+02 0.0000E+00

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.301E-02	0.210E+00	0.100E+03	0.817E+01	0.386E+06	0.000E+00	0.135E-03	0.484E+02
25	0.609E-01	0.169E+01	0.631E+02	0.515E+01	0.244E+06	0.000E+00	0.687E-03	0.246E+03
27	0.154E+00	0.146E+01	0.370E+02	0.435E+01	0.171E+06	0.000E+00	0.349E-03	0.125E+03
53	0.762E-02	0.104E+00	0.444E+02	0.522E+01	0.206E+06	0.000E+00	0.300E-04	0.107E+02
57	0.301E+00	-0.224E+00	-0.104E+02	-0.190E+01	0.599E+05	0.000E+00	0.150E-04	0.536E+01
56	0.469E+00	0.275E+01	0.291E+02	0.534E+01	0.168E+06	0.000E+00	0.516E-03	0.184E+03
78	0.471E+00	0.232E+01	0.267E+02	0.490E+01	0.154E+06	0.000E+00	0.400E-03	0.143E+03
68	0.289E+00	-0.650E+00	-0.180E+02	-0.331E+01	0.104E+06	0.000E+00	0.755E-04	0.270E+02
64	0.230E-01	0.355E+00	0.471E+02	0.864E+01	0.272E+06	0.000E+00	0.108E-03	0.385E+02

```

89      0.858E-02      0.447E-02      0.866E+01      0.102E+01      0.401E+05      0.000E+00      0.249E-06      0.892E-01

***** TOTAL ENTROPY GENERATION = 0.232E-02 BTU/(R-SEC) *****
**** TOTAL WORK LOST = 0.151E+01 HP ****

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 11 ITERATIONS
TAU = 10000000.000000 ISTEP = 1 DTAU =
10000000.000000

*****
TIME OF ANALYSIS WAS 0.000000000000000E+00 SECS
*****

```


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APPENDIX I—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 3

Simulation of a Compressible Flow in a Converging-Diverging Nozzle

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Example 3 Input File	17
Example 3 Output File	24

NODE	PRES	(PSI)	TEMP	(DEGF)	MASS	SOURC	HEAT	SOURC	THRST	AREA	CONCENTRATION
11	150				1000	0	0	0	0	0	0
12	14.7				60	0	0	0	0	0	0
13	14.7				60	0	0	0	0	0	0
14	14.7				60	0	0	0	0	0	0
15	14.7				60	0	0	0	0	0	0
16	14.7				60	0	0	0	0	0	0
17	14.7				60	0	0	0	0	0	0
1	150				1000	0	0	0	0	0	0
2	14.7				60	0	0	0	0	0	0
3	14.7				60	0	0	0	0	0	0
4	14.7				60	0	0	0	0	0	0
5	14.7				60	0	0	0	0	0	0
6	14.7				60	0	0	0	0	0	0
7	14.7				60	0	0	0	0	0	0
8	14.7				60	0	0	0	0	0	0
9	14.7				60	0	0	0	0	0	0
10	14.7				60	0	0	0	0	0	0
11	14.7				60	0	0	0	0	0	0
12	14.7				60	0	0	0	0	0	0
13	14.7				60	0	0	0	0	0	0
14	14.7				60	0	0	0	0	0	0
15	14.7				60	0	0	0	0	0	0
16	14.7				60	0	0	0	0	0	0
17	60				1000	0	0	0	0	0	0
INODE					NUMBER	NAMEBR					
2					2	12 23					
3					2	23 34					
4					2	34 45					
5					2	45 56					
6					2	56 67					
7					2	67 78					
8					2	78 89					
9					2	89 910					
10					2	910 1011					
11					2	1011 1112					
12					2	1112 1213					
13					2	1213 1314					
14					2	1314 1415					
15					2	1415 1516					
16					2	1516 1617					
BRANCH	UPNODE		DNNODE		OPTION	DESCRIPTION					
12	1		2		2	"Restrict 12"					
23	2		3		2	"Restrict 23"					
34	3		4		2	"Restrict 34"					
45	4		5		2	"Restrict 45"					
56	5		6		2	"Restrict 56"					

45	1	34		
56	1	45		
67	1	56		
78	1	67		
89	1	78		
910	1	89		
1011	1	910		
1112	1	1011		
1213	1	1112		
1314	1	1213		
1415	1	1314		
1516	1	1415		
1617	1	1516		
BRANCH		NODBR		NMDBR
12	1	23		
23	1	34		
34	1	45		
45	1	56		
56	1	67		
67	1	78		
78	1	89		
89	1	910		
910	1	1011		
1011	1	1112		
1112	1	1213		
1213	1	1314		
1314	1	1415		
1415	1	1516		
1516	1	1617		
1617	0			
BRANCH				
12				
UPSTRM BR.		ANGLE		
DNSTRM BR.		ANGLE		
23		0.00000		
BRANCH				
23				
UPSTRM BR.		ANGLE		
12		0.00000		
DNSTRM BR.		ANGLE		
34		0.00000		
BRANCH				
34				
UPSTRM BR.		ANGLE		
23		0.00000		
DNSTRM BR.		ANGLE		
45		0.00000		

BRANCH
45 UPSTRM BR. ANGLE
34 0.00000
DNSTRM BR. ANGLE
56 0.00000
BRANCH
56 UPSTRM BR. ANGLE
45 0.00000
DNSTRM BR. ANGLE
67 0.00000
BRANCH
67 UPSTRM BR. ANGLE
56 0.00000
DNSTRM BR. ANGLE
78 0.00000
BRANCH
78 UPSTRM BR. ANGLE
67 0.00000
DNSTRM BR. ANGLE
89 0.00000
BRANCH
89 UPSTRM BR. ANGLE
78 0.00000
DNSTRM BR. ANGLE
910 0.00000
BRANCH
910 UPSTRM BR. ANGLE
89 0.00000
DNSTRM BR. ANGLE
1011 0.00000
BRANCH
1011 UPSTRM BR. ANGLE
910 0.00000
DNSTRM BR. ANGLE
1112 0.00000
BRANCH
1112 UPSTRM BR. ANGLE
1011 0.00000
DNSTRM BR. ANGLE

```

1213      0.00000
BRANCH
1213      UPSTRM BR.      ANGLE
1112      0.00000
DNSTRM BR.      ANGLE
1314      0.00000
BRANCH
1314      UPSTRM BR.      ANGLE
1213      0.00000
DNSTRM BR.      ANGLE
1415      0.00000
BRANCH
1415      UPSTRM BR.      ANGLE
1314      0.00000
DNSTRM BR.      ANGLE
1516      0.00000
BRANCH
1516      UPSTRM BR.      ANGLE
1415      0.00000
DNSTRM BR.      ANGLE
1617      0.00000
BRANCH
1617      UPSTRM BR.      ANGLE
1516      0.00000
DNSTRM BR.      ANGLE
NUMBER OF BRANCHES WITH INERTIA
16
12
23
34
45
56
67
78
89
910
1011
1112
1213
1314
1415
1516

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 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/12/2012 14:56

TITLE :Simulation of Compressible Flow in a Converging-Diverging Nozzle
 ANALYST :jwb
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX3\Ex3.dat
 FILEOUT :Ex3.out

OPTION VARIABLES

ADDPROP	BUOYANCY	CONDX	CONJUG	CYCLIC	DALTON	DENCON	ENERGY
F	F	F	F	F	F	F	T
FLOWREG	GRAVITY	HCOEF	HEX	HRATE	IFRMIX	INERTIA	INSUC
0	F	F	F	F	1	T	F
INVAL	MIXTURE	MOVBN	MSORCE	NORMAL	NRSOLVT	OPVALVE	PLOTADD
F	F	F	F	F	F	F	F
PRESREG	PRESS	PRINTI	PRNTADD	PRNTIN	RADIATION	REACTING	ROTATION
0	F	F	F	F	F	F	F
SAVER	SECONDL	SHEAR	SIMULA	SIUNITS	STEADY	THRUST	TPA
F	T	F	T	F	T	F	F
TRANS_MOM	TRANSQ	TRANSV	TVM	TWOD	USRVAR	VARGEO	VARROT
F	F	F	F	F	F	F	F
RLFVLV							
F							

NNODES = 17
 NINT = 15
 NBR = 16
 NF = 1
 NVAR = 31
 Nhref = 2

FLUIDS: H2O

BOUNDARY NODES		P	T	RHO	AREA			
NODE	(PSI)	(F)	(LEM/FT^3)	(IN^2)				
1	0.1500E+03	0.1000E+04	0.1736E+00	0.0000E+00				
17	0.6000E+02	0.1000E+04	0.6918E-01	0.0000E+00				
SOLUTION INTERNAL NODES								
NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY		
2	0.1500E+03	0.1000E+04	0.9939E+00	0.1736E+00	0.0000E+00	0.1000E+01		
3	0.1373E+03	0.9725E+03	0.9939E+00	0.1620E+00	0.0000E+00	0.1000E+01		
4	0.1197E+03	0.9305E+03	0.9941E+00	0.1455E+00	0.0000E+00	0.1000E+01		
5	0.1045E+03	0.8897E+03	0.9942E+00	0.1308E+00	0.0000E+00	0.1000E+01		
6	0.8213E+02	0.8199E+03	0.9944E+00	0.1084E+00	0.0000E+00	0.1000E+01		
7	0.5974E+02	0.7320E+03	0.9946E+00	0.8463E-01	0.0000E+00	0.1000E+01		
8	0.4267E+02	0.6445E+03	0.9948E+00	0.6523E-01	0.0000E+00	0.1000E+01		
9	0.3498E+02	0.5953E+03	0.9950E+00	0.5597E-01	0.0000E+00	0.1000E+01		
10	0.4116E+02	0.6354E+03	0.9949E+00	0.6344E-01	0.0000E+00	0.1000E+01		
11	0.5165E+02	0.6935E+03	0.9947E+00	0.7560E-01	0.0000E+00	0.1000E+01		
12	0.5650E+02	0.7172E+03	0.9946E+00	0.8105E-01	0.0000E+00	0.1000E+01		
13	0.5839E+02	0.7259E+03	0.9946E+00	0.8315E-01	0.0000E+00	0.1000E+01		
14	0.5930E+02	0.7301E+03	0.9946E+00	0.8414E-01	0.0000E+00	0.1000E+01		
15	0.5974E+02	0.7320E+03	0.9946E+00	0.8463E-01	0.0000E+00	0.1000E+01		
16	0.5991E+02	0.7328E+03	0.9946E+00	0.8482E-01	0.0000E+00	0.1000E+01		
BRANCHES								
BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.000E+00	0.000E+00	0.336E+00	0.778E+03	0.376E+06	0.342E+00	0.000E+00	0.000E+00
23	0.000E+00	0.127E+02	0.336E+00	0.103E+04	0.432E+06	0.452E+00	0.000E+00	0.000E+00
34	0.000E+00	0.176E+02	0.336E+00	0.133E+04	0.485E+06	0.592E+00	0.000E+00	0.000E+00
45	0.000E+00	0.153E+02	0.336E+00	0.160E+04	0.520E+06	0.720E+00	0.000E+00	0.000E+00
56	0.000E+00	0.223E+02	0.336E+00	0.195E+04	0.563E+06	0.890E+00	0.000E+00	0.000E+00
67	0.000E+00	0.224E+02	0.336E+00	0.229E+04	0.591E+06	0.107E+01	0.000E+00	0.000E+00
78	0.000E+00	0.171E+02	0.336E+00	0.254E+04	0.595E+06	0.123E+01	0.000E+00	0.000E+00
89	0.000E+00	0.769E+01	0.336E+00	0.258E+04	0.576E+06	0.130E+01	0.000E+00	0.000E+00
910	0.000E+00	-0.618E+01	0.336E+00	0.219E+04	0.518E+06	0.112E+01	0.000E+00	0.000E+00
1011	0.000E+00	-0.105E+02	0.336E+00	0.135E+04	0.415E+06	0.682E+00	0.000E+00	0.000E+00
1112	0.000E+00	-0.485E+01	0.336E+00	0.840E+03	0.336E+06	0.413E+00	0.000E+00	0.000E+00
1213	0.000E+00	-0.189E+01	0.336E+00	0.602E+03	0.288E+06	0.293E+00	0.000E+00	0.000E+00
1314	0.000E+00	-0.903E+00	0.336E+00	0.465E+03	0.254E+06	0.226E+00	0.000E+00	0.000E+00
1415	0.000E+00	-0.443E+00	0.336E+00	0.393E+03	0.234E+06	0.190E+00	0.000E+00	0.000E+00
1516	0.000E+00	-0.174E+00	0.336E+00	0.365E+03	0.226E+06	0.177E+00	0.000E+00	0.000E+00
1617	0.000E+00	-0.857E-01	0.336E+00	0.351E+03	0.221E+06	0.170E+00	0.000E+00	0.000E+00

```
***** TOTAL ENTROPY GENERATION = 0.000E+00 BTU/(R-SEC) *****
***** TOTAL WORK LOST = 0.000E+00 HP *****
*****
TIME OF ANALYSIS WAS 3.125000000000000E-002 SECS
*****
```

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APPENDIX J—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 4

Simulation of the Mixing of Combustion Gases and a Cold Gas Stream

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Example 4 Input File	29
Example 4 Output File	31

GFSSP VERSION
604
GFSSP INSTALLATION PATH

ANALYST
ALOK MAJUMDAR
INPUT DATA FILE NAME
Ex4.dat
OUTPUT FILE NAME
Ex4.out

TITLE
Simulation of the Mixing of Combustion Gases and a Cold Gas Stream
USERVAR

F	DENCON	GRAVITY	ENERGY	MIXTURE	THRUST	STEADY	TRANSV	SAVER
F	F	F	T	T	F	T	F	F
F	HEX	HCOEF	REACTING	INERTIA	CONDX	ADDPROP	PRINTI	ROTATION
F	F	F	F	F	F	F	T	F
F	BUOYANCY	HRATE	INVAL	MSORCE	MOVBND	TPA	VARGEO	TVM
F	F	T	F	F	F	F	F	F
F	SHEAR	PRNTIN	PRNTADD	OPVALVE	TRANSQ	CONJUG	RADIAT	WINPLOT
F	F	T	T	F	F	F	F	T
F	PRESS	INSUC	VARROT	CYCLIC	CHKVALS	WINFILE	DALTON	NOSTATS
F	F	F	F	F	F	T	F	F
F	NORMAL	SIMUL	SECONDL	NRSOLVT	IBDF	NOPLT	PRESREG	FLOWREG
F	F	F	F	F	1	T	0	0
F	TRANS_MOM	USERVARS	PSMG	ISOLVE	PLOTADD	SIUNITS	TECPLOT	MDGEN
F	F	F	F	1	F	F	F	F
F	NUM_USER_VARS	IFR_MIX	PRINTD	SATTABL	MSORIN	PRELVIV	LAMINAR	HSTAG
1	1	F	F	F	F	F	T	T
NNODES	NINT	NBR	NF	NF				
4	1	3	2	2				
RELAXK	RELAXD	RELAXH	RELAXH	CC	NITER	RELAXNR	RELAXHC	RELAXTS
1	0.5	0.75	0.75	0.0001	500	1	1	1
NFLUID(1), I = 1, NF								
6	11							
NODE	INDEX	DESCRIPTION	MASS SOURC	HEAT SOURC	THRST AREA	CONCENTRATION		
1	2	" Node 1"	1500	0	0	0	0.1	0.9
2	2	" Node 2"	80	0	0	0	1.0	
3	1	" Node 3"	1500	0	0	0	0.1	0.9
4	2	" Node 4"	80	0	0	0	0.5	0.5
NODE	PRES (PSI)	TEMP (DEGF)						
1	500	1500						
2	500	80						
3	338.2	1500						
4	14.7	80						
INODE	NUMBER	NAMEBR						

BRANCH	UPNODE	3	DNNODE	13	23	34	DESCRIPTION
13	1		3	2		"Restrict 13"	
23	2		3	2		"Restrict 23"	
34	3		4	22		"Orifice 34"	
BRANCH		OPTION -2		FLOW COEFF	AREA		
13				0.6	1		
BRANCH		OPTION -2		FLOW COEFF	AREA		
23				0.6	1		
BRANCH		OPTION -22		AREA	FLOW COEF		
34				1	0.6		

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

RUN DATE:09/12/2012 14:57

TITLE :Simulation of the Mixing of Combustion Gases and a Cold Gas Stream
 ANALYST :ALOK MAJUMDAR
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX4\Ex4.dat
 FILEOUT :Ex4.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	CONDX	F	CONJUG	F	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	F	HCOEF	F	HEX	F	HRATE	T	IFRMIX	1	INERTIA	F	INSUC	F
INVAL	F	MIXTURE	F	MOVBN	F	MSORCE	F	NORMAL	F	NRSOLVT	F	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRINTI	T	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	F	SHEAR	F	SIMULA	F	SIUNITS	F	STEADY	T	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	F	TRANSV	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F														

NNODES = 4
 NINT = 1
 NBR = 3
 NF = 2
 NVAR = 4
 Nhref = 2

FLUIDS: O2 H2O

BOUNDARY NODES

NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)	CONCENTRATIONS
1	0.5000E+03	0.1500E+04	0.4419E+00	0.0000E+00	H2O 0.1000E+00 0.9000E+00
2	0.5000E+03	0.8000E+02	0.2819E+01	0.0000E+00	0.1000E+01 0.0000E+00
4	0.1470E+02	0.8000E+02	0.4727E+02	0.0000E+00	0.5000E+00 0.5000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)
3	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH	UPNODE	DNNODE	OPTION
13	1	3	2
23	2	3	2
34	3	4	22

BRANCH OPTION -2: FLOW COEF AREA

BRANCH	UPNODE	DNNODE	AREA
13	1	3	0.600E+00

BRANCH OPTION -2: FLOW COEF AREA

BRANCH	UPNODE	DNNODE	AREA
23	2	3	0.600E+00

BRANCH OPTION -22 FLOW COEF AREA

BRANCH	UPNODE	DNNODE	AREA
34	3	4	0.600E+00

INITIAL GUESS FOR INTERNAL NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	CONCENTRATIONS
3	0.3382E+03	0.1500E+04	0.9968E+00	0.3040E+00	O2 0.1000E+00 H2O 0.9000E+00

TRIAL SOLUTION

BRANCH	DELP (PSI)	FLOWRATE (LBM/SEC)
13	0.0000	0.0100
23	0.0000	0.0100
34	0.0000	0.0100

SOLUTION

INTERNAL NODES	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	CONC
3	0.4799E+03	0.7045E+03	0.9865E+00	0.1040E+01	0.0000E+00	O2 0.7447E+00 H2O 0.2553

NODE	H	ENTROPY	EMU	COND	CP	GAMA
3	0.4799E+03	0.7045E+03	0.9865E+00	0.1040E+01	0.0000E+00	0.7447E+00 0.2553

BTU/LB BTU/LB-R LBM/FT-SEC BTU/FT-S-R BTU/LB-R
 3 0.0000E+00 0.1533E+01 0.2091E-04 0.8265E-05 0.3819E+00 0.1293E+01

BRANCHES

BRANCH	KFACTOR (LBF-S ² /(LBM-FT) ²)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
13	0.203E+04	0.201E+02	0.120E+01	0.390E+03	0.578E+06	0.152E+00	0.515E-02	0.786E+04
23	0.318E+03	0.201E+02	0.302E+01	0.154E+03	0.286E+07	0.139E+00	0.741E-02	0.311E+04
34	0.861E+03	0.465E+03	0.422E+01	0.585E+03	0.273E+07	0.349E+00	0.686E-01	0.622E+05

WARNING! CHKGASP: T out of fluid property range at node 1

WARNING! CHKGASP: T out of fluid property range at node 3

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 27 ITERATIONS
 TAU = 10000000.00000 ISTEP = 1 DTAU = 10000000.000000

TIME OF ANALYSIS WAS 0.00000000000000E+00 SECS

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APPENDIX K—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 5

Simulation of a Flow System Involving a Heat Exchanger

<u>Contents</u>	<u>Page</u>
Example 5 Input File	36
Example 5 Output File	38

GFSSP VERSION
604
GFSSP INSTALLATION PATH

ANALYST
Todd Steadman
INPUT DATA FILE NAME
Ex5.dat
OUTPUT FILE NAME
Ex5.out

TITLE
Simulation of a Flow System Involving a Heat Exchanger
USERSETUP

F	DENCON	GRAVITY	ENERGY	MIXTURE	THRUST	STEADY	TRANSV	SAVER
F	F	F	T	F	F	T	F	F
F	HEX	HCOEF	REACTING	INERTIA	CONDX	ADDPROP	PRINTI	ROTATION
T	T	F	F	F	F	F	F	F
F	BUOYANCY	HRATE	INVAL	MSORCE	MOVBND	TPA	VARGEO	TVM
F	F	T	F	F	F	F	F	F
F	SHEAR	PRNTIN	PRNTADD	OPVALVE	TRANSQ	CONJUG	RADIAT	WINPLOT
F	F	T	F	F	F	F	F	T
F	PRESS	INSUC	VARROT	CYCLIC	CHKVALS	WINFILE	DALTON	NOSTATS
F	F	F	F	F	F	T	F	F
F	NORMAL	SIMUL	SECONDL	NRSOLVT	IBDF	NOFLT	PRESREG	FLOWREG
F	F	T	T	F	1	T	0	0
F	TRANS_MOM	USERVARS	PSMG	ISOLVE	PLOTADD	SIUNITS	TECPLOT	MDGEN
F	F	F	F	1	F	F	F	F
1	NUM_USER_VARS	IFR_MIX	PRINTD	SATTABL	MSORIN	PRELVLV	LAMINAR	HSTAG
1	1	F	F	F	F	F	T	T
8	NNODES	NINT	NBR	NF				
4	4	6	6	1				
RELAXK	RELAXD	RELAXH	RELAXH	CC	NITER	RELAXNR	RELAXHC	RELAXTS
1	0.5	1	1	0.0001	500	1	1	1
NFLUID(1),	I = 1, NF							
11								
11	INDEX	DESCRIPTION						
1	2	" Node 1"						
2	1	" Node 2"						
3	1	" Node 3"						
4	2	" Node 4"						
5	2	" Node 5"						
6	1	" Node 6"						
7	1	" Node 7"						
8	2	" Node 8"						
1	50	100	0	0	0	0	0	0
NODE	PRES (PSI)	TEMP (DEGF)	MASS SOURC	HEAT SOURC	THRST AREA	CONCENTRATION		

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

RUN DATE:09/12/2012 14:57

TITLE :Simulation of a Flow System Involving a Heat Exchanger
 ANALYST :Todd Steadman
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX5\Ex5.dat
 FILEOUT :Ex5.out

OPTION VARIABLES

ADDPROP	BUOYANCY	CONDX	CONJUG	CYCLIC	DALTON	DENCON	ENERGY
F	F	F	F	F	F	F	T
FLOWREG	GRAVITY	HCOEF	HEX	HRATE	IFRMIX	INERTIA	INSUC
0	F	T	T	T	1	F	F
INVAL	MIXTURE	MOVBN	MSORCE	NORMAL	NRSOLVT	OPVALVE	PLOTADD
F	F	F	F	F	F	F	F
PRESREG	PRESS	PRINTI	PRNTADD	PRNTIN	RADIATION	REACTING	ROTATION
0	F	F	F	T	F	F	F
SAVER	SECONDL	SHEAR	SIMULA	SIUNITS	STEADY	THRUST	TPA
F	T	F	T	F	T	F	F
TRANS_MOM	TRANSQ	TRANSV	TVM	TWOD	USRVAR	VARGEO	VARROT
F	F	F	F	F	F	F	F
RLFVLV							
F							

NNODES = 8
 NINT = 4
 NBR = 6
 NF = 1
 NVAR = 10
 NHREF = 2

FLUIDS: H2O

BOUNDARY NODES	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)
1	0.5000E+02	0.1000E+03	0.6200E+02	0.0000E+00
4	0.2500E+02	0.6000E+02	0.6237E+02	0.0000E+00
5	0.5000E+02	0.6000E+02	0.6238E+02	0.0000E+00
8	0.2500E+02	0.6000E+02	0.6237E+02	0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)	EPSPD	ANGLE	AREA
2	0.0000E+00	0.0000E+00	0.0000E+00	0.000E+00	0.000E+00	0.491E-01
3	0.0000E+00	0.0000E+00	0.0000E+00	0.000E+00	0.000E+00	0.491E-01
6	0.0000E+00	0.0000E+00	0.0000E+00	0.000E+00	0.000E+00	0.491E-01
7	0.0000E+00	0.0000E+00	0.0000E+00	0.000E+00	0.000E+00	0.491E-01

BRANCH	UPNODE	DNNODE	OPTION	EPSPD	ANGLE	AREA
12	1	2	1	0.000E+00	0.000E+00	0.491E-01
23	2	3	1	0.000E+00	0.000E+00	0.491E-01
34	3	4	1	0.000E+00	0.000E+00	0.491E-01
56	5	6	1	0.000E+00	0.000E+00	0.491E-01
67	6	7	1	0.000E+00	0.000E+00	0.491E-01
78	7	8	1	0.000E+00	0.000E+00	0.491E-01

SOLUTION INTERNAL NODES	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.4185E+02	0.1000E+03	0.2025E-02	0.6200E+02	0.0000E+00	0.0000E+00
3	0.3370E+02	0.7180E+02	0.1709E-02	0.6229E+02	0.0000E+00	0.0000E+00
6	0.4163E+02	0.6002E+02	0.2157E-02	0.6237E+02	0.0000E+00	0.0000E+00
7	0.3327E+02	0.6451E+02	0.1709E-02	0.6235E+02	0.0000E+00	0.0000E+00

BRANCHES	KFACTOR (LBF-S ² /(LBM-FT) ²)	DELTA P (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.150E+04	0.815E+01	0.885E+00	0.419E+02	0.118E+06	0.333E-01	0.385E-04	0.167E+02
23	0.150E+04	0.815E+01	0.885E+00	0.419E+02	0.118E+06	0.333E-01	0.385E-04	0.167E+02
34	0.160E+04	0.870E+01	0.885E+00	0.417E+02	0.845E+05	0.343E-01	0.430E-04	0.178E+02
56	0.412E+02	0.837E+01	0.541E+01	0.636E+02	0.219E+06	0.530E-01	0.258E-03	0.104E+03
67	0.412E+02	0.837E+01	0.541E+01	0.636E+02	0.219E+06	0.530E-01	0.258E-03	0.104E+03
78	0.407E+02	0.827E+01	0.541E+01	0.637E+02	0.234E+06	0.528E-01	0.253E-03	0.103E+03

***** TOTAL ENTROPY GENERATION = 0.890E-03 BTU/(R-SEC) *****

***** TOTAL WORK LOST = 0.661E+00 HP *****

TIME OF ANALYSIS WAS 0.000000000000000E+00 SECS

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APPENDIX L—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 6

Radial Flow on a Rotating Disk

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Example 6 Input File	43
Example 6 Output File	48

UPSTRM BR. ANGLE
DNSTRM BR. ANGLE
23 0.00000
BRANCH
23
UPSTRM BR. ANGLE
12 0.00000
DNSTRM BR. ANGLE
34 0.00000
BRANCH
34
UPSTRM BR. ANGLE
23 0.00000
DNSTRM BR. ANGLE
45 0.00000
BRANCH
45
UPSTRM BR. ANGLE
34 0.00000
DNSTRM BR. ANGLE
56 0.00000
BRANCH
56
UPSTRM BR. ANGLE
45 0.00000
DNSTRM BR. ANGLE
67 0.00000
BRANCH
67
UPSTRM BR. ANGLE
56 0.00000
DNSTRM BR. ANGLE
78 0.00000
BRANCH
78
UPSTRM BR. ANGLE
67 0.00000
DNSTRM BR. ANGLE
89 0.00000
BRANCH
89
UPSTRM BR. ANGLE
78 0.00000
DNSTRM BR. ANGLE
910 0.00000
BRANCH
910

UPSTRM BR. ANGLE
 89 0.00000
 DNSTRM BR. ANGLE
 1011 0.00000
 BRANCH

1011
 UPSTRM BR. ANGLE
 910 0.00000
 DNSTRM BR. ANGLE
 1112 0.00000
 BRANCH

1112
 UPSTRM BR. ANGLE
 1011 0.00000
 DNSTRM BR. ANGLE
 1213 0.00000
 BRANCH

1213
 UPSTRM BR. ANGLE
 1112 0.00000
 DNSTRM BR. ANGLE
 NUMBER OF BRANCHES WITH INERTIA

- 12
- 12
- 23
- 34
- 45
- 56
- 67
- 78
- 89
- 910
- 1011
- 1112
- 1213

9 NUMBER OF ROTATING BRANCHES

BRANCH	UPST RAD	DNST RAD	RPM	K ROT
23	1.25	2.25	5000	0.8671
34	2.25	3.625	5000	0.8158
45	3.625	4.6875	5000	0.763
56	4.6875	5.375	5000	0.7252
67	5.375	5.5	5000	0.7076
89	5.5	5.375	5000	0.7129
910	5.375	4.6875	5000	0.7349
1011	4.6875	3.625	5000	0.7824
1112	3.625	2.65	5000	0.8376

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/12/2012 14:58

TITLE :Radial Flow on a Rotating Radial Disk
 ANALYST :Paul Schallhorn
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX6\Ex6.dat
 FILEOUT :Ex6.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	CONJUG	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	F	HEX	F	IFRMIX	T	INERTIA	T	INSUC	F
INVAL	F	MIXTURE	F	MSORCE	F	NRSOLVT	F	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRNTADD	F	PRNTIN	F	RADIATION	F	REACTING	T
SAVER	F	SECONDL	F	SIMULA	T	SIUNITS	F	STEADY	T	THRUST	TPA
TRANS_MOM	F	TRANSQ	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	VARROT
RLFVLV	F										

NNODES = 13
 NINT = 11
 NBR = 12
 NF = 1
 NVAR = 23
 NHREF = 2

FLUIDS: H2O

BOUNDARY NODES		P	T	RHO	AREA
NODE	(PSI)	(F)	(LBM/FT^3)	(IN^2)	
1	0.9000E+02	0.8000E+02	0.6224E+02	0.0000E+00	
13	0.3000E+02	0.8000E+02	0.6222E+02	0.0000E+00	

SOLUTION INTERNAL NODES		TF (F)	Z	RHO	EM (LBM)	QUALITY
NODE	P (PSI)	(F)		(LBM/FT^3)		
2	0.9000E+02	0.8000E+02	0.4499E-02	0.6224E+02	0.0000E+00	0.0000E+00
3	0.1237E+03	0.8001E+02	0.6181E-02	0.6224E+02	0.0000E+00	0.0000E+00
4	0.1924E+03	0.8002E+02	0.9616E-02	0.6226E+02	0.0000E+00	0.0000E+00
5	0.2582E+03	0.8004E+02	0.1290E-01	0.6227E+02	0.0000E+00	0.0000E+00
6	0.3048E+03	0.8005E+02	0.1522E-01	0.6228E+02	0.0000E+00	0.0000E+00
7	0.3135E+03	0.8005E+02	0.1566E-01	0.6228E+02	0.0000E+00	0.0000E+00
8	0.3135E+03	0.8005E+02	0.1566E-01	0.6228E+02	0.0000E+00	0.0000E+00
9	0.3046E+03	0.8005E+02	0.1522E-01	0.6228E+02	0.0000E+00	0.0000E+00
10	0.2568E+03	0.8004E+02	0.1283E-01	0.6227E+02	0.0000E+00	0.0000E+00
11	0.1877E+03	0.8002E+02	0.9378E-02	0.6226E+02	0.0000E+00	0.0000E+00
12	0.1328E+03	0.8001E+02	0.6636E-02	0.6225E+02	0.0000E+00	0.0000E+00

BRANCHES		KFACTOR	DELTA	FLOW RATE	VELOCITY	REYN. NO.	MACH NO.	ENTROPY GEN.	LOST WORK
BRANCH	(LBM-F ² /LBM-FT ²) ²	(PSI)	(LBM/SEC)	(FT/SEC)				BTU/(R-SEC)	LBF-FT/SEC
12	0.000E+00	0.850E-11	0.729E+01	0.537E+01	0.966E+05	0.437E-02	0.000E+00	0.000E+00	0.000E+00
23	0.000E+00	-0.337E+02	0.729E+01	0.935E+01	0.128E+06	0.762E-02	0.000E+00	0.000E+00	0.000E+00
34	0.000E+00	-0.688E+02	0.729E+01	0.524E+01	0.954E+05	0.426E-02	0.000E+00	0.000E+00	0.000E+00
45	0.000E+00	-0.658E+02	0.729E+01	0.361E+01	0.792E+05	0.294E-02	0.000E+00	0.000E+00	0.000E+00
56	0.000E+00	-0.466E+02	0.729E+01	0.295E+01	0.716E+05	0.240E-02	0.000E+00	0.000E+00	0.000E+00
67	0.000E+00	-0.871E+01	0.729E+01	0.272E+01	0.688E+05	0.221E-02	0.000E+00	0.000E+00	0.000E+00
78	0.000E+00	0.859E-11	0.729E+01	0.247E+00	0.207E+05	0.201E-03	0.000E+00	0.000E+00	0.000E+00
89	0.000E+00	0.884E+01	0.729E+01	0.272E+01	0.688E+05	0.221E-02	0.000E+00	0.000E+00	0.000E+00
910	0.000E+00	0.478E+02	0.729E+01	0.295E+01	0.717E+05	0.240E-02	0.000E+00	0.000E+00	0.000E+00
1011	0.000E+00	0.692E+02	0.729E+01	0.361E+01	0.793E+05	0.294E-02	0.000E+00	0.000E+00	0.000E+00
1112	0.000E+00	0.549E+02	0.729E+01	0.487E+01	0.921E+05	0.397E-02	0.000E+00	0.000E+00	0.000E+00
1213	0.278E+03	0.103E+03	0.729E+01	0.271E+01	0.686E+05	0.221E-02	0.413E-02	0.173E+04	0.173E+04

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 6 ITERATIONS
 TAU = 100000000.000000 ISTEP = 1 DTAU = 100000000.000000

TIME OF ANALYSIS WAS 0.0000000000000000E+00 SECS

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APPENDIX M—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 7

Flow in a Long Bearing Squeeze Film Damper

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Example 7 Input File	53
Example 7 Output File	57

GFSSP VERSION
604
GFSSP INSTALLATION PATH
ANALYST
Paul Schallhorn
INPUT DATA FILE NAME
Ex7.dat
OUTPUT FILE NAME
Ex7.out
TITLE
Flow in a Long Bearing Squeeze Film Damper
USER
SETUP

DENCON	F	GRAVITY	F	ENERGY	F	MIXTURE	F	THRUST	F	STEADY	T	TRANSV	F	SAVER	F
HEX	T	HCOEF	F	REACTING	F	INERTIA	F	CONDX	F	ADDPROP	F	PRINTI	F	ROTATION	F
BUOYANCY	F	HRATE	F	INVAL	F	MSORCE	F	MOVBND	F	TPA	F	VARGEO	F	TVM	F
SHEAR	F	PRNTIN	T	PRNTADD	F	OPVALVE	F	TRANSQ	T	CONJUG	F	RADIAT	F	WINPLOT	F
PRESS	F	INSUC	F	VARROT	F	CYCLIC	F	CHKVALS	F	WINFILE	F	DALTON	F	NOSTATS	F
NORMAL	F	SIMUL	F	SECONDL	F	NRSOLVT	F	IBDF	F	NOFLT	T	PRESREG	F	FLOWREG	F
TRANS_MOM	F	USERSVARS	T	PSMG	F	ISOLVE	F	1	T	SIUNITS	T	TECPLOT	F	0	0
NUM_USER_VARS	F	IFR_MIX	F	PRINTD	F	SATTABL	F	PLOTADD	F	PRELVIV	F	LAMINAR	F	MDGEN	F
1	1	0.5	F	RELAX	F	0.0001	F	MSORIN	F	RELAXNR	F	T	T	HSTAG	F
NNODES	NINT	NBR	NBR	RELAXH	CC	0.0001	NITER	500	1	RELAXHC	1	RELAXTS	1	RELAXTS	1
20	18	19	RELAX	EMUREF	0.005932	INDEX	DESCRIPTION								
1	0.5	1	1	0.005932	2	" Node 1"									
RHOREF	57.806	1	1	" Node 2"	1	" Node 3"									
1	1	1	1	" Node 4"	1	" Node 5"									
1	1	1	1	" Node 6"	1	" Node 7"									
1	1	1	1	" Node 8"	1	" Node 9"									
1	1	1	1	" Node 10"	1	" Node 10"									

BRANCH	UPNODE	DNNODE	OPTION	DESCRIPTION	WIDTH	TYPE	AREA
17	2		1617	1718			
18	2		1718	1819			
19	2		1819	1920			
12	1	2	3	"Duct 12"	0.94	1	0.0118252
23	2	3	3	"Duct 23"	0.94	1	0.0169106
34	3	4	3	"Duct 34"	0.94	1	0.0265268
45	4	5	3	"Duct 45"	0.94	1	0.0396398
56	5	6	3	"Duct 56"	0.94	1	0.0548208
67	6	7	3	"Duct 67"	0.94	1	0.0704248
78	7	8	3	"Duct 78"	0.94	1	0.0847692
89	8	9	3	"Duct 89"	0.94	1	0.0962936
910	9	10	3	"Duct 910"	0.94	1	0.1037478
1011	10	11	3	"Duct 1011"	0.94	1	0.1063234
1112	11	12	3	"Duct 1112"	0.94	1	0.1037478
1213	12	13	3	"Duct 1213"	0.94	1	0.1037478
1314	13	14	3	"Duct 1314"	0.94	1	0.1037478
1415	14	15	3	"Duct 1415"	0.94	1	0.1037478
1516	15	16	3	"Duct 1516"	0.94	1	0.1037478
1617	16	17	3	"Duct 1617"	0.94	1	0.1037478
1718	17	18	3	"Duct 1718"	0.94	1	0.1037478
1819	18	19	3	"Duct 1819"	0.94	1	0.1037478
1920	19	20	3	"Duct 1920"	0.94	1	0.1037478
BRANCH		OPTION -3	LENGTH	HEIGHT			
12		OPTION -3	0.82673	0.01258			
23		OPTION -3	0.8267	0.01799			
34		OPTION -3	0.82673	0.02822			
45		OPTION -3	0.82673	0.04217			
56		OPTION -3	0.82673	0.05832			
67		OPTION -3	0.82673	0.07492			
78		OPTION -3	0.82673	0.09018			
89		OPTION -3	0.82673	0.10244			
910		OPTION -3	0.82673	0.11037			
1011		OPTION -3	0.82673	0.11311			
1112		OPTION -3	0.82673	0.11037			
1213		OPTION -3	0.82673	0.10244			

BRANCH	OPTION	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1314	-3	0.82673	0.09018	0.94	1	0.0847692
BRANCH		LENGTH	HEIGHT	WIDTH	TYPE	AREA
1415	-3	0.82673	0.07492	0.94	1	0.0704248
BRANCH		LENGTH	HEIGHT	WIDTH	TYPE	AREA
1516	-3	0.82673	0.05832	0.94	1	0.0548208
BRANCH		LENGTH	HEIGHT	WIDTH	TYPE	AREA
1617	-3	0.82673	0.04217	0.94	1	0.0396398
BRANCH		LENGTH	HEIGHT	WIDTH	TYPE	AREA
1718	-3	0.82673	0.02822	0.94	1	0.0265268
BRANCH		LENGTH	HEIGHT	WIDTH	TYPE	AREA
1819	-3	0.82673	0.01799	0.94	1	0.0169106
BRANCH		LENGTH	HEIGHT	WIDTH	TYPE	AREA
1920	-3	0.82673	0.01258	0.94	1	0.0118252

NUMBER OF NODES WITH MOVING BOUNDARY

18

NODE	AREAN	VBOUND
2	0.77713	0.25618
3	0.77713	0.4846
4	0.77713	0.6605
5	0.77713	0.76483
6	0.77713	0.78628
7	0.77713	0.72252
8	0.77713	0.58047
9	0.77713	0.37551
10	0.77713	0.12986
11	0.77713	-0.12986
12	0.77713	-0.37551
13	0.77713	-0.58047
14	0.77713	-0.72252
15	0.77713	-0.78628
16	0.77713	-0.76483
17	0.77713	-0.6605
18	0.77713	-0.4846
19	0.77713	-0.25618

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/12/2012 14:59

TITLE :Flow in a Long Bearing Squeeze Film Damper
 ANALYST :Paul Schallhorn
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX7\Ex7.dat
 FILEOUT :Ex7.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	CONJUG	F	CYCLIC	F	DALTON	F	DENCON	T	ENERGY	F
FLOWREG	0	GRAVITY	F	HEX	F	HRATE	T	IFRMIX	1	INERTIA	F	INSUC	F
INVAL	F	MIXTURE	F	MSORCE	F	NORMAL	F	NRSOLVT	F	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRNTADD	T	PRNTIN	F	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	F	SIMULA	T	SIUNITS	F	STEADY	T	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F												

NNODES	=	20
NINT	=	18
NBR	=	19
NF	=	0
NVAR	=	37
NHREF	=	2
RHOREF	=	57.8060 LBM/FT**3
EMUREF	=	0.5932E-02 LEM/FT-SEC

BOUNDARY NODES		
NODE	P (PSI)	AREA (IN^2)
1	0.0000E+00	0.0000E+00
20	0.0000E+00	0.0000E+00

SOLUTION INTERNAL NODES		
NODE	P (PSI)	EM (LBM)
2	0.1365E+02	0.0000E+00
3	0.1273E+02	0.0000E+00
4	0.9716E+01	0.0000E+00
5	0.7660E+01	0.0000E+00
6	0.5812E+01	0.0000E+00
7	0.4250E+01	0.0000E+00
8	0.2901E+01	0.0000E+00
9	0.1690E+01	0.0000E+00
10	0.5551E+00	0.0000E+00
11	-0.5551E+00	0.0000E+00
12	-0.1690E+01	0.0000E+00
13	-0.2901E+01	0.0000E+00
14	-0.4250E+01	0.0000E+00
15	-0.5812E+01	0.0000E+00
16	-0.7660E+01	0.0000E+00
17	-0.9716E+01	0.0000E+00
18	-0.1273E+02	0.0000E+00
19	-0.1365E+02	0.0000E+00

BRANCHES									
BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC	
12	0.440E+06	-0.136E+02	-0.668E-01	-0.141E+02	0.140E+04	0.000E+00	0.635E-05	0.227E+01	
23	0.770E+06	0.920E+00	0.131E-01	0.193E+01	0.230E+03	0.000E+00	0.841E-07	0.301E-01	
34	0.161E+05	0.301E+01	0.164E+00	0.154E+02	0.230E+04	0.000E+00	0.345E-05	0.123E+01	
45	0.216E+04	0.206E+01	0.370E+00	0.233E+02	0.425E+04	0.000E+00	0.530E-05	0.190E+01	
56	0.718E+03	0.185E+01	0.609E+00	0.277E+02	0.594E+04	0.000E+00	0.784E-05	0.280E+01	
67	0.308E+03	0.156E+01	0.854E+00	0.302E+02	0.735E+04	0.000E+00	0.929E-05	0.332E+01	
78	0.167E+03	0.135E+01	0.108E+01	0.317E+02	0.846E+04	0.000E+00	0.101E-04	0.363E+01	
89	0.110E+03	0.121E+01	0.126E+01	0.326E+02	0.927E+04	0.000E+00	0.106E-04	0.380E+01	
910	0.861E+02	0.113E+01	0.138E+01	0.331E+02	0.976E+04	0.000E+00	0.109E-04	0.389E+01	
1011	0.795E+02	0.111E+01	0.142E+01	0.332E+02	0.993E+04	0.000E+00	0.110E-04	0.392E+01	
1112	0.861E+02	0.113E+01	0.138E+01	0.331E+02	0.976E+04	0.000E+00	0.109E-04	0.389E+01	
1213	0.110E+03	0.121E+01	0.126E+01	0.326E+02	0.927E+04	0.000E+00	0.106E-04	0.380E+01	
1314	0.167E+03	0.135E+01	0.108E+01	0.317E+02	0.846E+04	0.000E+00	0.101E-04	0.363E+01	
1415	0.308E+03	0.156E+01	0.854E+00	0.302E+02	0.735E+04	0.000E+00	0.929E-05	0.332E+01	

1516	0.718E+03	0.185E+01	0.609E+00	0.277E+02	0.594E+04	0.000E+00	0.784E-05	0.280E+01
1617	0.216E+04	0.206E+01	0.370E+00	0.233E+02	0.425E+04	0.000E+00	0.530E-05	0.190E+01
1718	0.161E+05	0.301E+01	0.164E+00	0.154E+02	0.230E+04	0.000E+00	0.345E-05	0.123E+01
1819	0.770E+06	0.920E+00	0.131E-01	0.193E+01	0.230E+03	0.000E+00	0.841E-07	0.301E-01
1920	0.440E+06	-0.136E+02	-0.668E-01	-0.141E+02	0.140E+04	0.000E+00	0.635E-05	0.227E+01

***** TOTAL ENTROPY GENERATION = 0.139E-03 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.903E-01 HP *****

TIME OF ANALYSIS WAS 1.562500000000000E-002 SECS

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APPENDIX N—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 8

Simulation of the Blow Down of a Pressurized Tank

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Example 8 Input File	62
Example 8 History File	64
Example 8 Output File (Partial)	65

GFSSP VERSION
604
GFSSP INSTALLATION PATH

ANALYST
Alok Majumdar
Ex8.dat
OUTPUT FILE NAME
Ex8.out
TITLE
Simulation of the Blow Down of a Pressurized Tank
USETUP

F	DENCON	GRAVITY	ENERGY	MIXTURE	THRUST	STEADY	TRANSV	SAVER
F	HEX	HCOEF	REACTING	INERTIA	F	F	T	F
F	BUOYANCY	HRATE	INVAL	MSORCE	F	T	PRINTI	ROTATION
F	SHEAR	PRNTIN	PRNTADD	OPVALVE	F	F	VARGEO	TVM
F	PRESS	INSUC	VARROT	CYCLIC	F	F	RADIAT	WINPLOT
F	NORMAL	SIMUL	SECONDL	NRSOLVT	F	T	DALTON	NOSTATS
F	TRANS_MOM	USERSVARS	PSMG	ISOLVE	F	F	PRESREG	FLOWREG
F	NUM_USER_VARS	IFR_MIX	PRINTD	SATTABL	F	F	TECPLOT	MDGEN
1	1	1	F	F	F	F	LAMINAR	HSTAG
1	1	1	F	F	F	F	T	T
2	1	1	NBR	NF				
RELAXK	RELAXD	RELAXH	RELAXH	CC	NITER	RELAXNR	RELAXHC	RELAXTS
1	0.5	1	0.0001	0	500	1	1	1
DTAU	TIMEF	TIMEL	NPSTEP	NPSTEP	NEWSTEP	WPLSTEP	WPLBUFF	
1	0	200	25	25	1	50	1.1	
NFLUID(I), I = 1, NF								
33								
RREF	CPREF	GAMREF	EMUREF	AKREF	TREF	PREF	HREF	SREF
53.34	0.24	1.3999	1.26e-05	4.133e-06	-459	14.7	0	0
NODE	INDEX	DESCRIPTION						
1	1	" Node 1"						
2	2	" Node 2"						
NODE PRES (PSI)	TEMP (DEGF)	MASS SOURC	HEAT SOURC	THRST AREA	NODE-VOLUME	CONCENTRATION		
1	100	80	0	0	17280			
ex8hs2.dat								
INODE	NUMBER	NAMEBR						
1	1	12						

BRANCH	UPNODE	DNNODE	OPTION	DESCRIPTION
12	1	2	22	"Orifice 12"
BRANCH	OPTION	AREA	FLOW COEF	
12	-22	0.00785	1	

INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW

12	0
----	---

EXAMPLE 8 HISTORY FILE

EX8HS2.DAT

2
0 14.700 80.00 1.00
1000 14.700 80.00 1.00

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/12/2012 15:00

TITLE :Simulation of the Blow Down of a Pressurized Tank
 ANALYST :Alok Majumdar
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX8\Ex8.dat
 FILEOUT :Ex8.out

OPTION VARIABLES

ADDPROP	BUOYANCY	CONDX	CONJUG	CYCLIC	DALTON	DENCON	ENERGY
T	F	F	F	F	F	F	T
FLOWREG	GRAVITY	HCOEF	HEX	HRATE	IFRMIX	INERTIA	INSUC
0	F	F	F	F	1	F	F
INVAL	MIXTURE	MOVBNL	MSORCE	NORMAL	NRSOLVT	OPVALVE	PLOTADD
F	F	F	F	F	F	F	F
PRESREG	PRESS	PRINTI	PRNTADD	PRNTIN	RADIATION	REACTING	ROTATION
0	F	T	T	T	F	F	F
SAVER	SECONDL	SHEAR	SIMULA	SIUNITS	STEADY	THRUST	TPA
F	F	F	T	F	F	F	F
TRANS_MOM	TRANSQ	TRANSV	TVM	TWOD	USRVAR	VARGEO	VARROT
F	F	T	F	F	F	F	F
RLFVLV							
F							

NNODES = 2
 NINT = 1
 NBR = 1
 NF = 1
 NVAR = 3
 NHREF = 2

FLUIDS: IDEL

```

BOUNDARY NODES
NODE      P      T      RHO      AREA
(P      (F)      (LBM/FT^3)      (IN^2)
2      0.1470E+02      0.8000E+02      0.7354E-01      0.0000E+00

```

INPUT SPECIFICATIONS FOR INTERNAL NODES

```

NODE      AREA      MASS      HEAT
(IN^2)      (LBM/S)      (BTU/LBM)
1      0.0000E+00      0.0000E+00      0.0000E+00

```

```

BRANCH      UPNODE      DNNODE      OPTION
12      1      2
BRANCH OPTION -22 FLOW COEF AREA
12      0.100E+01      0.785E-02

```

INITIAL GUESS FOR INTERNAL NODES

```

NODE      P (PSI)      TF (F)      Z (COMP)      RHO      QUALITY
(LBM/FT^3)
1      0.1000E+03      0.8000E+02      0.1000E+01      0.5002E+00      0.0000E+00

```

TRIAL SOLUTION

```

BRANCH      DELP (PSI)      FLOWRATE (LBM/SEC)
12      0.0000      0.0000

```

```

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 9 ITERATIONS
TAU = 1.0000000000000000 ISTEP = 1 DTAU =
1.0000000000000000

```

```

:
:
:
:

```

```

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 9 ITERATIONS
TAU = 24.000000000000000 ISTEP = 24 DTAU =
1.000000000000000

    ISTEP = 25          TAU = 0.25000E+02
BOUNDARY NODES
NODE   P (PSI)      TF (F)      Z (COMP)      RHO      QUALITY
          (LBM/FT^3)
2  0.1470E+02  0.8000E+02  0.1000E+01  0.7354E-01  0.0000E+00

SOLUTION
INTERNAL NODES
NODE   P (PSI)      TF (F)      Z      RHO      EM (LBM)      QUALITY
          (LBM/FT^3)
1  0.8834E+02  0.6136E+02  0.1000E+01  0.4577E+00  0.4577E+01  0.0000E+00

NODE   H      ENTROPY      EMU      COND      CP      GAMA
      BTU/LB      BTU/LB-R      LBM/FT-SEC      BTU/FT-S-R      BTU/LB-R

1  0.1249E+03  0.1475E+01  0.1260E-04  0.4133E-05  0.2400E+00  0.1400E+01

BRANCHES
BRANCH  KFACTOR      DELP      FLOW RATE      VELOCITY      REYN. NO.      MACH NO.      ENTROPY GEN.      LOST WORK
      (LBF-S^2/(LBM-FT)^2) (PSI)      (LBM/SEC)      (FT/SEC)      (LBM/SEC)      (R-SEC)      BTU/(R-SEC)      LBF-FT/SEC
12  0.114E+08  0.736E+02  0.162E-01  0.647E+03  0.196E+06  0.579E+00  0.260E-03  0.105E+03

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 9 ITERATIONS
TAU = 25.000000000000000 ISTEP = 25 DTAU =
1.000000000000000
:
:
:
:

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 9 ITERATIONS
TAU = 99.000000000000000 ISTEP = 99 DTAU =
1.000000000000000

```


NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
1	0.9917E+02	0.1475E+01	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.204E+08	0.245E+02	0.805E-02	0.577E+03	0.976E+05	0.579E+00	0.129E-03	0.417E+02

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 9 ITERATIONS

TAU = 200.000000000000 ISTEP = 200 DTAU = 1.0000000000000000

TIME OF ANALYSIS WAS 0.1875000000000000 SECS

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APPENDIX O—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 9

A Reciprocating Piston-Cylinder

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Example 9 Input File	72
Example 9 History File	74
Example 9 Output File (Partial)	79

```

GFSSP VERSION
604
GFSSP INSTALLATION PATH

ANALYST
Paul Schallhorn
INPUT DATA FILE NAME
Ex9.dat
OUTPUT FILE NAME
Ex9.out
TITLE
A Reciprocating Piston-Cylinder
SETUP
F
DENCON          GRAVITY          ENERGY          MIXTURE          THRUST          STEADY          TRANSV          SAVER
F               F               T               F               F               F               T               F
HEX             HCOEF             REACTING        INERTIA          CONDX           ADDPROP         PRINTI         ROTATION
F               F               F               F               F               F               F               F
BUOYANCY       HRATE            INVAL          MSORCE          MOVBN          TPA            VARGEO         TVM
F               T               F               F               T               F               T               F
SHEAR          PRNTIN          PRNTADD        OPVALVE         TRANSQ         CONJUG         RADIAT         WINPLOT
F               F               T               F               F               F               F               T
PRESS          INSUC            VARROT         CYCLIC          CHKVALS        WINFILE        DALTON         NOSTATS
F               F               F               F               F               T               F               F
NORMAL         SIMUL            SECONDL        NRSOLVT         IBDF           NOFLT          PRESREG        FLOWREG
F               T               T               F               T               T               T               0
TRANS_MOM     USERVARS        PSMG          ISOLVE          PLOTADD        SIUNITS        TECPLOT        MDGEN
F               F               F               1               F               F               F               F
NUM_USER_VARS IFR_MIX         PRINTD        SATTABL         MSORIN         PRELVIV        LAMINAR        HSTAG
1               1               F               F               F               F               T               T
NNODES        NINT             NBR           NF
2               2               1
RELAXK        RELAXD          RELAXH        RELAX           RELAXNR        RELAXHC        RELAXTS
1               0.5           1             0.0001         500 1         1               1
DTAU          TIMEF           TIMEL         NPSTEP         NPWSTEP        WPLBUFF        1.1
0.0001        0              0.05         0.0001         1             50
NFLUID(1), I = 1, NF
4
NODE          INDEX          DESCRIPTION
1             1             " Node 1"
2             1             " Node 2"
NODE PRES (PSI) TEMP (DEGF) MASS SOURC  HEAT SOURC  THRST AREA  NODE-VOLUME  CONCENTRATION
1             14.7         75           0             0             0             0             0
2             14.7         75           0             0             0             0             0
ex9vg.dat
INODE        NUMBER        NAMEBR
1             1             12

```

BRANCH	UPNODE	1	DNNODE	2	12	OPTION	1	DESCRIPTION
12	1		2			1		"Pipe 12"
BRANCH		OPTION	-1	LENGTH	7			DIA
12								3

INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW

12 0

NUMBER OF NODES WITH MOVING BOUNDARY

2

NODE

1

2

EPSPD 0

ANGLE 0

AREA 0

7.0685775

VARIABLE GEOMETRY HISTORY FILE

41	0.000000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.001250	0.0000	0.0000	0.0000	0.0000	0.0000
	0.002500	0.0000	0.0000	0.0000	0.0000	0.0000
	0.003750	0.0000	0.0000	0.0000	0.0000	0.0000
	0.005000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.006250	0.0000	0.0000	0.0000	0.0000	0.0000
	0.007500	0.0000	0.0000	0.0000	0.0000	0.0000
	0.008750	0.0000	0.0000	0.0000	0.0000	0.0000
	0.010000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.011250	0.0000	0.0000	0.0000	0.0000	0.0000
	0.012500	0.0000	0.0000	0.0000	0.0000	0.0000
	0.013750	0.0000	0.0000	0.0000	0.0000	0.0000
	0.015000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.016250	0.0000	0.0000	0.0000	0.0000	0.0000
	0.017500	0.0000	0.0000	0.0000	0.0000	0.0000
	0.018750	0.0000	0.0000	0.0000	0.0000	0.0000
	0.020000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.021250	0.0000	0.0000	0.0000	0.0000	0.0000
	0.022500	0.0000	0.0000	0.0000	0.0000	0.0000
	0.023750	0.0000	0.0000	0.0000	0.0000	0.0000
	0.025000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.026250	0.0000	0.0000	0.0000	0.0000	0.0000
	0.027500	0.0000	0.0000	0.0000	0.0000	0.0000
	0.028750	0.0000	0.0000	0.0000	0.0000	0.0000
	0.030000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.031250	0.0000	0.0000	0.0000	0.0000	0.0000
	0.032500	0.0000	0.0000	0.0000	0.0000	0.0000
	0.033750	0.0000	0.0000	0.0000	0.0000	0.0000
	0.035000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.036250	0.0000	0.0000	0.0000	0.0000	0.0000
	0.037500	0.0000	0.0000	0.0000	0.0000	0.0000
	0.038750	0.0000	0.0000	0.0000	0.0000	0.0000
	0.040000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.041250	0.0000	0.0000	0.0000	0.0000	0.0000
	0.042500	0.0000	0.0000	0.0000	0.0000	0.0000
	0.043750	0.0000	0.0000	0.0000	0.0000	0.0000
	0.045000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.046250	0.0000	0.0000	0.0000	0.0000	0.0000
	0.047500	0.0000	0.0000	0.0000	0.0000	0.0000
	0.048750	0.0000	0.0000	0.0000	0.0000	0.0000
	0.050000	0.0000	0.0000	0.0000	0.0000	0.0000
	BRANCH VOLUME					
	0.000000	49.48004	0.0000	100.000	0.0000	0.0000
	0.001250	49.21895	0.0000	100.000	0.0000	0.0000

0.002500	48.44213	0.0000	100.000	0.0000
0.003750	47.16871	0.0000	100.000	0.0000
0.005000	45.43005	0.0000	100.000	0.0000
0.006250	43.26896	0.0000	100.000	0.0000
0.007500	40.73865	0.0000	100.000	0.0000
0.008750	37.90143	0.0000	100.000	0.0000
0.010000	34.82716	0.0000	100.000	0.0000
0.011250	31.59153	0.0000	100.000	0.0000
0.012500	28.27423	0.0000	100.000	0.0000
0.013750	24.95692	0.0000	100.000	0.0000
0.015000	21.72130	0.0000	100.000	0.0000
0.016250	18.64704	0.0000	100.000	0.0000
0.017500	15.80983	0.0000	100.000	0.0000
0.018750	13.27954	0.0000	100.000	0.0000
0.020000	11.11847	0.0000	100.000	0.0000
0.021250	9.379835	0.0000	100.000	0.0000
0.022500	8.106441	0.0000	100.000	0.0000
0.023750	7.329646	0.0000	100.000	0.0000
0.025000	7.068578	0.0000	100.000	0.0000
0.026250	7.329646	0.0000	100.000	0.0000
0.027500	8.106441	0.0000	100.000	0.0000
0.028750	9.379835	0.0000	100.000	0.0000
0.030000	11.11847	0.0000	100.000	0.0000
0.031250	13.27954	0.0000	100.000	0.0000
0.032500	15.80983	0.0000	100.000	0.0000
0.033750	18.64704	0.0000	100.000	0.0000
0.035000	21.72130	0.0000	100.000	0.0000
0.036250	24.95692	0.0000	100.000	0.0000
0.037500	28.27423	0.0000	100.000	0.0000
0.038750	31.59153	0.0000	100.000	0.0000
0.040000	34.82716	0.0000	100.000	0.0000
0.041250	37.90143	0.0000	100.000	0.0000
0.042500	40.73865	0.0000	100.000	0.0000
0.043750	43.26896	0.0000	100.000	0.0000
0.045000	45.43005	0.0000	100.000	0.0000
0.046250	47.16871	0.0000	100.000	0.0000
0.047500	48.44213	0.0000	100.000	0.0000
0.048750	49.21895	0.0000	100.000	0.0000
0.050000	49.48004	0.0000	100.000	0.0000
BRANCH AREA				
0.000000	7.06858347	1.0000	1.0000	1.0000
0.001250	7.06858347	1.0000	1.0000	1.0000
0.002500	7.06858347	1.0000	1.0000	1.0000
0.003750	7.06858347	1.0000	1.0000	1.0000
0.005000	7.06858347	1.0000	1.0000	1.0000
0.006250	7.06858347	1.0000	1.0000	1.0000
0.007500	7.06858347	1.0000	1.0000	1.0000

0.008750	7.06858347	1.0000	1.0000	1.0000
0.010000	7.06858347	1.0000	1.0000	1.0000
0.011250	7.06858347	1.0000	1.0000	1.0000
0.012500	7.06858347	1.0000	1.0000	1.0000
0.013750	7.06858347	1.0000	1.0000	1.0000
0.015000	7.06858347	1.0000	1.0000	1.0000
0.016250	7.06858347	1.0000	1.0000	1.0000
0.017500	7.06858347	1.0000	1.0000	1.0000
0.018750	7.06858347	1.0000	1.0000	1.0000
0.020000	7.06858347	1.0000	1.0000	1.0000
0.021250	7.06858347	1.0000	1.0000	1.0000
0.022500	7.06858347	1.0000	1.0000	1.0000
0.023750	7.06858347	1.0000	1.0000	1.0000
0.025000	7.06858347	1.0000	1.0000	1.0000
0.026250	7.06858347	1.0000	1.0000	1.0000
0.027500	7.06858347	1.0000	1.0000	1.0000
0.028750	7.06858347	1.0000	1.0000	1.0000
0.030000	7.06858347	1.0000	1.0000	1.0000
0.031250	7.06858347	1.0000	1.0000	1.0000
0.032500	7.06858347	1.0000	1.0000	1.0000
0.033750	7.06858347	1.0000	1.0000	1.0000
0.035000	7.06858347	1.0000	1.0000	1.0000
0.036250	7.06858347	1.0000	1.0000	1.0000
0.037500	7.06858347	1.0000	1.0000	1.0000
0.038750	7.06858347	1.0000	1.0000	1.0000
0.040000	7.06858347	1.0000	1.0000	1.0000
0.041250	7.06858347	1.0000	1.0000	1.0000
0.042500	7.06858347	1.0000	1.0000	1.0000
0.043750	7.06858347	1.0000	1.0000	1.0000
0.045000	7.06858347	1.0000	1.0000	1.0000
0.046250	7.06858347	1.0000	1.0000	1.0000
0.047500	7.06858347	1.0000	1.0000	1.0000
0.048750	7.06858347	1.0000	1.0000	1.0000
0.050000	7.06858347	1.0000	1.0000	1.0000
1				
0.000000	7.06858347		0.000000	
0.001250	7.06858347		2.457263	
0.002500	7.06858347		4.854020	
0.003750	7.06858347		7.131254	
0.005000	7.06858347		9.232895	
0.006250	7.06858347		11.10719	
0.007500	7.06858347		12.70799	
0.008750	7.06858347		13.99588	
0.010000	7.06858347		14.93914	
0.011250	7.06858347		15.51456	
0.012500	7.06858347		15.70795	
0.013750	7.06858347		15.51456	

0.015000	7.06858347	14.93916
0.016250	7.06858347	13.99590
0.017500	7.06858347	12.70802
0.018750	7.06858347	11.10722
0.020000	7.06858347	9.232928
0.021250	7.06858347	7.131292
0.022500	7.06858347	4.854059
0.023750	7.06858347	2.457304
0.025000	7.06858347	0.000000
0.026250	7.06858347	-2.457222
0.027500	7.06858347	-4.853980
0.028750	7.06858347	-7.131217
0.030000	7.06858347	-9.232861
0.031250	7.06858347	-11.10716
0.032500	7.06858347	-12.70797
0.033750	7.06858347	-13.99586
0.035000	7.06858347	-14.93913
0.036250	7.06858347	-15.51455
0.037500	7.06858347	-15.70795
0.038750	7.06858347	-15.51457
0.040000	7.06858347	-14.93917
0.041250	7.06858347	-13.99592
0.042500	7.06858347	-12.70804
0.043750	7.06858347	-11.10725
0.045000	7.06858347	-9.232962
0.046250	7.06858347	-7.131329
0.047500	7.06858347	-4.854099
0.048750	7.06858347	-2.457345
0.050000	7.06858347	0.000000
2		
0.000000	7.06858347	0.000000
0.001250	7.06858347	2.457263
0.002500	7.06858347	4.854020
0.003750	7.06858347	7.131254
0.005000	7.06858347	9.232895
0.006250	7.06858347	11.10719
0.007500	7.06858347	12.70799
0.008750	7.06858347	13.99588
0.010000	7.06858347	14.93914
0.011250	7.06858347	15.51456
0.012500	7.06858347	15.70795
0.013750	7.06858347	15.51456
0.015000	7.06858347	14.93916
0.016250	7.06858347	13.99590
0.017500	7.06858347	12.70802
0.018750	7.06858347	11.10722
0.020000	7.06858347	9.232928

0.021250	7.06858347	7.131292
0.022500	7.06858347	4.854059
0.023750	7.06858347	2.457304
0.025000	7.06858347	0.000000
0.026250	7.06858347	-2.457222
0.027500	7.06858347	-4.853980
0.028750	7.06858347	-7.131217
0.030000	7.06858347	-9.232861
0.031250	7.06858347	-11.10716
0.032500	7.06858347	-12.70797
0.033750	7.06858347	-13.99586
0.035000	7.06858347	-14.93913
0.036250	7.06858347	-15.51455
0.037500	7.06858347	-15.70795
0.038750	7.06858347	-15.51457
0.040000	7.06858347	-14.93917
0.041250	7.06858347	-13.99592
0.042500	7.06858347	-12.70804
0.043750	7.06858347	-11.10725
0.045000	7.06858347	-9.232962
0.046250	7.06858347	-7.131329
0.047500	7.06858347	-4.854099
0.048750	7.06858347	-2.457345
0.050000	7.06858347	0.000000

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

RUN DATE:09/12/2012 15:01

TITLE :A Reciprocating Piston-Cylinder
 ANALYST :Paul Schallhorn
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX9\Ex9.dat
 FILEOUT :Ex9.out

OPTION VARIABLES

ADDPROP	BUOYANCY	CONDX	CONJUG	CYCLIC	DALTON	DENCON	ENERGY
F	F	F	F	F	F	F	T
FLOWREG	GRAVITY	HCOEF	HEX	HRATE	IFRMIX	INERTIA	INSUC
0	F	F	F	T	1	F	F
INVAL	MIXTURE	MOVBN	MSORCE	NORMAL	NRSOLVT	OPVALVE	PLOTADD
F	F	T	F	F	F	F	F
PRESREG	PRESS	PRINTI	PRNTADD	PRNTIN	RADIATION	REACTING	ROTATION
0	F	F	T	F	F	F	F
SAVER	SECONDL	SHEAR	SIMULA	SIUNITS	STEADY	THRUST	TPA
F	T	F	T	F	F	F	F
TRANS_MOM	TRANSQ	TRANSV	TVM	TWOD	USRVAR	VARGEO	VARROT
F	F	T	F	F	F	T	F
RLFVLV							
F							

NNODES = 2
 NINT = 2
 NBR = 1
 NF = 1
 NVAR = 5
 NHREF = 2

FLUIDS: N2

ISTEP = 1 TAU = 0.10000E-03

SOLUTION INTERNAL NODES										
INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY				
1	0.1471E+02	0.7509E+02	0.1000E+01	0.7181E-01	0.1028E-02	0.1000E+01				
2	0.1471E+02	0.7509E+02	0.1000E+01	0.7181E-01	0.1028E-02	0.1000E+01				

SOLUTION INTERNAL NODES										
INTERNAL NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA				
1	0.1975E+03	0.1054E+01	0.1199E-04	0.4154E-05	0.2487E+00	0.1401E+01				
2	0.1975E+03	0.1054E+01	0.1199E-04	0.4154E-05	0.2487E+00	0.1401E+01				

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
1,2	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

***** TOTAL ENTROPY GENERATION = 0.000E+00 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.000E+00 HP *****

:
:
:
:

ISTEP = 250 TAU = 0.25000E-01

SOLUTION INTERNAL NODES										
INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY				
1	0.2235E+03	0.6934E+03	0.1007E+01	0.5023E+00	0.1028E-02	0.1000E+01				
2	0.2235E+03	0.6934E+03	0.1007E+01	0.5023E+00	0.1028E-02	0.1000E+01				

SOLUTION INTERNAL NODES										
INTERNAL NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA				
1	0.3536E+03	0.1054E+01	0.2052E-04	0.7339E-05	0.2597E+00	0.1382E+01				

```

2 0.3536E+03 0.1054E+01 0.2052E-04 0.7339E-05 0.2597E+00 0.1382E+01
BRANCHES
BRANCH KFACTOR DELP FLOW RATE VELOCITY REYN. NO. MACH NO. ENTROPY GEN. LOST WORK
(LBF-S^2/(LBM-FT)^2) (PSI) (LBM/SEC) (FT/SEC) (LBM/FT^3) (BTU/(R-SEC)) (LBF-FT/SEC)
12 0.233E+21 0.000E+00 -0.331E-22 -0.134E-20 0.821E-17 0.798E-24 0.188E-52 0.168E-46

```

***** TOTAL ENTROPY GENERATION = 0.188E-52 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.306E-49 HP *****

AT ISTEP= 250

WARNING! CHKGASP: T out of fluid property range at node 1

AT ISTEP= 250

WARNING! CHKGASP: T out of fluid property range at node 2

:
:
:
:

ISTEP = 500 TAU = 0.50000E-01

```

SOLUTION
INTERNAL NODES
NODE P (PSI) TF (F) Z RHO EM (LBM) QUALITY
(LBF-S^2/(LBM-FT)^2) (LBM/FT^3)
1 0.1470E+02 0.7501E+02 0.1000E+01 0.7178E-01 0.1028E-02 0.1000E+01
2 0.1470E+02 0.7501E+02 0.1000E+01 0.7178E-01 0.1028E-02 0.1000E+01
NODE H ENTROPY EMU COND CP GAMA
BTU/LB BTU/LB-R LBM/FT-SEC BTU/FT-S-R BTU/LB-R
1 0.1975E+03 0.1054E+01 0.1199E-04 0.4154E-05 0.2487E+00 0.1401E+01
2 0.1975E+03 0.1054E+01 0.1199E-04 0.4154E-05 0.2487E+00 0.1401E+01

```

```

BRANCHES
BRANCH KFACTOR DELP FLOW RATE VELOCITY REYN. NO. MACH NO. ENTROPY GEN. LOST WORK
(LBF-S^2/(LBM-FT)^2) (PSI) (LBM/SEC) (FT/SEC) (LBM/FT^3) (BTU/(R-SEC)) (LBF-FT/SEC)
12 0.955E+21 0.000E+00 -0.331E-22 -0.939E-20 0.141E-16 0.814E-23 0.116E-50 0.482E-45

```

```
***** TOTAL ENTROPY GENERATION = 0.116E-50 BTU/(R-SEC) *****
***** TOTAL WORK LOST = 0.876E-48 HP *****
*****
TIME OF ANALYSIS WAS 1.562500000000000E-002 SECS
```

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APPENDIX P—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 10

Pressurization of a Propellant Tank

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Example 10 Output File (Partial)	107

GFSSP VERSION
604
GFSSP INSTALLATION PATH

ANALYST
Todd Steadman
INPUT DATA FILE NAME
EX10.dat
OUTPUT FILE NAME
Ex10.out
TITLE
Pressurization of a Propellant Tank
USERSETUP

F	DENCON	GRAVITY	ENERGY	MIXTURE	THRUST	STEADY	TRANSV	SAVER
F	HEX	HCOEF	REACTING	T	F	F	T	F
F	BUOYANCY	HRA TE	INVAL	F	F	F	F	F
F	SHEAR	PRNTIN	PRNTADD	F	F	F	F	F
F	PRESS	INSUC	VARROT	F	F	F	F	F
T	NORMAL	SIMUL	SECONDL	F	F	F	F	F
F	TRANS_MOM	USERSVARS	PSMG	F	F	F	F	F
F	NUM_USER_VARS	IFR_MIX	PRINTD	F	F	F	F	F
1	1	1	0	F	F	F	T	T
5	2	3	0	F	F	F	T	T
1	RELAXK	RELAXD	RELAXH	CC	NITER	RELAXNR	RELAXHC	RELAXTS
0.1	0.5	0.5	0	0.001	500	1	1	1
NFLUID(1),	TIMEF	TIMEL	TIMEL	NPSTEP	NPWSTEP	WPLSTEP	WPLBUFF	1.1
1	0	200	200	10	1	50	50	1.1
6	I = 1, NF							
INDEX	DESCRIPTION	MASS SOURC	HEAT SOURC	THRST AREA	NODE-VOLUME	CONCENTRATION		
1	" Node 1"	0	0	0	0	43200		1 0
2	" Node 2"	0	0	0	0	820800		0 1
3	" Node 3"							
4	" Node 4"							
5	" Node 5"							
2	TEMP (DEGF)							
67	-264							
4	74.76							

ex10h1.dat
 ex10h3.dat
 ex10h5.dat

INODE	NUMBER	NAMEBR	UPNODE	DNNODE	OPTION	DESCRIPTION	TNKTH	TNKRHO	TNKCP	TNKCON	ARHC	FCIHC	TNKTM	CIP
2	1	12												
4	2	34												
BRANCH														
12	1		2	2		"Restrict 12"								
34	3		4	2		"Restrict 34"								
45	4		5	2		"Restrict 45"								
BRANCH														
12			OPTION -2		FLOW COEFF	AREA								
					0.6	0.785								
BRANCH														
34			OPTION -2		FLOW COEFF	AREA								
					0	4015								
BRANCH														
45			OPTION -2		FLOW COEFF	AREA								
					0.3043	14.25								
INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW														
12	1													
34	0.01													
45	0.01													
NUMBER OF PRESSURIZATION PROPELLANT TANKS IN CIRCUIT														
1														
TNKTYPE	NODUL	NODULB	NODPRP	IBRPRP	TNKAR	TNKTH	TNKRHO	TNKCP	TNKCON	ARHC	FCIHC	TNKTM	CIP	
FNIP	CIP													
1	2	3	4	34	6431.9	0.375	170	0.2	0.0362	4015	1	-264	0.27	
0.25	0.54	0.25												

EXAMPLE 10 HISTORY FILES

EX10H1.DAT

2

0.0 95.00 120.00 1.0 0.0
1000 95.00 120.00 1.0 0.0

EX10H3.DAT

2

0.00 74.76 -264.0 0.0 1.0
1000 74.76 -264.0 0.0 1.0

EX10H5.DAT

2

0.00 50.00 -264.00 0.00 1.00
1000 50.00 -264.00 0.00 1.00

```

C*****
C *
C ***** GFSSP USER SUBROUTINES *****
C *
C *
C*****
C SUBROUTINE USRINT IS CALLED FROM INIT TO SPECIFY INITIAL VALUES COMPUTED
C BY USER SPECIFIED THERMODYNAMIC PROPERTY PACKAGE
C
C SUBROUTINE SORCEM(IPN,TERMU) IS CALLED FROM EQNS FOR MASS SOURCES.
C IN THIS ROUTINE THE USER DEFINES ANY ADDITIONAL MASS
C SOURCES TO THE MODEL (MASS SOURCES ARE IN LBM/SEC). USER
C CAN MODIFY TRANSIENT TERM BY REDEFINING THE ARGUMENT TERMU.
C
C SUBROUTINE SORCEF(I,TERM0,TERM1,TERM2,TERM3,TERM4,TERM5,TERM6,TERM7,
C TERM8,TERM9,TERM10,TERM100) IS CALLED FROM EQNS FOR
C MOMENTUM SOURCES. USER CAN MODIFY INDIVIDUAL TERMS OR
C DEFINE ADDITIONAL MOMENTUM SOURCES THROUGH TERM100.
C
C SUBROUTINE SORCEQ IS CALLED FROM EITHER THE ENERGY ROUTINE (EITHER
C ENTHALPY OR ENTROPY). IN THIS ROUTINE THE USER DEFINES
C ANY ADDITIONAL HEAT SOURCES TO THE MODEL (HEAT SOURCES
C ARE IN BTU/SEC)
C
C SUBROUTINE SORCEC IS CALLED FROM THE SPECIES CONCENTRATION ROUTINE
C IN THIS ROUTINE THE USER DEFINES ANY ADDITIONAL SPECIES
C CONCENTRATION SOURCES TO THE MODEL (CONCENTRATION SOURCES
C ARE IN MASS FRACTIONS SUCH THAT THE SUM OF ALL OF THE
C CONCENTRATIONS EQUALS 1.0)
C SUBROUTINE SORCETS IS CALLED FROM SURROUTINE TSOLID AND TSOLIDNR. IN THIS
C ROUTINE THE USER DEFINES ANY ADDITIONAL HEAT SOURCES TO ANY
C SOLID NODE
C
C SUBROUTINE KFUSER IS CALLED FROM THE RESIST ROUTINE. IN THIS ROUTINE
C THE USER DEFINES ANY VARIATION OF THE K-FACTOR OF A BRANCH
C SUCH THAT THE K-FACTOR IS DEFINED AS THE PRESSURE DROP
C DIVIDED BY THE MASS FLOW RATE^2 (PRESSURE IS IN PSF, FLOW
C RATE IS IN LBM/SEC; I.E. THE K-FACTOR IS IN PSF-SEC^2/
C (LBM-FT)^2)
C
C SUBROUTINE PRPUSER IS CALLED FROM THE DENSITY ROUTINE. IN THIS
C ROUTINE THE USER ADDS OR MODIFIES FLUID PROPERTIES (ALLOWS
C FOR USER SPECIFIED FLUID)
C
C SUBROUTINE TSTEP IS CALLED FROM THE MAIN ROUTINE. IN THIS ROUTINE
C THE USER CAN MODIFY THE TIMESTEP, DTAU, FOR AN UNSTEADY
C MODEL (DTAU IS IN SECONDS)
C

```

```

C SUBROUTINE BNDUSER IS CALLED FROM THE BOUND ROUTINE. IN THIS ROUTINE
C THE USER CAN MODIFY BOUNDARY CONDITIONS AND GEOMETRY AT
C EACH TIMESTEP FOR AN UNSTEADY MODEL (PRESSURE IS IN PSF,
C TEMPERATURE IS IN DEG. R, LENGTH {ETC.} IS IN FT, AREA IS
C IN FT^2, VOLUME IS IN FT^3)
C
C SUBROUTINE PRNUSER IS CALLED FROM THE PRINT ROUTINE. IN THIS ROUTINE
C THE USER CAN MODIFY ADD ADDITIONAL OUTPUT FILES SPECIFIC
C TO A PARTICULAR MODEL
C
C SUBROUTINE FILNUM IS CALLED FROM THE MAIN ROUTINE. IN THIS ROUTINE
C ESTABLISHES THE FILE NUMBERS THAT ARE TO BE OPENED FOR ALL
C FILES IN GFSSP, AND INCLUDES 10 USER FILE NUMBERS FOR USE
C IN THE PRNUSER SUBROUTINE
C
C SUBROUTINE USRSET IS CALLED FROM THE READIN ROUTINE. IN THIS ROUTINE
C THE USER SETS UP THE MAJORITY OF THE MODEL; ONLY A DUMMY
C SEGMENT OF AN INPUT FILE IS NECESSARY TO BE READ, WITH THE
C REMAINDER OF THE MODEL SETUP IN THIS SUBROUTINE.
C
C SUBROUTINE USRHCF IS CALLED FROM SUBROUTINE CONVHC. IN THIS ROUTINE
C USER SPECIFIES THE HEAT TRANSFER COEFFICIENT. THE HEAT
C TRANSFER COEFFICIENT CALCULATED BY GFSSP OR SPECIFIED BY
C USER IS OVER-WRITTEN
C
C SUBROUTINE USRADJUST IS CALLED FROM MAIN ROUTINE. IN THIS ROUTINE
C USER CAN ADJUST THE BOUNDARY CONDITION OR GEOMETRY UNTIL
C DESIRED FLOW CONDITION IS ACHIEVED
C *****
C SUBROUTINE FILENUM
C PURPOSE: ESTABLISH THE FORTRAN FILE NUMBERS FOR READING &
C WRITING OF INFORMATION
C *****
C INCLUDE 'COMBLK.FOR'
C *****
C FILES ALREADY WITHIN GFSSP
C
C NWRITE = FILE # CORRESPONDING TO THE WRITEIN SUBROUTINE
C (WRITING INPUT DECK FROM COMMAND LINE PREPROCESSOR)
C NPRINT = FILE # CORRESPONDING TO THE PRINT SUBROUTINE
C (WRITING THE MAIN OUTPUT FILE)
C NREAD = FILE # CORRESPONDING TO THE READIN SUBROUTINE
C (READING IN THE INPUT DECK)
C NGSPPK = FILE # CORRESPONDING TO A NON-GASP PROPERTY PACKAGE
C NFNOD = FILE # CORRESPONDING TO THE FNODE RESTART FILE
C NGSFOUT = FILE # CORRESPONDING TO THE GFSSP.OUT FILE

```

```

C
C (DEBUGGING FILE)
C NFBR = FILE # CORRESPONDING TO THE FBRANCH RESTART FILE
C NGASP = FILE # CORRESPONDING TO THE GASP.OUT FILE
C (DEBUGGING FILE)
C NHSTN = FILE # CORRESPONDING TO THE HISTN.XLS FILE
C NHSTB = FILE # CORRESPONDING TO THE HISTB.XLS FILE
C NHSTF = FILE # CORRESPONDING TO B.C. & VARGEO HISTORY FILES
C NCVHST = FILE # CORRESPONDING TO THE CONTROL VALVE HISTORY FILE
C NCVCHR1 = FILE # CORRESPONDING TO THE FIRST OF TWO CONTROL
C VALVE FILES
C NCVCHR2 = FILE # CORRESPONDING TO THE SECOND OF TWO CONTROL
C VALVE FILES
C NHSTROT = FILE # CORRESPONDING TO THE VARIABLE ROTATION
C HISTORY FILE
C NERROR = FILE # CORRESPONDING TO THE ERROR.XLS FILE
C NRP1DAT = FILE # CORRESPONDING TO THE RPI PROPERTY DATA FILES
C NDPLT = FILE # CORRESPONDING TO NODE RESULTS FOR VTASC POST-PROCESSING
C NBRPLT = FILE # CORRESPONDING TO NODE RESULTS FOR VTASC POST-PROCESSING
C NDWINP = FILE # CORRESPONDING TO NODE RESULTS FOR WINPLOT POST-PROCESSING
C NBRWINP = FILE # CORRESPONDING TO BRANCH RESULTS FOR WINPLOT POST-PROCESSING
C NCOND = FILE # CORRESPONDING TO THERMAL CONDUCTIVITY PROPERTY DATA
C NCP = FILE # CORRESPONDING TO SPECIFIC HEAT PROPERTY DATA
C NSLDPLT = FILE # CORRESPONDING TO SOLID NODE RESULTS FOR PLOTTING
C NSSCPLT = FILE # CORRESPONDING TO SOLID TO SOLID CONDUCTOR RESULTS FOR PLOTTING
C NSFCPLT = FILE # CORRESPONDING TO SOLID TO FLUID CONDUCTOR RESULTS FOR PLOTTING
C NSACPLT = FILE # CORRESPONDING TO SOLID TO AMBIENT CONDUCTOR RESULTS FOR PLOTTING
C
C NGSPK=1
C NPRINT=10
C NFNOD=11
C NGFSOUT=12
C NFBR=13
C NREAD=15
C NGASP=17
C NHSTN=18
C NHSTB=19
C NWRITE=20
C NHSTF=21
C NCVHST=28
C NCVCHR1=29
C NCVCHR2=30
C NHSTROT=35
C NERROR=55
C NRP1DAT=51
C NDPLT=52
C NBRPLT=53
C NDWINP=54

```

```

NBRWINP=56
NCOND = 57
NCP = 58
NSLDPLT = 59
NSSCPLT = 60
NSFCPLT = 61
NSACPLT = 62
NSSRCPLT = 67

C
C FILE NUMBERS FOR USER DEFINED FILES (THESE FILES CAN BE USED
C IN ANY OF THE USER SUBROUTINES; HOWEVER, MOST LIKELY USE IS
C IN THE PRUSER SUBROUTINE). COMMENT OUT FILE NUMBERS NOT IN USE.
C
C NUSR1=14
C NUSR2=
C NUSR3=
C NUSR4=
C NUSR5=
C NUSR6=
C NUSR7=
C NUSR8=
C NUSR9=
C NUSR10=
C
C RETURN
C END
C *****
C SUBROUTINE USRINT
C PURPOSE: PROVIDE INITIAL CONDITIONS WHEN ALTERNATE THERMODYNAMIC
C PROPERTY PACKAGE IS USED
C *****
C INCLUDE 'COMBLK.FOR'
C *****
C ADD CODE HERE
C RETURN
C END
C *****
C SUBROUTINE SORCEM(IPN,TERMU)
C PURPOSE: ADD MASS SOURCES
C IPN - GESSP INDEX NUMBER FOR NODE
C TERMU - UNSTEADY TERM IN MASS CONSERVATION EQUATION
C *****
C INCLUDE 'COMBLK.FOR'
C *****
C ADD CODE HERE
C RETURN

```

```

END
C*****
SUBROUTINE SOURCE(I,TERM0,TERM1,TERM2,TERM3,TERM4,TERM5,TERM6,
&          TERM7,TERM8,TERM9,TERM10,TERM100)
C  PURPOSE: ADD MOMENTUM SOURCES (LBF)
C  I - GFSSP INDEX NUMBER FOR BRANCH
C  TERM0 - UNSTEADY TERM IN MOMENTUM CONSERVATION EQUATION
C  TERM1 - LONGITUDINAL INERTIA
C  TERM2 - PRESSURE GRADIENT
C  TERM3 - GRAVITY FORCE
C  TERM4 - FRICTION FORCE
C  TERM5 - CENTRIFUGAL FORCE
C  TERM6 - EXTERNAL MOMETUM SOURCE DUE TO PUMP
C  TERM7 - MOMENTUM SOURCE DUE TO TRANSVERSE FLOW(MULTI-DIMENSIONAL MODEL)
C  TERM8 - MOMENTUM SOURCE DUE TO SHEAR(MULTI-DIMENSIONAL MODEL)
C  TERM9 - VARIABLE GEOMETRY UNSTEADY TERM
C  TERM10 - NORMAL STRESS
C  TERM100 - USER SUPPLIED MOMENTUM SOURCE
C*****
C          INCLUDE 'COMBLK.FOR'
C*****
C  ADD CODE HERE

TERM0=0.0

RETURN
END
C*****
SUBROUTINE SOURCEQ(IPN,TERMD)
C  PURPOSE: ADD HEAT SOURCES
C  IPN - GFSSP INDEX NUMBER FOR NODE
C  TERMD - COMPONENT OF LINEARIZED SOURCE TERM APPEARING IN THE
C          DENOMINATOR OF THE ENTHALPY OR ENTROPY EQUATION
C*****
C          INCLUDE 'COMBLK.FOR'
C*****
C          ADD CODE HERE
RETURN
END
C*****
SUBROUTINE SOURCEC
C  PURPOSE: ADD CONCENTRATION SOURCES
C*****
C          INCLUDE 'COMBLK.FOR'
C*****
C          ADD CODE HERE

```

```

C  PURPOSE:  COMPUTE MASS TRANSFER OF PROPELLANT INTO THE ULLAGE
C  DURING TANK PRESSURIZATION
      LOGICAL NOMASS
      CHARACTER*8, FLUID

      IF (PRESS) THEN
        NOMASS=.FALSE.
      IF (NOMASS) THEN
        GO TO 10
      ENDIF
      DO I=1, NTANK
        C  FIND NODE INDICES
        DO II=1, NNODES
          NUMBER=NODE(II)
          IF (NUMBER .EQ. NODUL(I)) IPUL=II
          IF (NUMBER .EQ. NODPRP(I)) IPRP=II
        ENDDO
      C  FIND MASS TRANSFER FROM HEAT TRANSFER
      SORCEMAS(IPUL)=0.0
      DO J=1,NF
        DIFFLU=ABS(1.0-CX(IPRP,J))
        IF (DIFFLU .LE. 1.0E-04) THEN
          NFLU=NFLUID(J)
          KFLU=J
          ENDF ! (IF (DIFFLU...
        ENDDO ! (DO J=1,NF...
        IF (NFLU.EQ.4) FLUID='NITROGEN'
        IF (NFLU.EQ.6) FLUID='OXYGEN'
        IF (NFLU.EQ.10) FLUID='HYDROGEN'
        IF (NFLU.EQ.12) FLUID='RP1'
        CALL SATPRP (FLUID, P (IPUL), TSAT(I), HFG (I))
        SORCECON(IPUL,KFLU)=QULPRP (I) / (HFG (I) +CENODE (IPRP)
          & *MAX (TSAT (I)-TF (IPUL),0.0))
        SORCEMAS (IPUL)=SORCEMAS (IPUL)+SORCECON (IPUL,KFLU)
        SORCEMAS (IPRP)=-SORCEMAS (IPUL)
      ENDDO ! (DO I=1,NTANK)
      ENDIF ! (IF (PRESS))
10  CONTINUE
      RETURN
      END
C*****
C  SUBROUTINE SORCETS (IPSN,TERMD)
C  PURPOSE:  ADD SOURCE TERM IN SOLID TEMPERATURE EQUATION
C*****
C  INCLUDE 'COMBLK.FOR'
C*****
C  ADD CODE HERE

```

```

RETURN
END
C *****
SUBROUTINE KPUSER(I, RHOU, EMU, XVU, XVOUL, EMUUL, AKNEW)
C  PURPOSE: ADD A NEW RESISTANCE OPTION
C *****
INCLUDE 'comblk.for'
C *****
C  ADD CODE HERE

RETURN
END
C *****
SUBROUTINE PRPUSER
C  PURPOSE: ADD NEW FLUID PROPERTY
C *****
INCLUDE 'COMBLK.FOR'
C *****
C  ADD CODE HERE
RETURN
END
C *****
SUBROUTINE TSTEP
C  PURPOSE: MODIFY TIME STEP
C *****
INCLUDE 'COMBLK.FOR'
C *****
C  ADD CODE HERE
C  FRICTBP = .TRUE.
C  DFLI = .FALSE.
RETURN
END
C *****
SUBROUTINE ENDUSER
C  PURPOSE: MODIFY BOUNDARY CONDITIONS
C *****
INCLUDE 'COMBLK.FOR'
C *****
C  ADD CODE HERE
RETURN
END
C *****
SUBROUTINE PRNUSER

```



```

C      PURPOSE: ADD NEW OUTPUT
C*****
C      INCLUDE 'COMBLK.FOR'
C*****
C      ADD CODE HERE
C
C      GENERATE EXCEL FILE FOR PLOT
C      OPEN (NUSR1,FILE = 'EX10.XLS',STATUS = 'UNKNOWN')
C      VOLULG=VOLUME (2)
C      VOLPRP=VOLUME (4)
C      TFTNK1=TNKTM(1)-460.
C      WRITE (NUSR1,200) TAU,QULWAL(1),QULPRP(1),
C      & QCOND(1),VOLULG,VOLPRP,TFTNK1,SORCECON(2,2),
C      & CX(2,2)
C      FORMAT (2X,E12.6,100(2X,2E12.6))
C      RETURN
C      END
C*****
C      SUBROUTINE USRSET(FILEIN,TITLE,HISTORY,FNODE,FBRANCH,PCURVE,
C      & HISTGEO,HISTQ,HISTVLV,OVALV,CVALV,ANALYST,FILEOUT)
C      PURPOSE: USER SETS UP THE MAJORITY OF THE MODEL
C*****
C      INCLUDE 'COMBLK.FOR'
C*****
C      CHARACTER*256, FILEIN,FILEOUT,ANALYST
C      CHARACTER*80, TITLE
C      CHARACTER*20, HISTQ(100),PCURVE(10),HISTGEO,HISTROT
C      CHARACTER*256, HISTORY(100)
C      CHARACTER*20, HISTVLV(10),OVALV(10),CVALV(10)
C      CHARACTER*20, FNODE,FBRANCH
C
C      THIS IS THE DEFAULT CODE FOR THIS BLOCK, COMMENT THIS OUT WHEN
C      CREATING A MODEL WITHIN THIS SUBROUTINE
C
C      WRITE(*,*) ' '
C      WRITE(*,*) ' USER ROUTINE USRSET DOES NOT HAVE A MODEL DEVELOPED'
C      WRITE(*,*) ' '
C      WRITE(*,*) ' '
C      WRITE(*,*) ' OPEN THE USER SUBROUTINE FILE AND MODIFY SUBROUTINE'
C      WRITE(*,*) ' USRSET TO DEVELOP MODEL OR CHANGE LOGICAL VARIABLE'
C      WRITE(*,*) ' '
C      WRITE(*,*) ' USETUP TO FALSE AND DEVELOP MODEL IN INPUT FILE'
C      WRITE(*,*) ' '
C      STOP
C
C      END OF DEFAULT CODE
C
C      RETURN
C      END
C*****

```

```

SUBROUTINE USRHCFC (NUMBER, HCF)
C   PURPOSE: PROVIDE HEAT TRANSFER COEFFICIENT *****
C *****
C   INCLUDE 'COMBLK.FOR'
C *****
C   ADD CODE HERE

RETURN
END
C *****
SUBROUTINE USRADJUST
C   PURPOSE: ADJUST BOUNDARY CONDITION OR GEOMETRY FOR STEADY-STATE MODEL *****
C *****
C   INCLUDE 'COMBLK.FOR'
C *****
C   ADD CODE HERE
RETURN
END
C *****
C *****
C *****
SUBROUTINE KFADJUST (I, RHO, EMU, RHOUL, EMUL, RHOUV, EMUV, ISATU,
&
AKNEW)
C   PURPOSE: ADD A NEW RESISTANCE OPTION *****
C *****
C   INCLUDE 'comblk.for'
C *****
C   ADD CODE HERE
RETURN
END
C *****
SUBROUTINE PRPADJUST
C   PURPOSE: ADJUST THERMODYNAMIC OR THERMOPHYSICAL PROPERTY *****
C *****
C   INCLUDE 'comblk.for'
C *****
C   ADD CODE HERE
RETURN
END
C *****
SUBROUTINE TADJUST
C   PURPOSE: ADJUST TEMPERATURE IF NECESSARY *****
C *****
C   INCLUDE 'comblk.for'
C *****
C   ADD CODE HERE
RETURN

```

```

END
C*****
SUBROUTINE PADJUST
C  PURPOSE: ADJUST PRESSURE IF NECESSARY
C*****
INCLUDE 'comblk.for'
RETURN
END
C*****
SUBROUTINE FLADJUST
C  PURPOSE: ADJUST FLOWRATE IF NECESSARY
C*****
INCLUDE 'comblk.for'
C  ADD CODE HERE
RETURN
END
C*****
SUBROUTINE HADJUST
C  PURPOSE: ADJUST ENTHALPY IF NECESSARY
C*****
INCLUDE 'comblk.for'
C  ADD CODE HERE
RETURN
END
C*****
SUBROUTINE SORCEHXQ (IFN, TERMD, K)
C  PURPOSE: ADD HEAT SOURCES
C  IFN - GESSP INDEX NUMBER FOR NODE
C  TERMD - COMPONENT OF LINEARIZED SOURCE TERM APPEARING IN THE
C          DENOMINATOR OF THE ENTHALPY OR ENTROPY EQUATION
C*****
INCLUDE 'comblk.for'
C  ADD CODE HERE
RETURN
END
C*****
SUBROUTINE USRMDG
C  PURPOSE: ADJUST INPUT PARAMETERS FOR MULTI-D FLOW, IF NECESSARY
C*****
INCLUDE 'comblk.for'
C  ADD CODE HERE
RETURN

```

```

END
C*****
C ***** END OF USER SUBROUTINES *****
C *****
C*****
C*****
C*****
SUBROUTINE SATPRP (FLUID, PRS, STRT, HTVAP)
C
C THIS SUBROUTINE CALCULATES
C ** SATURATION TEMPERATURE FROM VAPOR PRESSURE RELATION **
C ** ENTHALPY OF EVAPORATION FROM CLAPEYRON EQUATION *****
C ** SATPRP UTILIZED ENGLISH UNITS IN CALCULATIONS *****
C *****
CHARACTER*8, FLUID
C **** FO (PEOS,TEOS): VAPOR PRESSURE RELATION FOR OXYGEN *****
C **** FN (PEOS,TEOS): VAPOR PRESSURE RELATION FOR NITROGEN *****
C **** FH (PEOS,TEOS): VAPOR PRESSURE RELATION FOR HYDROGEN *****
C **** FR (PEOS,TEOS): VAPOR PRESSURE RELATION FOR RP-1 *****
C **** FDASHO (TEOS): GRADIENT OF VAPOR PRESSURE CURVE FOR OXYGEN **
C **** FDASHN (TEOS): GRADIENT OF VAPOR PRESSURE CURVE FOR NITROGEN **
C **** FDASHH (TEOS): GRADIENT OF VAPOR PRESSURE CURVE FOR HYDROGEN **
C **** FDASHR (TEOS): GRADIENT OF VAPOR PRESSURE CURVE FOR RP-1 *****
C **** A, B, C & D ARE CONSTANTS OF VAPOR PRESSURE RELATION *****
FO (PEOS,TEOS) = ALOG (PEOS) - 81.65833 + 2856.85477/TEOS +
&13.04607*ALOG (TEOS) - 0.03101*TEOS
FN (PEOS,TEOS) = ALOG (PEOS) + 76.60382 - 117.1873/TEOS - 17.40608
&*ALOG (TEOS) + 0.05372*TEOS
FH (PEOS,TEOS) = ALOG (PEOS) - 11.403728 + 211.94778/TEOS + 1.22794
&*ALOG (TEOS) - 0.040478*TEOS
FR (PEOS,TEOS) = ALOG (PEOS) + 3551.8 - 888437.6/TEOS - 68.05
&*ALOG (TEOS) - 2.73183*TEOS
FDASHO (TEOS) = -2856.85477/(TEOS*TEOS) + 13.04607/TEOS - 0.03101
FDASHN (TEOS) = 117.1873/(TEOS*TEOS) - 17.4068/TEOS + 0.05372
FDASHH (TEOS) = -211.94778/(TEOS*TEOS) + 1.22794/TEOS - 0.040478
FDASHR (TEOS) = 888437.6/(TEOS*TEOS) - 68.05/TEOS - 2.73183
DATA RLX, CNVRG/0.5, 0.001/
PEOS = PRS/144.
ITER = 0
IF (FLUID.EQ. 'OXYGEN') GO TO 100
IF (FLUID.EQ. 'NITROGEN') GO TO 200
IF (FLUID.EQ. 'HYDROGEN') GO TO 333
IF (FLUID.EQ. 'RP1') GO TO 444
C
100 CONTINUE
C DATA FOR OXYGEN IN ENGLISH UNITS
C TEOS IS IN DEG R; PEOS IS IN PSIA

```

```

A =81.65833
B = -2856.85477
C =-13.04607
D = 0.03101
C NOTE: TEOS IS A GUESS TEMPERATURE
TEOS= 135.
GO TO 1000

C
C CONTINUE
200 DATA FOR NITROGEN IN ENGLISH UNITS
C TEOS IS DEG R; PEOS IS IN PSIA
C A = 67.78808
B = -2156.13382
C = -10.97167
D = 0.0327
C NOTE: TEOS IS A GUESS TEMPERATURE
TEOS = 209.2
GO TO 1000

C
C CONTINUE
333 DATA FOR HYDROGEN IN ENGLISH UNITS
C TEOS IS IN DEG R ; PEOS IS IN PSI
A=-11.403728
B=-211.94778
C=-1.22794
D=0.040478
C NOTE: TEOS IS A GUESS TEMPERATURE
TEOS=PEOS/2.7586
GO TO 1000

C
C CONTINUE
444 DATA FOR RP-1 IN ENGLISH UNITS
C TEOS IS IN DEG R ; PEOS IS IN PSI
A=-3551.8
B=888437.6
C=68.05
D=2.73183
C NOTE: TEOS IS A GUESS TEMPERATURE
TEOS=855.
GO TO 1000

C THE FOLLOWING LOOP CALCULATES STRT AND HTVAP
C
C CONTINUE
1000 IF (ITER .GT. 1000) THEN
WRITE(*,*) 'SAT TMP EQN DID NOT CONVERGE'
GO TO 5000
ENDIF

```

```

C      CALCULATE TEOS FROM VAPOR-PRESSURE RELATION USING NEWTON-
C      RAPHSON METHOD
C
IF (FLUID.EQ.'OXYGEN') ANUM =-FO(PEOS,TEOS)
IF (FLUID.EQ.'NITROGEN') ANUM =-FN(PEOS,TEOS)
IF (FLUID.EQ.'HYDROGEN') ANUM=-FH(PEOS,TEOS)
IF (FLUID.EQ.'RPI') ANUM=-FR(PEOS,TEOS)
IF (FLUID.EQ.'OXYGEN') DENOM = FDASHO(TEOS)
IF (FLUID.EQ.'NITROGEN') DENOM = FDASHN(TEOS)
IF (FLUID.EQ.'HYDROGEN') DENOM = FDASHH(TEOS)
IF (FLUID.EQ.'RPI') DENOM = FDASHR(TEOS)
TDASH = ANUM/DENOM
TEOS = TEOS + RLX*TDASH
IF (FLUID.EQ.'OXYGEN') RES = FO(PEOS,TEOS)
IF (FLUID.EQ.'NITROGEN') RES = FN(PEOS,TEOS)
IF (FLUID.EQ.'HYDROGEN') RES=FH(PEOS,TEOS)
IF (FLUID.EQ.'RPI') RES=FR(PEOS,TEOS)
ITER = ITER + 1
IF (ABS(RES).GT.CNVRG) GO TO 1000
STRT = TEOS
VG AND VF ARE IN CUBIC FEET PER POUND-MASS
CALL BWR(FLUID,PEOS,STRT,VG,VF)
HEG IS IN BTU PER POUND-MASS
DPDT = PEOS*(-B/(STRT**2) + C/STRT + D)
HTVAP = STRT*(VG-VF)*DPDT*(144.*0.0012849)
5000 CONTINUE
RETURN
END
C*****
C      SUBROUTINE BWR(FLUID,PBWR,TBWR,VG,VF)
C*****
C      CHARACTER*8,FLUID
C      LOGICAL SUCCES
C      F(PR,VR,TR,B,C,D,C4,BETA,GAMA)=(PR*VR)/TR-1.- (B/VR) -
C      &(C/VR**2) - (D/VR**5) - (C4/ (TR**3*VR**2)) * (BETA+GAMA/VR**2) *
C      &EXP (-GAMA/VR**2)
C      *** LEE-KELSER CONSTANTS FOR SIMPLE FLUID ***
C      DATA B1S,B2S,B3S,B4S/0.1181193,0.265728,0.15479,0.030323/
C      DATA C1S,C2S,C3S,C4S/0.0236744,0.0186984,0.0,0.042724/
C      DATA D1S,D2S/0.15488E-04,0.623689E-04/
C      DATA BETAS,GAMAS/0.65392,0.060167/
C      *** LEE-KELSER CONSTANTS FOR REFERENCE FLUID ***
C      DATA B1R,B2R,B3R,B4R/0.2026579,0.331511,0.027655,0.203488/
C      DATA C1R,C2R,C3R,C4R/0.0313385,0.0503618,0.016901,0.041577/
C      DATA D1R,D2R/0.48736E-04,0.07403361E-04/
C      DATA BETAR,GAMAR/1.226,0.03754/

```

```

DATA OMEGAR/0.3978/
DATA RCONST,CC/8.31434,0.001/
DATA RELAX,FACT/0.5,2./
VF=0.
VG=0.
C ***** OBTAIN CRITICAL CONSTANTS *****
CALL CONST1(FLUID,PC,TC,TB,WMOL)
C *** CONVERT P FROM PSI TO PASCALS
PK=PBWR/1.45E-04
C *** CONVERT PK FROM PASCALS TO KILO-PASCALS
PK=PK/1000.
C *** CONVERT T FROM DEG R TO DEG K
TEMPF=TBWR-460.
TEMPC=(5./9.)*(TEMPF-32.)
TK=TEMPC+273.16
C *** CALCULATE VG FOR RP-1 ONLY
IF (FLUID.EQ.'REL') THEN
C GAS CONSTANT FOR RP1 ADJUSTED BY 1000 TO ACCOUNT FOR KPA IN IDEAL GAS EQN
RRP1=8315/(WMOL*1000)
VG=(RRP1*TK)/PK
GO TO 40
ENDIF
C *** CHECK TO SEE IF STATE POINT FALLS IN INACCURACY WINDOW FOR **
C ** HYDROGEN ONLY
PKI=PK
TKI=TK
IF(FLUID.EQ.'HYDROGEN')THEN
CALL INTERPOLE(PKI,TKI,VG)
ENDIF
30 PR=PK/PC
TR=TK/TC
C *** CALCULATE IDEAL REDUCED VOLUME OF A SIMPLE FLUID ***
B=B1S-(B2S/TR)-(B3S/TR**2)-(B4S/TR**3)
C=C1S-(C2S/TR)+(C3S/TR**3)
D=D1S+(D2S/TR)
C INITIAL GUESS IS FROM IDEAL GAS LAW
VMOL=RCONST*TK/PK
VMIDEAL=VMOL
C DETERMINE THE INITIAL RANGE OF VR
VR1=(VMIDEAL*PC)/(RCONST*TC)
VR2=10.*VR1
C ***** FIND THRESHOLD FROM ZBRAC *****
CALL ZBRAC(PR,VR1,VR2,TR,B,C,D,C4S,BETAS,GAMAS,SUCCESS)
C ***** OBTAIN SOLUTION (=VR) *****
VRS=RTBIS(PR,VR1,VR2,TR,B,C,D,C4S,BETAS,GAMAS,CC,J1)

```

```

      ZS=(PR*VRS)/TR
C   *** CALCULATE THE IDEAL REDUCED VOLUME OF REFERENCE FLUID ***
      B=B1R-(B2R/TR)-(B3R/TR**2)-(B4R/TR**3)
      C=C1R-(C2R/TR)+(C3R/TR**3)
      D=D1R+(D2R/TR)
C   *** USE VR FROM SIMPLE FLUID AS FIRST GUESS ***
C   *** OBTAIN THRESHOLD ***
      VR1=VRS
      VR2=2.*VRS
      CALL ZBRAC (PR, VR1, VR2, TR, B, C, D, C4R, BETAR, GAMAR, SUCCES)
C   *** OBTAIN A SOLUTION (=VR) ***
      VRR=RTBIS (PR, VR1, VR2, TR, B, C, D, C4R, BETAR, GAMAR, CC, J2)
      ITER=J1+J2
      ZR=(PR*VRR)/TR
C   *** CALCULATE THE ACENTRIC FACTOR; OMEGA ***
C   ** FIRST CONVERT PC FROM KPA TO ATM ***
      PCA=PC*(0.009867)
      THETA=TB/TC
      ALPHA=-ALOG(PCA)-5.97214+(6.09648/THETA)+1.28862*
      &ALOG(THETA)-0.169347*(THETA**6)
      BETA=15.2518-(15.6875/THETA)-13.4721*ALOG(THETA)+
      &0.43577*(THETA**6)
      OMEGA=ALPHA/BETA
C   *** CALCULATE COMPRESSIBILITY FACTOR FOR THE FLUID OF INTEREST ***
      ZBWR=ZS+(OMEGA/OMEGAR)*(ZR-ZS)
      VR=(ZBWR*TR)/PR
      VMOL=(VR*RCONST*TC)/PC
      VG=VMOL/MMOL
C   *** CONVERT VG FROM M**3/KG TO FT**3/LBM ***
      40 CONTINUE
      VG=VG*16.018067
      IF (FLUID.EQ.'OXYGEN') VF=-0.34614+1.1286E-02*TBWR-1.3837E-04
      &*(TBWR**2)+8.2613E-07*(TBWR**3)-2.4007E-09*(TBWR**4)+
      &2.7247E-12*(TBWR**5)
      IF (FLUID.EQ.'HYDROGEN') VF=-13.132+1.7962*TBWR-9.4964E-02
      &*(TBWR**2)+2.464E-03*(TBWR**3)-3.1377E-05*(TBWR**4)
      &+1.5712E-07*(TBWR**5)
      IF (FLUID.EQ.'NITROGEN') VF=-0.01204 + 0.00061*TBWR
      &-4.23216E-06*TBWR*TBWR +1.06765E-08*TBWR*TBWR*TBWR
      CONVERT VF FROM M**3/KG TO FT**3/LBM
C   ***
C   IF (FLUID.EQ.'NITROGEN') VF=VF*16.018067
      IF (FLUID.EQ.'HYDROGEN') .AND. TBWR .GT. 59) VF=0.
      IF (FLUID.EQ.'RP1') VF=0.01923
      RETURN
      END
C   *****
      FUNCTION RTBIS (PR, VR1, VR2, TR, B, C, D, C4, BETA, GAMA, CC, J)

```



```

C USING BISECTION, FIND THE ROOT OF A FUNTCTION F KNOWN TO LIE
C BETWEEN VR1 AND VR2. THE ROOT, RETURNED AS RTBIS, WILL BE
C REFINED UNTIL ITS ACCURACY IS (+/-)CC.
C *****
C PARAMETER (JMAX=40)
  F(PR,VR,TR,B,C,D,C4,BETA,GAMA)=PR*VR/TR-1.-B/VR-C/VR**2-D/VR**5
  & -C4/(TR**3*VR**2)*(BETA+GAMA/VR**2)*EXP(-GAMA/VR**2)
  FMID=F(PR,VR2,TR,B,C,D,C4,BETA,GAMA)
  F1=F(PR,VR1,TR,B,C,D,C4,BETA,GAMA)
  IF (F1*FMID.GE.0.) PRINT*, 'ROOT MUST BE BRACKETED FOR
&BISECTION.'
C ** ORIENT THE SEARCH SO THAT F1 > 0 LIES AT VR+DELVR ***
  IF (F1.LT.0.) THEN
    RTBIS=VR1
    DELVR=VR2-VR1
  ELSE
    RTBIS=VR2
    DELVR=VR1-VR2
  ENDIF
  DO 11 J= 1, JMAX
    DELVR=DELVR*0.5
    XMID=RTBIS+DELVR
    FMID=F(PR, XMID, TR, B, C, D, C4, BETA, GAMA)
    IF (FMID.LE.0.) RTBIS=XMID
    IF (ABS(DELVR/XMID).LT.CC.OR.FMID.EQ.0.) RETURN
  CONTINUE
  PRINT*, ' TOO MANY BISECTIONS'
  END
C *****
C SUBROUTINE CONST1 (FLUID, PC, TC, TB, WMOL)
C *****
  CHARACTER*8, FLUID
  IF (FLUID.EQ.'OXYGEN') THEN
    *** CRITICAL CONSTANTS ARE IN DEG K AND KPA RESPECTIVELY ***
    TC=154.576
    PC=5.0427E03
    WMOL=31.9999
  *** BOILING PT IS AT 1 ATM IN DEG K **
    TB=90.2
  ENDIF
  IF (FLUID.EQ.'HYDROGEN') THEN
    *** CRITICAL CONSTANTS ARE IN DEG K AND KPA RESPECTIVELY ***
    TC=33.19
    PC=1315.
    WMOL=2.106

```

```

C *** BOILING PT IS AT 1 ATM IN DEG K **
  TB=20.4
  ENDIF
  IF (FLUID.EQ. 'NITROGEN') THEN
    TC=126.2
    PC=3390
    WMOL=28.013
    TB=77.347
  ENDIF
  IF (FLUID.EQ. 'RP1') THEN
    TC=658.
    PC=1820.
    WMOL=170.33
    TB=489.
  ENDIF
  RETURN
  END

C *****
C SUBROUTINE ZBRAC (PR,VR1,VR2,TR,B,C,D,C4,BETA,GAMA,SUCCESS)
C GIVEN A FUNCTION F AND AN INITIAL GUESSED RANGE VR1 TO VR2,
C THE ROUTINE EXPANDS THE RANGE GEOMETRICALLY UNTIL A ROOT IS
C BRACKETED BY THE RETURN VALUES VR1 AND VR2 (IN WHICH CASE
C SUCCESS RETURNS AS .TRUE.) OR UNTIL THE RANGE BECOMES
C UNACCEPTABLY LARGE (IN WHICH CASE SUCCESS RETURNS AS .FALSE.).
C *****
C *****
PARAMETER (FACTOR=1.25, NTRY=50)
LOGICAL SUCCESS
F (PR,VR,TR,B,C,D,C4,BETA,GAMA) =PR*VR/TR-1.-B/VR-C/VR**2-D/VR**5
& -C4/(TR**3*VR**2)*(BETA+GAMA/VR**2)*EXP(-GAMA/VR**2)
IF (VR1.EQ.VR2) PRINT*, 'YOU HAVE TO GUESS AN INITIAL RANGE'
F1=F (PR,VR1,TR,B,C,D,C4,BETA,GAMA)
F2=F (PR,VR2,TR,B,C,D,C4,BETA,GAMA)
SUCCESS=.TRUE.
DO 11 J=1,NTRY
  IF (F1*F2.LT.0.) RETURN
  IF (ABS (F1).LT.ABS (F2)) THEN
    VR1=VR1+FACTOR*(VR1-VR2)
    VR1=AMAX1 (0.001,VR1)
    F1=F (PR,VR1,TR,B,C,D,C4,BETA,GAMA)
  ELSE
    VR2=VR2+FACTOR*(VR2-VR1)
    F2=F (PR,VR2,TR,B,C,D,C4,BETA,GAMA)
  ENDIF
11 CONTINUE
SUCCESS=.FALSE.
RETURN

```

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/12/2012 15:02

TITLE :Pressurization of a Propellant Tank
 ANALYST :Todd Steadman
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX10\Ex10.dat
 FILEOUT :Ex10.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	CONJUG	F	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	F	HEX	F	HRATE	T	IFRMIX	1	INERTIA	F	INSUC	F
INVAL	F	MIXTURE	F	MSORCE	F	NORMAL	F	NRSOLVT	F	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	F	SIMULA	T	SIUNITS	F	STEADY	F	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F												

NNODES = 5
 NINT = 2
 NBR = 3
 NF = 2
 NVAR = 7
 NHREF = 2

FLUIDS: HE O2

```

BOUNDARY NODES
NODE      P      T      RHO      AREA      CONCENTRATIONS
(P(SI))  (F)    (LBM/FT^3)  (IN^2)
1  0.9500E+02  0.1200E+03  0.6091E-01  0.0000E+00  0.1000E+01  0.0000E+00
3  0.7470E+02 -0.2640E+03  0.6509E+02  0.0000E+00  0.0000E+00  0.1000E+01
5  0.5000E+02 -0.2640E+03  0.8187E+00  0.0000E+00  0.0000E+00  0.1000E+01

```

INPUT SPECIFICATIONS FOR INTERNAL NODES

```

NODE      AREA      MASS      HEAT
(IN^2)    (LBM/S)  (BTU/S)
2  0.0000E+00  0.0000E+00  0.0000E+00
4  0.0000E+00 -0.1000E-01  0.0000E+00

```

```

BRANCH  UPNODE  DNNODE  OPTION
12      1        2        2
34      3        4        2
45      4        5        2
BRANCH OPTION -2: FLOW COEF AREA
12      0.600E+00  0.785E+00
BRANCH OPTION -2: FLOW COEF AREA
34      0.000E+00  0.402E+04
BRANCH OPTION -2: FLOW COEF AREA
45      0.304E+00  0.142E+02

```

NUMBER OF PRESSURIZATION SYSTEMS = 1

```

NODUL  NODPRP  QULPRP  QULWAL  QCOND  TNKTM  VOLPROP  VOLJLG
BTU/Sec  BTU/Sec  BTU/Sec  R      BTU^3   FC^3    FC^3
2  4  0.0000  0.0000  0.0000  195.6700  475.0000  25.0000

```

ISTEP = 10 TAU = 0.10000E+01

```

BOUNDARY NODES
NODE      P(P(SI))  TF(F)  Z(COMP)  RHO      CONCENTRATIONS
(LBM/FT^3)
1  0.9500E+02  0.1200E+03  0.1004E+01  0.6091E-01  0.1000E+01  0.0000E+00
3  0.9344E+02 -0.2640E+03  0.1751E-01  0.6509E+02  0.0000E+00  0.1000E+01
5  0.5000E+02 -0.2640E+03  0.9309E+00  0.8187E+00  0.0000E+00  0.1000E+01

```

SOLUTION

```

INTERNAL NODES
NODE      P(P(SI))  TF(F)  Z      RHO      EM(LBM)  CONC
(LBM/FT^3)

```

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.8665E+02	-0.2105E+03	0.1007E+01	0.1290E+00	0.3472E+01	0.9987E+00
4	0.9344E+02	-0.2640E+03	0.2187E-01	0.6512E+02	0.3081E+05	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.0000E+00	0.5660E+01	0.8122E-05	0.1504E-04	0.1242E+01	0.1669E+01
4	0.0000E+00	0.7815E+00	0.8476E-04	0.1822E-04	0.4229E+00	0.2029E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.238E+05	0.835E+01	0.224E+00	0.676E+03	0.237E+06	0.195E+00	0.982E-02	0.443E+04
34	0.000E+00	0.104E-11	0.162E+03	0.893E-01	0.410E+06	0.114E-03	0.000E+00	0.000E+00
45	0.263E+00	0.434E+02	0.154E+03	0.239E+02	0.652E+07	0.305E-01	0.973E-01	0.148E+05

NUMBER OF PRESSURIZATION SYSTEMS = 1

NODUL	NODPRP	QULPRP	QULWAL	QCOND	TNKTM	VOLPROP	VOLULG
BTU/Sec	BTU/Sec	BTU/Sec	R	FT^3	FT^3	FT^3	FT^3
2	4	0.6653	2.1919	0.0000	195.6938	473.0888	26.9112

ISTEP =1000 TAU = 0.10000E+03

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	CONCENTRATIONS
1	0.9500E+02	0.1200E+03	0.0000E+00	0.6091E-01	0.1000E+01
3	0.9321E+02	-0.2640E+03	0.0000E+00	0.6510E+02	0.0000E+00
5	0.5000E+02	-0.2640E+03	0.0000E+00	0.8191E+00	0.0000E+00

INTERNAL NODES	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	CONC
2	0.8944E+02	-0.7853E+02	0.1005E+01	0.1002E+00	0.2378E+02	0.8515E+00
4	0.9321E+02	-0.2640E+03	0.2182E-01	0.6513E+02	0.1512E+05	0.0000E+00

SOLUTION

INTERNAL NODES	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.8944E+02	-0.7853E+02	0.1005E+01	0.1002E+00	0.2378E+02	0.8515E+00
4	0.9321E+02	-0.2640E+03	0.2182E-01	0.6513E+02	0.1512E+05	0.0000E+00

2 0.2495E+03 0.5460E+01 0.1076E-04 0.1961E-04 0.1091E+01 0.1662E+01
 4 0.7491E+02 0.7814E+00 0.8483E-04 0.1822E-04 0.4228E+00 0.2029E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.238E+05	0.556E+01	0.183E+00	0.552E+03	0.194E+06	0.159E+00	0.534E-02	0.241E+04
34	0.000E+00	0.000E+00	0.154E+03	0.847E-01	0.388E+06	0.108E-03	0.000E+00	0.000E+00
45	0.263E+00	0.432E+02	0.154E+03	0.239E+02	0.650E+07	0.304E-01	0.965E-01	0.147E+05

NUMBER OF PRESSURIZATION SYSTEMS = 1

NODUL	NODPRP	QULPRP	QULWAL	QCOND	TNKTM	VOLPROP	VOLULG
2	4	2.9585	38.9020	0.0901	213.2504	232.1752	267.8248

:
:
:
:
:

ISTEP = 2000 TAU = 0.20000E+03

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	CONCENTRATIONS
1	0.9500E+02	0.1200E+03	0.1004E+01	0.6091E-01	HE O2 0.1000E+01 0.0000E+00
3	0.8799E+02	-0.2640E+03	0.1751E-01	0.6509E+02	0.0000E+00 0.1000E+01
5	0.5000E+02	-0.2640E+03	0.9309E+00	0.8187E+00	0.0000E+00 0.1000E+01

SOLUTION

INTERNAL NODES

INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	CONC
2	0.8788E+02	-0.8244E+02	0.1005E+01	0.1002E+00	0.4943E+02	HE O2 0.8444E+00 0.1556
4	0.8799E+02	-0.2640E+03	0.2060E-01	0.6511E+02	0.4230E+03	0.0000E+00 1.0000

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.0000E+00	0.5422E+01	0.1068E-04	0.1945E-04	0.1083E+01	0.1662E+01
4	0.0000E+00	0.7816E+00	0.8470E-04	0.1821E-04	0.4230E+00	0.2030E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.238E+05	0.712E+01	0.207E+00	0.624E+03	0.219E+06	0.180E+00	0.773E-02	0.349E+04

34	0.000E+00	0.000E+00	0.144E+03	0.795E-01	0.364E+06	0.101E-03	0.000E+00	0.000E+00
45	0.263E+00	0.380E+02	0.144E+03	0.224E+02	0.611E+07	0.285E-01	0.796E-01	0.121E+05

NUMBER OF PRESSURIZATION SYSTEMS = 1

NODUL	NODPRP	QULPRP	QULWAL	QCOND	TNKTM	VOLPROP	VOLJLG
		BTU/Sec	BTU/Sec	BTU/Sec	R	Ft^3	Ft^3
2	4	2.8710	56.1603	6.5609	231.6004	6.4972	493.5028

TIME OF ANALYSIS WAS 1.60937500000000 SECS

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APPENDIX Q—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 11

Power Balancing of a Turbopump Assembly

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Example 11 Input File	114
Example 11 Pump Characteristic Data File	118
Example 11 Output File	119

```

GFSSP VERSION
604
GFSSP INSTALLATION PATH

ANALYST
PS
INPUT DATA FILE NAME
Ex11.dat
OUTPUT FILE NAME
Ex11.out
TITLE
Power Balancing of a Turbopump Assembly
SETUP
F
DENCEN GRAVITY ENERGY MIXTURE THRUST STEADY TRANSV SAVER
F T T F F F
HEX HCOEF REACTING INERTIA CONDX ADDPROP PRINTI ROTATION
T T F F F F
BUOYANCY HRATE INVAL MSORCE MOVBNF TPA CONJUG TVM
F T F F F T
SHEAR PRNTIN PRNTADD OPVALVE TRANSQ WINPLOT
F T T F F
PRESS INSC VARROT CYCLIC CHKVALS WINFILE NOSTATS
F F F F F
NORMAL SIMUL SECONDL NRSOLVT IBDF PLOTADD PRESREG FLOWREG
F T F F F F
TRANS_MOM USERVARS PSMG PLOTADD SIUNITS MDGEN
F F F F F
NUM_USER_VARS IFR_MIX PRINTD SATTABL MSORIN PRELVIV HSTAG
1 1 1 1 1 1 1 1 1 1
NNODES NINT NBR NF
20 17 20 1
RELAXX RELAXD RELAXH RELAXH RELAXNR RELAXHC RELAXTS
1 0.5 1 1 500 1 1
NFLUID(1), I = 1, NF
10
NODE INDEX DESCRIPTION
1 " Node 1"
2 " Node 2"
3 " Node 3"
4 " Node 4"
5 " Node 5"
6 " Node 6"
7 " Node 7"
8 " Node 8"
9 " Node 9"
10 " Node 10"

```


BRANCH	UPNODE	DNNODE	OPTION	1618	1819	1920	DESCRIPTION	AREA	ANGLE	AREA
18	2			16			"CV 12"	0		0.12111873243
19	2			15			"Pump 23"	0		0.12111873243
23	3			1			"Pipe 34"	0		0.12111873243
34	4			1			"Pipe 45"	0		0.12111873243
45	5			1			"Pipe 57"	0		0.12111873243
57	7			1			"Pipe 78"	0		0.12111873243
78	8			1			"Pipe 46"	0		0.12111873243
46	4			1			"Pipe 68"	0		0.12111873243
68	6			1			"CV 89"	0		0.12111873243
89	9			16			"Pipe 910"	0		0.12111873243
910	10			1			"Pipe 1011"	0		0.12111873243
1011	11			1			"CV 1112"	0		0.12111873243
1112	11			16			"Pump 1213"	0		0.12111873243
1213	12			15			"Pipe 1314"	0		0.12111873243
1314	13			1			"Pipe 1415"	0		0.12111873243
1415	14			1			"Pipe 1516"	0		0.12111873243
1516	15			1			"CV 1617"	0		0.12111873243
1617	16			16			"CV 1618"	0		0.12111873243
1618	16			16			"Pipe 1819"	0		0.12111873243
1819	18			1			"Pipe 1920"	0		0.12111873243
1920	19			1			AREA	0		0.12111873243
BRANCH	OPTION -16			CV			AREA	0		0.12111873243
12				2.877			EFFICIENCY	0.12112		
BRANCH	OPTION -15			HORSEPOWER			AREA	0		
23				0			EPSD	0.0025	ANGLE	0
BRANCH	OPTION -1			LENGTH			EPSD	0.0025	ANGLE	0
34				100			DIA	0.3927	ANGLE	0
BRANCH	OPTION -1			LENGTH			DIA	0.3927	ANGLE	0
45				100			DIA	0.3927	ANGLE	0
BRANCH	OPTION -1			LENGTH			DIA	0.3927	ANGLE	0
57				100			DIA	0.3927	ANGLE	0
BRANCH	OPTION -1			LENGTH			DIA	0.3927	ANGLE	0
78				100			DIA	0.3927	ANGLE	0
BRANCH	OPTION -1			LENGTH			DIA	0.3927	ANGLE	0
46				100			DIA	0.3927	ANGLE	0
BRANCH	OPTION -1			LENGTH			DIA	0.3927	ANGLE	0
68				100			DIA	0.3927	ANGLE	0
BRANCH	OPTION -16			CV			AREA	0		0.12111873243
89				3.554			AREA	0		0.12111873243
BRANCH	OPTION -1			LENGTH			DIA	0.19635	ANGLE	0
910				100			DIA	0.3927	ANGLE	0
BRANCH	OPTION -1			LENGTH			DIA	0.3927	ANGLE	0
1011				100			DIA	0.3927	ANGLE	0
BRANCH	OPTION -16			CV			AREA	0		0.12111873243
1112				3.554			AREA	0		0.12111873243

BRANCH	OPTION -15	HORSEPOWER	EFFICIENCY	AREA				
1213		0	1	0.019635				
BRANCH	OPTION -1	LENGTH	DIA	EPD	ANGLE	AREA		
1314		100	0.3927	0	0.0025	0	0.12111873243	
BRANCH	OPTION -1	LENGTH	DIA	EPD	ANGLE	AREA		
1415		100	0.3927	0	0.0025	0	0.12111873243	
BRANCH	OPTION -1	LENGTH	DIA	EPD	ANGLE	AREA		
1516		100	0.3927	0	0.0025	0	0.12111873243	
BRANCH	OPTION -16	CV	AREA					
1617		0.00354	0.01					
BRANCH	OPTION -16	CV	AREA					
1618		3.554	0.19635					
BRANCH	OPTION -1	LENGTH	DIA	EPD	ANGLE	AREA		
1819		100	0.3927	0	0.0025	0	0.12111873243	
BRANCH	OPTION -1	LENGTH	DIA	EPD	ANGLE	AREA		
1920		100	0.3927	0	0.0025	0	0.12111873243	
NUMBER OF HEAT EXCHANGERS								
2								
IBRHOT	IBRCLD	ITYPHX	ARHOT	ARCOLD	UA	HEXEEF		
1415	2	0	0	0		0.8		
1819	2	0	0	0		0.9		
NUMBER OF TURBOPUMP ASSEMBLY IN THE CIRCUIT								
1								
IBRPMP	IBRTRB	SPEED (RPM)	EFFTURB	DIATRB	PSITRD			
23	1213	80000	0.5	3.435	0.4			
PUMP CHARACTERISTICS CURVE DATA FILE								
ex11pmp23.dat								

Example 11 Pump Characteristic Data File

EX11PMP23.DAT

```

18
0.000      8.680E-06      0.000
3.035E-05      8.971E-06      8.8724E-10
6.071E-05      9.190E-06      9.7065E-10
9.106E-05      9.341E-06      1.0804E-09
1.214E-04      9.436E-06      1.2166E-09
1.518E-04      9.486E-06      1.3393E-09
1.821E-04      9.486E-06      1.4570E-09
2.125E-04      9.445E-06      1.5644E-09
2.428E-04      9.372E-06      1.6733E-09
2.732E-04      9.263E-06      1.7872E-09
3.035E-04      9.117E-06      1.9105E-09
3.339E-04      8.935E-06      2.0558E-09
3.643E-04      8.753E-06      2.2161E-09
3.718E-04      8.689E-06      2.2698E-09
3.749E-04      8.625E-06      2.2869E-09
3.794E-04      8.479E-06      2.3215E-09
3.807E-04      8.388E-06      2.3281E-09
3.810E-04      0.000E+00      0.000

```

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

RUN DATE:09/12/2012 15:04

TITLE :Power Balancing of a Turbopump Assembly
 ANALYST :PS
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX11\Ex11.dat
 FILEOUT :Ex11.out

OPTION VARIABLES

ADDPROP	BUOYANCY	CONDX	CONJUG	CYCLIC	DALTON	DENCON	ENERGY
F	F	F	F	F	F	F	T
FLOWREG	GRAVITY	HCOEF	HEX	HRATE	IFRMIX	INERTIA	INSUC
0	F	T	T	T	1	F	F
INVAL	MIXTURE	MOVBN	MSORCE	NORMAL	NRSOLVT	OPVALVE	PLOTADD
F	F	F	F	F	F	F	F
PRESREG	PRESS	PRINTI	PRNTADD	PRNTIN	RADIATION	REACTING	ROTATION
0	F	F	T	F	F	F	F
SAVER	SECONDL	SHEAR	SIMULA	SIUNITS	STEADY	THRUST	TPA
F	F	F	T	F	T	F	T
TRANS_MOM	TRANSQ	TRANSV	TVM	TWOD	USRVAR	VARGEO	VARROT
F	F	F	F	F	F	F	F
RLFVLV							
F							

NNODES = 20
 NINT = 17
 NBR = 20
 NF = 1
 NVAR = 37
 NHREF = 2

FLUIDS: H2

BOUNDARY NODES		P	T	RHO	AREA	
NODE	(PSI)	(F)	(LBM/FT^3)	(IN^2)		
1	0.6000E+02	-0.4190E+03	0.4264E+01	0.0000E+00		
17	0.1470E+02	0.8000E+02	0.5112E-02	0.0000E+00		
20	0.1470E+02	0.8000E+02	0.5112E-02	0.0000E+00		
1						
IBRTRB	SPEED(RPM)	ETATRB	PSITR	TORQUE(LB-IN)	HPOWER	
23	0.800E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	
SOLUTION						
INTERNAL NODES						
NODE	P(PSI)	TF(F)	Z	RHO	EM(LBM)	QUALITY
				(LBM/FT^3)		
2	0.5542E+02	-0.4190E+03	0.6007E-01	0.4258E+01	0.0000E+00	0.0000E+00
3	0.1789E+04	-0.4073E+03	0.1368E+01	0.4697E+01	0.0000E+00	0.0000E+00
4	0.1779E+04	-0.4072E+03	0.1358E+01	0.4690E+01	0.0000E+00	0.0000E+00
5	0.1777E+04	-0.4072E+03	0.1357E+01	0.4690E+01	0.0000E+00	0.0000E+00
6	0.1774E+04	-0.4072E+03	0.1355E+01	0.4688E+01	0.0000E+00	0.0000E+00
7	0.1776E+04	-0.1455E+03	0.1091E+01	0.9734E+00	0.0000E+00	0.1000E+01
8	0.1770E+04	-0.3064E+03	0.1063E+01	0.2041E+01	0.0000E+00	0.1000E+01
9	0.1764E+04	-0.3064E+03	0.1062E+01	0.2035E+01	0.0000E+00	0.1000E+01
10	0.1740E+04	0.1482E+03	0.1065E+01	0.5050E+00	0.0000E+00	0.1000E+01
11	0.1644E+04	0.1486E+03	0.1061E+01	0.4783E+00	0.0000E+00	0.1000E+01
12	0.1617E+04	0.1487E+03	0.1060E+01	0.4709E+00	0.0000E+00	0.1000E+01
13	0.1078E+04	0.9107E+02	0.1043E+01	0.3525E+00	0.0000E+00	0.1000E+01
14	0.9399E+03	0.9153E+02	0.1038E+01	0.3087E+00	0.0000E+00	0.1000E+01
15	0.7827E+03	-0.3345E+01	0.1034E+01	0.3115E+00	0.0000E+00	0.1000E+01
16	0.6269E+03	-0.3025E+01	0.1028E+01	0.2509E+00	0.0000E+00	0.1000E+01
18	0.5763E+03	0.2498E+03	0.1020E+01	0.1496E+00	0.0000E+00	0.1000E+01
19	0.2537E+03	-0.2248E+03	0.1008E+01	0.2013E+00	0.0000E+00	0.1000E+01
NODE	H	ENTROPY	EMU	COND	CP	GAMA
	BTU/LB	BTU/LB-R	LBM/FT-SEC	BTU/FT-S-R	BTU/LB-R	
2	-0.9806E+02	0.6873E+01	0.7613E-05	0.1636E-04	0.2569E+01	0.1939E+01
3	-0.2274E+02	0.6873E+01	0.9957E-05	0.2254E-04	0.2465E+01	0.1537E+01
4	-0.2274E+02	0.6873E+01	0.9900E-05	0.2252E-04	0.2472E+01	0.1541E+01
5	-0.2274E+02	0.6873E+01	0.9893E-05	0.2251E-04	0.2473E+01	0.1541E+01
6	-0.2274E+02	0.6873E+01	0.9876E-05	0.2250E-04	0.2475E+01	0.1542E+01
7	0.9641E+03	0.6873E+01	0.4454E-05	0.2583E-04	0.4050E+01	0.1393E+01
8	0.3238E+03	0.6873E+01	0.3648E-05	0.1630E-04	0.3731E+01	0.1811E+01
9	0.3238E+03	0.6873E+01	0.3643E-05	0.1628E-04	0.3731E+01	0.1811E+01
10	0.2069E+04	0.6873E+01	0.6574E-05	0.3411E-04	0.3538E+01	0.1411E+01
11	0.2069E+04	0.6873E+01	0.6566E-05	0.3408E-04	0.3536E+01	0.1410E+01

BRANCH	KFACTOR (LBF-S ² /(LBM-FT) ²)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.2069E+04	0.6873E+01	0.6564E-05	0.3407E-04	0.3535E+01	0.1410E+01		
13	0.1857E+04	0.6873E+01	0.6099E-05	0.3195E-04	0.3575E+01	0.1401E+01		
14	0.1857E+04	0.6873E+01	0.6087E-05	0.3192E-04	0.3570E+01	0.1399E+01		
15	0.1510E+04	0.6873E+01	0.5363E-05	0.2854E-04	0.3714E+01	0.1382E+01		
16	0.1510E+04	0.6873E+01	0.5344E-05	0.2850E-04	0.3705E+01	0.1379E+01		
18	0.2408E+04	0.6873E+01	0.7157E-05	0.3684E-04	0.3497E+01	0.1400E+01		
19	0.6568E+03	0.6873E+01	0.3405E-05	0.1810E-04	0.3796E+01	0.1381E+01		
BRANCHES								
BRANCH	KFACTOR (LBF-S ² /(LBM-FT) ²)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.132E+05	0.457E+01	0.224E+00	0.385E+02	0.894E+06	0.276E-01	0.109E-02	0.346E+02
23	0.000E+00	-0.173E+04	0.224E+00	0.624E+02	0.114E+07	0.447E-01	0.000E+00	0.000E+00
34	0.298E+05	0.104E+02	0.224E+00	0.566E+02	0.874E+06	0.402E-01	0.175E-02	0.711E+02
45	0.303E+05	0.130E+01	0.785E-01	0.199E+02	0.309E+06	0.141E-01	0.767E-04	0.313E+01
57	0.303E+05	0.130E+01	0.785E-01	0.199E+02	0.309E+06	0.141E-01	0.767E-04	0.313E+01
78	0.144E+06	0.618E+01	0.785E-01	0.959E+02	0.686E+06	0.292E-01	0.294E-03	0.718E+02
46	0.300E+05	0.438E+01	0.145E+00	0.368E+02	0.570E+06	0.261E-01	0.479E-03	0.195E+02
68	0.300E+05	0.439E+01	0.145E+00	0.368E+02	0.572E+06	0.260E-01	0.479E-03	0.196E+02
89	0.180E+05	0.626E+01	0.224E+00	0.804E+02	0.187E+07	0.307E-01	0.829E-03	0.988E+02
910	0.685E+05	0.238E+02	0.224E+00	0.131E+03	0.239E+07	0.499E-01	0.316E-02	0.377E+03
1011	0.277E+06	0.962E+02	0.224E+00	0.527E+03	0.132E+07	0.114E+00	0.130E-01	0.613E+04
1112	0.770E+05	0.267E+02	0.224E+00	0.343E+03	0.104E+07	0.746E-01	0.380E-02	0.180E+04
1213	0.000E+00	0.539E+03	0.224E+00	0.348E+04	0.329E+07	0.757E+00	0.000E+00	0.000E+00
1314	0.397E+06	0.138E+03	0.224E+00	0.754E+03	0.143E+07	0.173E+00	0.294E-01	0.126E+05
1415	0.453E+06	0.157E+03	0.224E+00	0.861E+03	0.143E+07	0.197E+00	0.382E-01	0.164E+05
1516	0.448E+06	0.156E+03	0.224E+00	0.854E+03	0.162E+07	0.216E+00	0.454E-01	0.161E+05
1617	0.148E+12	0.612E+03	0.772E-03	0.443E+02	0.196E+05	0.112E-01	0.763E-03	0.271E+03
1618	0.147E+06	0.506E+02	0.223E+00	0.651E+03	0.127E+07	0.165E+00	0.182E-01	0.647E+04
1819	0.935E+06	0.323E+03	0.223E+00	0.177E+04	0.121E+07	0.358E+00	0.125E+00	0.692E+05
1920	0.693E+06	0.239E+03	0.223E+00	0.132E+04	0.255E+07	0.466E+00	0.209E+00	0.381E+05
1								
IBRPMP	IBTRTB	SPEED(RPM)	ETATRB	PSITR	TORQUE(LB-IN)	HPOWER		
23	1213	0.800E+05	0.578E+00	0.269E+00	0.511E+02	0.649E+02		

TIME OF ANALYSIS WAS 0.4531250000000000 SECS								

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APPENDIX R—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 12

Helium Pressurization of LOX and RP-1 Propellant Tanks

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Example 12 Output File (Partial)	148

```

GFSSP VERSION
604
GFSSP INSTALLATION PATH

ANALYST
Todd Steadman
INPUT DATA FILE NAME
Ex12.dat
OUTPUT FILE NAME
Ex12.out
TITLE
Helium Pressurization of LOX and RP-1 Propellant Tanks
USERSETUP
F
DENCON          GRAVITY          ENERGY          MIXTURE          THRUST          STEADY          TRANSV          SAVER
F              F              T              T              F              F              T              F
HEX             HCOEF             REACTING         INERTIA          CONDX           ADDPROP        PRINTI         ROTATION
F              F              F              T              F              F              F              F
BUOYANCY       HRATE            INVAL           MSORCE          MOVBN          TPA           VARGEO        TVM
F              F              F              F              F              F              F              F
SHEAR         PRNTIN          PRNTADD        OPVALVE         TRANSQ         CONJUG        RADIAT        WINPLOT
F              T              T              F              F              F              F              T
PRESS         INSC            VARROT         CYCLIC          CHKVALS        WINFILE       DALTON        NOSTATS
T              F              F              F              F              T              F              F
NORMAL        SIMUL           SECONDL        NRSOLVT        IBDF           NOFLT         PRESREG       FLOWREG
F              F              F              F              1              T              0              0
TRANS_MOM     USERVARS        PSMG           ISOLVE         PLOTADD        SIUNITS       TECPLOT       MDGEN
F              F              F              1              F              F              F              F
NUM_USER_VARS IFR_MIX         PRINTD         SATTABL        MSORIN         PRELVIV       LAMINAR       HSTAG
1              1              F              F              F              F              T              T
NNODES        NINT            NBR            NF              NF              NF              NF              NF
65            59              64              3              3              3              3              3
RELAXX        RELAXD          RELAXH         RELAXH         RELAXH         RELAXH         RELAXH         RELAXTS
1              0.5            0.01          0.01          0.01          0.01          0.01          1
DTAU          TIMEF           TIMEL          TIMEL          TIMEL          TIMEL          TIMEL          TIMEL
0.1           0              60             60             60             60             60             1.5
NFLUID(I), I = 1, NF
1 6 12
NODE          INDEX          DESCRIPTION
1            2            " Node 1"
2            1            " Node 2"
3            1            " Node 3"
4            1            " Node 4"
5            1            " Node 5"
6            1            " Node 6"
7            1            " Node 7"
8            1            " Node 8"

```

9	1	" Node 9"
10	1	" Node 10"
11	1	" Node 11"
12	1	" Node 12"
13	1	" Node 13"
14	1	" Node 14"
15	1	" Node 15"
16	1	" Node 16"
17	1	" Node 17"
18	1	" Node 18"
19	1	" Node 19"
20	1	" Node 20"
21	1	" Node 21"
22	1	" Node 22"
23	1	" Node 23"
24	1	" Node 24"
25	1	" Node 25"
26	1	" Node 26"
27	1	" Node 27"
28	1	" Node 28"
29	1	" Node 29"
30	2	" Node 30"
31	1	" Node 31"
32	1	" Node 32"
33	1	" Node 33"
34	2	" Node 34"
35	1	" Node 35"
36	1	" Node 36"
37	1	" Node 37"
38	1	" Node 38"
39	1	" Node 39"
40	1	" Node 40"
41	1	" Node 41"
42	1	" Node 42"
43	1	" Node 43"
44	1	" Node 44"
45	1	" Node 45"
46	1	" Node 46"
47	1	" Node 47"
48	1	" Node 48"
49	1	" Node 49"
50	1	" Node 50"
51	1	" Node 51"
52	1	" Node 52"
53	1	" Node 53"
54	1	" Node 54"
55	2	" Node 55"

NODE	PRES (PSI)	TEMP (DEGF)	MASS SOURC	HEAT SOURC	THRST AREA	NODE-VOLUME	CONCENTRATION
56	762	120	0	0	0	0	0
57	741.3	120.1	0	0	0	0	0
58	741.2	120.1	0	0	0	0	0
59	741.1	120.1	0	0	0	0	0
60	735.2	120.3	0	0	0	0	0
61	733.2	120.3	0	0	0	0	0
62	733.2	120.3	0	0	0	0	0
63	732.8	120.3	0	0	0	0	0
64	726.4	120.3	0	0	0	0	0
65	725.3	120.3	0	0	0	0	0
2	724.9	120.3	0	0	0	0	0
3	724.9	120.3	0	0	0	0	0
4	724.9	120.3	0	0	0	0	0
5	724.9	120.3	0	0	0	0	0
6	724.9	120.3	0	0	0	0	0
7	91.37	125.4	0	0	0	0	0
8	91.37	125.4	0	0	0	0	0
9	723.5	120.3	0	0	0	0	0
10	723.3	120.3	0	0	0	0	0
11	722.2	120.3	0	0	0	0	0
12	721.9	120.3	0	0	0	0	0
13	91.36	125.4	0	0	0	0	0
14	80.61	125.5	0	0	0	0	0
15	72.25	125.6	0	0	0	0	0
16	68.17	125.7	0	0	0	0	0
17	62.67	125.6	0	0	0	0	0
18	57.96	125.7	0	0	0	0	0
19	49.99	125.8	0	0	0	0	0
20	50	125.8	0	0	0	0	0
21	50	70	0	0	0	0	0
22	53.57	70	0	0	0	0	0
23	27.13	70	0	0	0	0	0
24	959	70	0	0	0	0	0
25	733.1	120.3	0	0	0	0	0
26	732.2	120.3	0	0	0	0	0
27	728.3	120.3	0	0	0	0	0
28	728.3	120.3	0	0	0	0	0
29	728.3	120.3	0	0	0	0	0
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							

BRANCH	UPNODE	DNNODE	OPTION	DESCRIPTION
19				
20			1018	1019
21			1019	1020
22			1021	1020 1022
23			1022	1023
24			1023	1024
25			1024	1025
26			1025	1026
27			1026	1027
28			1027	1028
29			1028	1029
31			1029	
32			1030	1031
33			1031	1032
35			1032	1033
36			1033	1034
37			1034	1035
38			1035	1036
39			1036	1037
40			1037	1038
41			1038	1039
42			1039	1040
43			1040	1046
44			1041	1042
45			1042	1043
46			1043	1044
47			1044	1045
48			1046	1045 1047
49			1047	1048
50			1048	1049
51			1049	1050
52			1050	1051
53			1051	1052
54			1052	1053
56			1053	1054
57			1054	
58			1055	1056
60			1056	1057
61			1057	1058
62			1058	1059
63			1059	1060
64			1060	1061
1001	1	2	1061	1062
1002	2	3	1062	1063
1003	3	4	1063	1064
1004	4	5		
			1	"Pipe 1001"
			2	"Restrict 1002"
			13	"Valve 1003"
			1	"Pipe 1004"

1005	5	6	2	"Restrict 1005"
1006	6	7	1	"Pipe 1006"
1007	7	8	13	"Valve 1007"
1008	8	9	7	"Reduct 1008"
1009	9	10	1	"Pipe 1009"
1010	10	11	2	"Restrict 1010"
1011	11	12	1	"Pipe 1011"
1012	12	13	13	"Valve 1012"
1013	13	14	1	"Pipe 1013"
1014	14	15	2	"Restrict 1014"
1015	15	16	1	"Pipe 1015"
1021	16	21	2	"Restrict 1021"
1016	12	17	13	"Valve 1016"
1017	17	18	1	"Pipe 1017"
1018	18	19	18	"Valve 1018"
1019	19	20	1	"Pipe 1019"
1020	20	21	2	"Restrict 1020"
1022	21	22	13	"Valve 1022"
1023	22	23	2	"Restrict 1023"
1024	23	24	1	"Pipe 1024"
1025	24	25	2	"Restrict 1025"
1026	25	26	1	"Pipe 1026"
1027	26	27	8	"Expan 1027"
1028	27	28	2	"Restrict 1028"
1029	28	29	2	"Restrict 1029"
1030	30	31	2	"Restrict 1030"
1031	31	32	2	"Restrict 1031"
1032	32	33	14	"Pump 1032"
1033	33	34	2	"Restrict 1033"
1034	7	35	13	"Valve 1034"
1035	35	36	7	"Reduct 1035"
1036	36	37	2	"Restrict 1036"
1037	37	38	13	"Valve 1037"
1038	38	39	1	"Pipe 1038"
1039	39	40	2	"Restrict 1039"
1040	40	41	1	"Pipe 1040"
1046	41	42	2	"Restrict 1046"
1041	37	42	13	"Valve 1041"
1042	42	43	1	"Pipe 1042"
1043	43	44	18	"Valve 1043"
1044	44	45	1	"Pipe 1044"
1045	45	46	2	"Restrict 1045"
1047	46	47	13	"Valve 1047"
1048	47	48	2	"Restrict 1048"
1049	48	49	1	"Pipe 1049"
1050	49	50	2	"Restrict 1050"
1051	50	51	1	"Pipe 1051"

BRANCH	OPTION	-1	LENGTH	DIA	EPSP	ANGLE	AREA	INITIAL VALVE POSITION
1017	OPTION -1		7.5	0.53	0.0015094339623	0	0.22061815775	
BRANCH	OPTION -18-2		VALVE OPTION	CL	AREA	CONTROL NODE	0	0.22061815775
1018	OPTION -18-2		2	0.6	0.2827	29	T	
BRANCH	VALVE CYCLE TIME		NUMBER OF CYCLES		PRESSURE FILE HISTORY FILE NAME			
0.05			5					
exj12rp1.dat								
BRANCH	OPTION -1		LENGTH	DIA	EPSP	ANGLE	AREA	
1019	OPTION -1		9	0.53	0.0015094339623	0	0.22061815775	
BRANCH	OPTION -2		FLOW COEFF	AREA				
1020	OPTION -2		0.6	0.02895				
BRANCH	OPTION -13		DIA	K1	K2	AREA		
1022	OPTION -13		0.53	500	0.7	0.22062		
BRANCH	OPTION -2		FLOW COEFF	AREA				
1023	OPTION -2		0.83056	0.2255				
BRANCH	OPTION -1		LENGTH	DIA	EPSP	ANGLE	AREA	
1024	OPTION -1		14	0.53	0.0015094339623	0	0.22061815775	
BRANCH	OPTION -2		FLOW COEFF	AREA				
1025	OPTION -2		0.6	0.4185				
BRANCH	OPTION -1		LENGTH	DIA	EPSP	ANGLE	AREA	
1026	OPTION -1		14	0.53	0.0015094339623	0	0.22061815775	
BRANCH	OPTION -8		PIPE DIA	EXP DIA	AREA			
1027	OPTION -8		0.53	3	0.22062			
BRANCH	OPTION -2		FLOW COEFF	AREA				
1028	OPTION -2		0	7.0686				
BRANCH	OPTION -2		FLOW COEFF	AREA				
1029	OPTION -2		0.6	37.699				
BRANCH	OPTION -2		FLOW COEFF	AREA				
1030	OPTION -2		0	3987				
BRANCH	OPTION -2		FLOW COEFF	AREA				
1031	OPTION -2		0.181	14.25				
BRANCH	OPTION -14		PUMP CONST1	PUMP CONST2	PUMP CONST3	AREA		
1032	OPTION -14		1.6876e+05	0	-4.9362	14.25		
BRANCH	OPTION -2		FLOW COEFF	AREA				
1033	OPTION -2		0.0464	14.25				
BRANCH	OPTION -13		DIA	K1	K2	AREA		
1034	OPTION -13		1.3	200	0.1	1.3273		
BRANCH	OPTION -7		PIPE DIA	RED. DIA	AREA			
1035	OPTION -7		1.3	0.78	1.3273			
BRANCH	OPTION -2		FLOW COEFF	AREA				
1036	OPTION -2		0.6	0.63617				
BRANCH	OPTION -13		DIA	K1	K2	AREA		
1037	OPTION -13		0.78	500	0.7	0.47784		
BRANCH	OPTION -1		LENGTH	DIA	EPSP	ANGLE	AREA	
1038	OPTION -1		11	0.78	0.0010256410256	0	0.477835839	
BRANCH	OPTION -2		FLOW COEFF	AREA				
1039	OPTION -2		0.6	1e-05				

BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA	0.477835839
1040		18	0.78		0.0010256410256	0	
BRANCH	OPTION -2	FLOW COEFF	AREA				
1046		0.6	0.01767				
BRANCH	OPTION -13	DIA	K1	K2	AREA		
1041		0.78	500	0.7	0.47784		
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA	0.477835839
1042		28	0.78		0.0010256410256	0	
BRANCH	OPTION -18-2	VALVE OPTION	CL	AREA	CONTROL NODE	INITIAL VALVE POSITION	
1043		2	0.6	0.63617	54	T	
VALVE CYCLE TIME		NUMBER OF CYCLES		PRESSURE FILE HISTORY FILE NAME			
0.05		5					
ex12lox.dat							
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA	0.477835839
1044		15	0.78		0.0010256410256	0	
BRANCH	OPTION -2	FLOW COEFF	AREA				
1045		0.6	0.10179				
BRANCH	OPTION -13	DIA	K1	K2	AREA		
1047		0.78	500	0.7	0.47784		
BRANCH	OPTION -2	FLOW COEFF	AREA				
1048		0.77371	0.55351				
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA	0.477835839
1049		13	0.78		0.0010256410256	0	
BRANCH	OPTION -2	FLOW COEFF	AREA				
1050		0.6	0.7854				
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA	0.477835839
1051		21	0.78		0.0010256410256	0	
BRANCH	OPTION -8	PIPE DIA	EXP DIA	AREA			
1052		0.78	3	0.47784			
BRANCH	OPTION -2	FLOW COEFF	AREA				
1055		0	4015				
BRANCH	OPTION -2	FLOW COEFF	AREA				
1056		0.304	14.25				
BRANCH	OPTION -14	PUMP CONST1	PUMP CONST2	PUMP CONST3	AREA		
1057		1.7603e+05	0	-2.5799	14.25		
BRANCH	OPTION -2	FLOW COEFF	AREA				
1058		0.105	14.25				
BRANCH	OPTION -13	DIA	K1	K2	AREA		
1059		1.3	200	0.1	1.3273		
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA	1.327321775
1060		19	1.3		0.00061538461538	0	
BRANCH	OPTION -2	FLOW COEFF	AREA				
1061		0.6	0.63617				
BRANCH	OPTION -7	PIPE DIA	RED. DIA	AREA			
1062		1.3	0.53	1.3273			
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA	0.22061815775
1063		143	0.53		0.0015094339623	0	

BRANCH	OPTION -1	LENGTH	DIA	EPSD	ANGLE	AREA
1064		28	0.53			0.22061815775
BRANCH	OPTION -2	FLOW COEFF	AREA			
1053		0	7.0686			
BRANCH	OPTION -2	FLOW COEFF	AREA			
1054		0.6	37.699			
INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW						
1001		0.803				
1002		0.803				
1003		0.423				
1004		0.423				
1005		0.423				
1006		0.423				
1007		0.082				
1008		0.082				
1009		0.082				
1010		0.082				
1011		0.082				
1012		0.0001				
1013		0.0001				
1014		0.0001				
1015		0.0001				
1021		0.0001				
1016		0.0819				
1017		0.0819				
1018		0.0819				
1019		0.0819				
1020		0.0819				
1022		0.0819				
1023		0.0819				
1024		0.0819				
1025		0.0819				
1026		0.0819				
1027		0.0819				
1028		0.0819				
1029		0.0819				
1030		64				
1031		64				
1032		64				
1033		64				
1034		0.341				
1035		0.341				
1036		0.341				
1037		0.0001				
1038		0.0001				
1039		0.0001				
1040		0.0001				

1046 0.0001
 1041 0.3409
 1042 0.3409
 1043 0.3409
 1044 0.3409
 1045 0.3409
 1047 0.3409
 1048 0.3409
 1049 0.3409
 1050 0.3409
 1051 0.3409
 1052 0.3409
 1055 140
 1056 140
 1057 140
 1058 140
 1059 0.38
 1060 0.38
 1061 0.38
 1062 0.38
 1063 0.38
 1064 0.38
 1053 0.3409
 1054 0.3409

BRANCH	NOUBR	NMUBR
1001	0	
1002	1	1001
1003	2	1002 1059
1004	1	1003
1005	1	1004
1006	1	1005
1007	2	1006 1034
1008	1	1007
1009	1	1008
1010	1	1009
1011	1	1010
1012	2	1011 1016
1013	1	1012
1014	1	1013
1015	1	1014
1021	1	1015
1016	2	1011 1012
1017	1	1016
1018	1	1017
1019	1	1018
1020	1	1019
1022	2	1021 1020

1023	1	1022	
1024	1	1023	
1025	1	1024	
1026	1	1025	
1027	1	1026	
1028	1	1027	
1029	1	1028	
1030	0		
1031	1	1030	
1032	1	1031	
1033	1	1032	
1034	2	1006	1007
1035	1	1034	
1036	1	1035	
1037	2	1036	1041
1038	1	1037	
1039	1	1038	
1040	1	1039	
1046	1	1040	
1041	2	1036	1037
1042	1	1041	
1043	1	1042	
1044	1	1043	
1045	1	1044	
1047	2	1046	1045
1048	1	1047	
1049	1	1048	
1050	1	1049	
1051	1	1050	
1052	1	1051	
1055	0		
1056	1	1055	
1057	1	1056	
1058	1	1057	
1059	2	1002	1003
1060	1	1059	
1061	1	1060	
1062	1	1061	
1063	1	1062	
1064	1	1063	
1053	1	1052	
1054	1	1053	
BRANCH		NODER	NMDBR
1001	1	1002	
1002	2	1003	1059
1003	1	1004	
1004	1	1005	

1005	1	1006	
1006	2	1007	1034
1007	1	1008	
1008	1	1009	
1009	1	1010	
1010	1	1011	
1011	2	1012	1016
1012	1	1013	
1013	1	1014	
1014	1	1015	
1015	1	1021	
1021	2	1020	1022
1016	1	1017	
1017	1	1018	
1018	1	1019	
1019	1	1020	
1020	2	1021	1022
1022	1	1023	
1023	1	1024	
1024	1	1025	
1025	1	1026	
1026	1	1027	
1027	1	1028	
1028	1	1029	
1029	0		
1030	1	1031	
1031	1	1032	
1032	1	1033	
1033	0		
1034	1	1035	
1035	1	1036	
1036	2	1037	1041
1037	1	1038	
1038	1	1039	
1039	1	1040	
1040	1	1046	
1046	2	1045	1047
1041	1	1042	
1042	1	1043	
1043	1	1044	
1044	1	1045	
1045	2	1046	1047
1047	1	1048	
1048	1	1049	
1049	1	1050	
1050	1	1051	
1051	1	1052	

1052	1	1053
1055	1	1056
1056	1	1057
1057	1	1058
1058	0	
1059	1	1060
1060	1	1061
1061	1	1062
1062	1	1063
1063	1	1064
1064	0	
1053	1	1054
1054	0	
BRANCH		
1001		
UPSTRM BR.		ANGLE
DNSTRM BR.		ANGLE
1002		0.00000
BRANCH		
1002		
UPSTRM BR.		ANGLE
1001		0.00000
DNSTRM BR.		ANGLE
1003		0.00000
1059		0.00000
BRANCH		
1003		
UPSTRM BR.		ANGLE
1002		0.00000
1059		0.00000
DNSTRM BR.		ANGLE
1004		0.00000
BRANCH		
1004		
UPSTRM BR.		ANGLE
1003		0.00000
DNSTRM BR.		ANGLE
1005		0.00000
BRANCH		
1005		
UPSTRM BR.		ANGLE
1004		0.00000
DNSTRM BR.		ANGLE
1006		0.00000
BRANCH		
1006		
UPSTRM BR.		ANGLE

```

1005      0.00000
DNSTRM BR.    ANGLE
1007      0.00000
1034      0.00000
BRANCH
1007
UPSTRM BR.    ANGLE
1006      0.00000
1034      0.00000
DNSTRM BR.    ANGLE
1008      0.00000
BRANCH
1008
UPSTRM BR.    ANGLE
1007      0.00000
DNSTRM BR.    ANGLE
1009      0.00000
BRANCH
1009
UPSTRM BR.    ANGLE
1008      0.00000
DNSTRM BR.    ANGLE
1010      0.00000
BRANCH
1010
UPSTRM BR.    ANGLE
1009      0.00000
DNSTRM BR.    ANGLE
1011      0.00000
BRANCH
1011
UPSTRM BR.    ANGLE
1010      0.00000
DNSTRM BR.    ANGLE
1012      0.00000
1016      0.00000
BRANCH
1012
UPSTRM BR.    ANGLE
1011      0.00000
1016      0.00000
DNSTRM BR.    ANGLE
1013      0.00000
BRANCH
1013
UPSTRM BR.    ANGLE
1012      0.00000

```

DNSTRM BR. ANGLE
 1014 0.00000
 BRANCH
 1014
 UPSTRM BR. ANGLE
 1013 0.00000
 DNSTRM BR. ANGLE
 1015 0.00000
 BRANCH
 1015
 UPSTRM BR. ANGLE
 1014 0.00000
 DNSTRM BR. ANGLE
 1021 0.00000
 BRANCH
 1021
 UPSTRM BR. ANGLE
 1015 0.00000
 DNSTRM BR. ANGLE
 1020 0.00000
 1022 0.00000
 BRANCH
 1016
 UPSTRM BR. ANGLE
 1011 0.00000
 1012 0.00000
 DNSTRM BR. ANGLE
 1017 0.00000
 BRANCH
 1017
 UPSTRM BR. ANGLE
 1016 0.00000
 DNSTRM BR. ANGLE
 1018 0.00000
 BRANCH
 1018
 UPSTRM BR. ANGLE
 1017 0.00000
 DNSTRM BR. ANGLE
 1019 0.00000
 BRANCH
 1019
 UPSTRM BR. ANGLE
 1018 0.00000
 DNSTRM BR. ANGLE
 1020 0.00000
 BRANCH

```

1020
UPSTRM BR.      ANGLE
1019      0.00000
DNSTRM BR.      ANGLE
1021      0.00000
1022      0.00000
BRANCH
1022
UPSTRM BR.      ANGLE
1021      0.00000
1020      0.00000
DNSTRM BR.      ANGLE
1023      0.00000
BRANCH
1023
UPSTRM BR.      ANGLE
1022      0.00000
DNSTRM BR.      ANGLE
1024      0.00000
BRANCH
1024
UPSTRM BR.      ANGLE
1023      0.00000
DNSTRM BR.      ANGLE
1025      0.00000
BRANCH
1025
UPSTRM BR.      ANGLE
1024      0.00000
DNSTRM BR.      ANGLE
1026      0.00000
BRANCH
1026
UPSTRM BR.      ANGLE
1025      0.00000
DNSTRM BR.      ANGLE
1027      0.00000
BRANCH
1027
UPSTRM BR.      ANGLE
1026      0.00000
DNSTRM BR.      ANGLE
1028      0.00000
BRANCH
1028
UPSTRM BR.      ANGLE
1027      0.00000

```

DNSTRM BR. ANGLE
1029 0.00000
BRANCH
1029
UPSTRM BR. ANGLE
1028 0.00000
DNSTRM BR. ANGLE
BRANCH
1030
UPSTRM BR. ANGLE
DNSTRM BR. ANGLE
1031 0.00000
BRANCH
1031
UPSTRM BR. ANGLE
1030 0.00000
DNSTRM BR. ANGLE
1032 0.00000
BRANCH
1032
UPSTRM BR. ANGLE
1031 0.00000
DNSTRM BR. ANGLE
1033 0.00000
BRANCH
1033
UPSTRM BR. ANGLE
1032 0.00000
DNSTRM BR. ANGLE
BRANCH
1034
UPSTRM BR. ANGLE
1006 0.00000
1007 0.00000
DNSTRM BR. ANGLE
1035 0.00000
BRANCH
1035
UPSTRM BR. ANGLE
1034 0.00000
DNSTRM BR. ANGLE
1036 0.00000
BRANCH
1036
UPSTRM BR. ANGLE
1035 0.00000
DNSTRM BR. ANGLE

1037	0.00000
1041	0.00000
BRANCH	
1037	
UPSTRM BR.	ANGLE
1036	0.00000
1041	0.00000
DNSTRM BR.	ANGLE
1038	0.00000
BRANCH	
1038	
UPSTRM BR.	ANGLE
1037	0.00000
DNSTRM BR.	ANGLE
1039	0.00000
BRANCH	
1039	
UPSTRM BR.	ANGLE
1038	0.00000
DNSTRM BR.	ANGLE
1040	0.00000
BRANCH	
1040	
UPSTRM BR.	ANGLE
1039	0.00000
DNSTRM BR.	ANGLE
1046	0.00000
BRANCH	
1046	
UPSTRM BR.	ANGLE
1040	0.00000
DNSTRM BR.	ANGLE
1045	0.00000
1047	0.00000
BRANCH	
1041	
UPSTRM BR.	ANGLE
1036	0.00000
1037	0.00000
DNSTRM BR.	ANGLE
1042	0.00000
BRANCH	
1042	
UPSTRM BR.	ANGLE
1041	0.00000
DNSTRM BR.	ANGLE
1043	0.00000


```

BRANCH
1043
UPSTRM BR.    ANGLE
1042          0.00000
DNSTRM BR.    ANGLE
1044          0.00000
BRANCH
1044
UPSTRM BR.    ANGLE
1043          0.00000
DNSTRM BR.    ANGLE
1045          0.00000
BRANCH
1045
UPSTRM BR.    ANGLE
1044          0.00000
DNSTRM BR.    ANGLE
1046          0.00000
1047          0.00000
BRANCH
1047
UPSTRM BR.    ANGLE
1046          0.00000
1045          0.00000
DNSTRM BR.    ANGLE
1048          0.00000
BRANCH
1048
UPSTRM BR.    ANGLE
1047          0.00000
DNSTRM BR.    ANGLE
1049          0.00000
BRANCH
1049
UPSTRM BR.    ANGLE
1048          0.00000
DNSTRM BR.    ANGLE
1050          0.00000
BRANCH
1050
UPSTRM BR.    ANGLE
1049          0.00000
DNSTRM BR.    ANGLE
1051          0.00000
BRANCH
1051
UPSTRM BR.    ANGLE

```

1050 0.00000
DNSTRM BR. ANGLE
1052 0.00000
BRANCH
1052
UPSTRM BR. ANGLE
1051 0.00000
DNSTRM BR. ANGLE
1053 0.00000
BRANCH
1055
UPSTRM BR. ANGLE
DNSTRM BR. ANGLE
1056 0.00000
BRANCH
1056
UPSTRM BR. ANGLE
1055 0.00000
DNSTRM BR. ANGLE
1057 0.00000
BRANCH
1057
UPSTRM BR. ANGLE
1056 0.00000
DNSTRM BR. ANGLE
1058 0.00000
BRANCH
1058
UPSTRM BR. ANGLE
1057 0.00000
DNSTRM BR. ANGLE
BRANCH
1059
UPSTRM BR. ANGLE
1002 0.00000
1003 0.00000
DNSTRM BR. ANGLE
1060 0.00000
BRANCH
1060
UPSTRM BR. ANGLE
1059 0.00000
DNSTRM BR. ANGLE
1061 0.00000
BRANCH
1061
UPSTRM BR. ANGLE

1060 0.00000
 DNSTRM BR. ANGLE
 1062 0.00000
 BRANCH
 1062
 UPSTRM BR. ANGLE
 1061 0.00000
 DNSTRM BR. ANGLE
 1063 0.00000
 BRANCH
 1063
 UPSTRM BR. ANGLE
 1062 0.00000
 DNSTRM BR. ANGLE
 1064 0.00000
 BRANCH
 1064
 UPSTRM BR. ANGLE
 1063 0.00000
 DNSTRM BR. ANGLE
 1053
 UPSTRM BR. ANGLE
 1052 0.00000
 DNSTRM BR. ANGLE
 1054 0.00000
 BRANCH
 1054
 UPSTRM BR. ANGLE
 1053 0.00000
 DNSTRM BR. ANGLE
 NUMBER OF BRANCHES WITH INERTIA

7

1008
 1020
 1027
 1035
 1045
 1052
 1062

NUMBER OF PRESSURIZATION PROPELLANT TANKS IN CIRCUIT

2

TNKTYPE	NODUL	NODULB	NODPRP	IBRPRP	TNKAR	TNKTH	TNKRHO	TNKCP	TNKCON	ARHC	FCTHC	TNKTM	CIP
1	29	30	31	1030	5442	0.38	170	0.2	0.03622	3987	1	70	0.27
0.25	0.54	0.25											

1 54 55 56 1055 6431.9 0.375 170 0.2 0.03622 4015 1 -300 0.27
 0.25 0.54 0.25

EXAMPLE 12 HISTORY FILES

EXI2HS1.DAT

3
 -500 765.00 120.0 1.00 0.00 0.00
 0 765.00 120.0 1.00 0.00 0.00
 300 765.00 120.0 1.00 0.00 0.00

EXI2HS2.DAT

6
 -500. 14.700 70.00 0.00 0.00 1.00
 -499. 20.000 70.00 0.00 0.00 1.00
 -420. 20.000 70.00 0.00 0.00 1.00
 -419. 50.000 70.00 0.00 0.00 1.00
 0 50.000 70.00 0.00 0.00 1.00
 300 50.000 70.00 0.00 0.00 1.00

EXI2HS3.DAT

5
 -500 14.700 70.00 0.00 0.00 1.00
 -420 14.700 70.00 0.00 0.00 1.00
 -418 652.00 70.00 0.00 0.00 1.00
 0 652.00 70.00 0.00 0.00 1.00
 300 652.00 70.00 0.00 0.00 1.00

EXI2HS4.DAT

6
 -500. 14.700 -300. 0.00 1.00 0.00
 -499. 20.000 -300. 0.00 1.00 0.00
 -420. 20.000 -300. 0.00 1.00 0.00
 -419. 67.000 -300. 0.00 1.00 0.00
 0 67.000 -300. 0.00 1.00 0.00
 300 67.000 -300. 0.00 1.00 0.00

EXI2HS5.DAT

5
 -500 14.700 -300. 0.00 1.00 0.00

```

-420 14.700 -300. 0.00 1.00 0.00
-419 652.00 -300. 0.00 1.00 0.00
0 652.00 -300. 0.00 1.00 0.00
300 652.00 -300. 0.00 1.00 0.00

```

EX12HS6.DAT

```

3
-500. 615.00 120.0 1.00 0.00 0.00
0 615.00 120.0 1.00 0.00 0.00
300 615.00 120.0 1.00 0.00 0.00

```

```

C*****
C
C ***** GFSSP USER SUBROUTINES *****
C
C*****
:
:
:
:

```

```

C*****
SUBROUTINE PRNUSER
PURPOSE: ADD NEW OUTPUT
*****
INCLUDE 'COMBLK.FOR'
*****
C ADD CODE HERE
C GENERATE EXCEL FILE FOR PLOT
OPEN (NUSR1,FILE = 'EX12.XLS',STATUS = 'UNKNOWN')
VOLUL1=VOLUME(29)
VOLUL2=VOLUME(54)
TFTNK1=TINKTM(1)-460.
TFTNK2=TINKTM(2)-460.
WRITE (NUSR1,200) TAU,QULWAL(1),QULWAL(2),QULPRP(1),QULPRP(2),
& QCOND(1),QCOND(2),VOLUL1,VOLUL2,TFTNK1,TFTNK2,
& SORCECON(29,3),SORCECON(54,2),CX(29,3),CX(54,2)
200 FORMAT (2X,E12.6,10(2X,2E12.6))
RETURN
END

```

NOTE: All other user subroutines are identical with Example 10 (Appendix 5)

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/12/2012 15:10

TITLE :Helium Pressurization of LOX and RP-1 Propellant Tanks
 ANALYST :Todd Steadman
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX12\Ex12.dat
 FILEOUT :Ex12.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	CONDX	F	CONJUG	F	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	F	HCOEF	F	HEX	F	HRATE	T	IFRMIX	1	INERTIA	T	INSUC	F
INVAL	F	MIXTURE	F	MOVBNB	F	MSORCE	F	NORMAL	F	NRSOLVT	F	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRINTI	F	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	F	SHEAR	F	SIMULA	F	SIUNITS	F	STEADY	F	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	F	TRANSV	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F														

NNODES = 65
 NINT = 59
 NBR = 64
 NF = 3
 NVAR = 182
 NHREF = 2

FLUIDS: HE O2 RP1

BOUNDARY NODES		CONCENTRATIONS									
NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)	HE	O2	RP1	HE	O2	RP1	HE
1	0.7650E+03	0.1200E+03	0.4783E+00	0.0000E+00	0.0000E+00	0.1000E+01	0.0000E+00	0.0000E+00	0.1000E+01	0.0000E+00	0.0000E+00
30	0.5368E+02	0.7000E+02	0.5151E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.0000
34	0.6520E+03	0.7000E+02	0.5170E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.0000
55	0.7548E+02	-0.3000E+03	0.7172E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1000E+01	0.0000
59	0.6520E+03	-0.3000E+03	0.7226E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1000E+01	0.0000
65	0.6150E+03	0.1200E+03	0.3867E+00	0.0000E+00	0.0000E+00	0.1000E+01	0.0000E+00	0.0000E+00	0.1000E+01	0.0000E+00	0.0000

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)
2	0.0000E+00	0.0000E+00	0.0000E+00
3	0.0000E+00	0.0000E+00	0.0000E+00
4	0.0000E+00	0.0000E+00	0.0000E+00
5	0.0000E+00	0.0000E+00	0.0000E+00
6	0.0000E+00	0.0000E+00	0.0000E+00
7	0.0000E+00	0.0000E+00	0.0000E+00
8	0.0000E+00	0.0000E+00	0.0000E+00
9	0.0000E+00	0.0000E+00	0.0000E+00
10	0.0000E+00	0.0000E+00	0.0000E+00
11	0.0000E+00	0.0000E+00	0.0000E+00
12	0.0000E+00	0.0000E+00	0.0000E+00
13	0.0000E+00	0.0000E+00	0.0000E+00
14	0.0000E+00	0.0000E+00	0.0000E+00
15	0.0000E+00	0.0000E+00	0.0000E+00
16	0.0000E+00	0.0000E+00	0.0000E+00
17	0.0000E+00	0.0000E+00	0.0000E+00
18	0.0000E+00	0.0000E+00	0.0000E+00
19	0.0000E+00	0.0000E+00	0.0000E+00
20	0.0000E+00	0.0000E+00	0.0000E+00
21	0.0000E+00	0.0000E+00	0.0000E+00
22	0.0000E+00	0.0000E+00	0.0000E+00
23	0.0000E+00	0.0000E+00	0.0000E+00
24	0.0000E+00	0.0000E+00	0.0000E+00
25	0.0000E+00	0.0000E+00	0.0000E+00
26	0.0000E+00	0.0000E+00	0.0000E+00
27	0.0000E+00	0.0000E+00	0.0000E+00
28	0.0000E+00	0.0000E+00	0.0000E+00
29	0.0000E+00	0.0000E+00	0.0000E+00
31	0.0000E+00	-0.6400E+02	0.0000E+00
32	0.0000E+00	0.0000E+00	0.0000E+00
33	0.0000E+00	0.0000E+00	0.0000E+00
35	0.0000E+00	0.0000E+00	0.0000E+00

36	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
37	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
38	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
39	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
40	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
41	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
42	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
43	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
44	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
45	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
46	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
47	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
48	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
49	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
50	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
51	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
53	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
54	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
56	0.0000E+00	-0.1400E+03	0.0000E+00	0.0000E+00
57	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
58	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
60	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
61	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
63	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
64	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH	UPNODE	DNNODE	OPTION
1001	1	2	1
1002	2	3	2
1003	3	4	13
1004	4	5	1
1005	5	6	2
1006	6	7	1
1007	7	8	13
1008	8	9	7
1009	9	10	1
1010	10	11	2
1011	11	12	1
1012	12	13	13
1013	13	14	1
1014	14	15	2
1015	15	16	1
1021	16	21	2
1016	12	17	13
1017	17	18	1

BRANCH	OPTION	-1:	LENGTH	DIA	EPSP	ANGLE	AREA
1018		18	19	18			
1019		19	20	1			
1020		20	21	2			
1021		21	22	13			
1022		22	23	2			
1023		23	24	1			
1024		24	25	2			
1025		25	26	1			
1026		26	27	8			
1027		27	28	2			
1028		28	29	2			
1029		29	30	2			
1030		30	31	2			
1031		31	32	2			
1032		32	33	14			
1033		33	34	2			
1034		7	35	13			
1035		35	36	7			
1036		36	37	2			
1037		37	38	13			
1038		38	39	1			
1039		39	40	2			
1040		40	41	1			
1041		41	42	2			
1042		42	43	13			
1043		43	44	1			
1044		44	45	18			
1045		45	46	1			
1046		46	47	2			
1047		47	48	13			
1048		48	49	2			
1049		49	50	1			
1050		50	51	2			
1051		51	52	1			
1052		52	53	8			
1053		53	54	2			
1054		54	55	2			
1055		55	56	2			
1056		56	57	2			
1057		57	58	14			
1058		58	59	2			
1059		3	60	13			
1060		60	61	1			
1061		61	62	2			
1062		62	63	7			
1063		63	64	1			
1064		64	65	1			
1065		65	66	1			
1066		66	67	2			
1067		67	68	2			
1068		68	69	2			
1069		69	70	2			
1070		70	71	2			
1071		71	72	2			
1072		72	73	2			
1073		73	74	2			
1074		74	75	2			
1075		75	76	2			
1076		76	77	2			
1077		77	78	2			
1078		78	79	2			
1079		79	80	2			
1080		80	81	2			
1081		81	82	2			
1082		82	83	2			
1083		83	84	2			
1084		84	85	2			
1085		85	86	2			
1086		86	87	2			
1087		87	88	2			
1088		88	89	2			
1089		89	90	2			
1090		90	91	2			
1091		91	92	2			
1092		92	93	2			
1093		93	94	2			
1094		94	95	2			
1095		95	96	2			
1096		96	97	2			
1097		97	98	2			
1098		98	99	2			
1099		99	100	2			

```

1001      0.128E+03  0.130E+01  0.615E-03  0.000E+00  0.133E+01
BRANCH OPTION -2: FLOW COEF AREA
1002      0.600E+00  0.636E+00
BRANCH OPTION -13: DIA K1 K2 AREA
1003      0.130E+01  0.200E+03  0.100E+00  0.133E+01
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1004      0.170E+02  0.130E+01  0.615E-03  0.000E+00  0.133E+01
BRANCH OPTION -2: FLOW COEF AREA
1005      0.600E+00  0.636E+00
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1006      0.288E+03  0.130E+01  0.615E-03  0.000E+00  0.133E+01
BRANCH OPTION -13: DIA K1 K2 AREA
1007      0.130E+01  0.200E+03  0.100E+00  0.133E+01
BRANCH OPTION -7: PIPE DIA REDUCED DIA AREA
1008      0.130E+01  0.530E+00  0.133E+01
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1009      0.221E+03  0.530E+00  0.151E-02  0.000E+00  0.221E+00
BRANCH OPTION -2: FLOW COEF AREA
1010      0.600E+00  0.283E+00
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1011      0.120E+02  0.530E+00  0.151E-02  0.000E+00  0.221E+00
BRANCH OPTION -13: DIA K1 K2 AREA
1012      0.530E+00  0.500E+03  0.700E+00  0.221E+00
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1013      0.140E+02  0.530E+00  0.151E-02  0.000E+00  0.221E+00
BRANCH OPTION -2: FLOW COEF AREA
1014      0.600E+00  0.100E-04
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1015      0.140E+02  0.530E+00  0.151E-02  0.000E+00  0.221E+00
BRANCH OPTION -2: FLOW COEF AREA
1021      0.600E+00  0.785E-02
BRANCH OPTION -13: DIA K1 K2 AREA
1016      0.530E+00  0.500E+03  0.700E+00  0.221E+00
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1017      0.750E+01  0.530E+00  0.151E-02  0.000E+00  0.221E+00
BR OPT-> 18-2 SUBOPT FLOW COEF, AREA, CTRL NODE, INIT POS
1018      2  0.60000  0.28270  29.00000  T
BR OPT-> 18-2(continued), CYCLE TIME, CYCLE STEPS, PR TOL FILE
          0.05000  5.00000  ex12rpl.dat
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1019      0.900E+01  0.530E+00  0.151E-02  0.000E+00  0.221E+00
BRANCH OPTION -2: FLOW COEF AREA
1020      0.600E+00  0.290E-01
BRANCH OPTION -13: DIA K1 K2 AREA
1022      0.530E+00  0.500E+03  0.700E+00  0.221E+00
BRANCH OPTION -2: FLOW COEF AREA
1023      0.831E+00  0.226E+00

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BRANCH	OPTION	-1:	LENGTH	DIA	EPSP	ANGLE	AREA
1024			0.140E+02	0.530E+00	0.151E-02	0.000E+00	0.221E+00
BRANCH	OPTION	-2:	FLOW COEF	AREA			
1025			0.600E+00	0.418E+00			
BRANCH	OPTION	-1:	LENGTH	DIA	EPSP	ANGLE	AREA
1026			0.140E+02	0.530E+00	0.151E-02	0.000E+00	0.221E+00
BRANCH	OPTION	-8:	PIPE DIA	EXP DIA	AREA		
1027			0.530E+00	0.300E+01	0.221E+00		
BRANCH	OPTION	-2:	FLOW COEF	AREA			
1028			0.000E+00	0.707E+01			
BRANCH	OPTION	-2:	FLOW COEF	AREA			
1029			0.600E+00	0.377E+02			
BRANCH	OPTION	-2:	FLOW COEF	AREA			
1030			0.000E+00	0.399E+04			
BRANCH	OPTION	-2:	FLOW COEF	AREA			
1031			0.181E+00	0.142E+02			
BRANCH	OPTION	-14:	PUMP CONS1	PUMP CONS2	PUMP CONS3	AREA	
1032			0.169E+06	0.000E+00	-0.494E+01	0.142E+02	
BRANCH	OPTION	-2:	FLOW COEF	AREA			
1033			0.464E-01	0.142E+02			
BRANCH	OPTION	-13:	DIA K1	K2	AREA		
1034			0.130E+01	0.200E+03	0.100E+00	0.133E+01	
BRANCH	OPTION	-7:	PIPE DIA	REDUCED DIA	AREA		
1035			0.130E+01	0.780E+00	0.133E+01		
BRANCH	OPTION	-2:	FLOW COEF	AREA			
1036			0.600E+00	0.636E+00			
BRANCH	OPTION	-13:	DIA K1	K2	AREA		
1037			0.780E+00	0.500E+03	0.700E+00	0.478E+00	
BRANCH	OPTION	-1:	LENGTH	DIA	EPSP	ANGLE	AREA
1038			0.110E+02	0.780E+00	0.103E-02	0.000E+00	0.478E+00
BRANCH	OPTION	-2:	FLOW COEF	AREA			
1039			0.600E+00	0.100E-04			
BRANCH	OPTION	-1:	LENGTH	DIA	EPSP	ANGLE	AREA
1040			0.180E+02	0.780E+00	0.103E-02	0.000E+00	0.478E+00
BRANCH	OPTION	-2:	FLOW COEF	AREA			
1046			0.600E+00	0.177E-01			
BRANCH	OPTION	-13:	DIA K1	K2	AREA		
1041			0.780E+00	0.500E+03	0.700E+00	0.478E+00	
BRANCH	OPTION	-1:	LENGTH	DIA	EPSP	ANGLE	AREA
1042			0.280E+02	0.780E+00	0.103E-02	0.000E+00	0.478E+00
BR OPT->	18-2	SUBOPT	FLOW COEF,	AREA, CTRL	NODE, INIT	POS	
1043		2	0.60000	0.63617	54.00000	T	
BR OPT->	18-2	(continued),	CYCLE TIME,	CYCLE STEPS,	PR TOL	FILE	
			0.05000	5.00000	ex121ox.dat		
BRANCH	OPTION	-1:	LENGTH	DIA	EPSP	ANGLE	AREA
1044			0.150E+02	0.780E+00	0.103E-02	0.000E+00	0.478E+00
BRANCH	OPTION	-2:	FLOW COEF	AREA			

ISTEP = 1 TAU = 0.10000E+00

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	CONCENTRATIONS		
					HE	O2	RP1
1	0.7650E+03	0.1200E+03	0.1029E+01	0.4783E+00	0.1000E+01	0.0000E+00	0.0000
30	0.5368E+02	0.7000E+02	0.2938E-01	0.5151E+02	0.0000E+00	0.0000E+00	1.0000
34	0.6520E+03	0.3817E+00	0.5170E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.0000
55	0.7548E+02	-0.3000E+03	0.1745E-01	0.7172E+02	0.0000E+00	0.1000E+01	0.0000
59	0.6520E+03	-0.3000E+03	0.1686E+00	0.7226E+02	0.0000E+00	0.1000E+01	0.0000
65	0.6150E+03	0.1200E+03	0.1024E+01	0.3867E+00	0.1000E+01	0.0000E+00	0.0000

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	CONC
					HE	O2
2	0.7619E+03	0.1200E+03	0.1029E+01	0.4765E+00	0.4685E-01	0.1000E+01
3	0.7412E+03	0.1200E+03	0.1028E+01	0.4638E+00	0.0000E+00	0.1000E+01
4	0.7411E+03	0.1200E+03	0.1028E+01	0.4637E+00	0.3028E-02	0.1000E+01
5	0.7409E+03	0.1200E+03	0.1028E+01	0.4637E+00	0.3027E-02	0.1000E+01
6	0.7350E+03	0.1201E+03	0.1028E+01	0.4600E+00	0.5088E-01	0.1000E+01
7	0.7329E+03	0.1202E+03	0.1028E+01	0.4587E+00	0.5073E-01	0.1000E+01
8	0.7329E+03	0.1201E+03	0.1028E+01	0.4587E+00	-0.1472E-18	0.1000E+01
9	0.7326E+03	0.1205E+03	0.1028E+01	0.4582E+00	0.6464E-02	0.1000E+01
10	0.7258E+03	0.1209E+03	0.1028E+01	0.4537E+00	0.6401E-02	0.1000E+01
11	0.7246E+03	0.1233E+03	0.1028E+01	0.4512E+00	0.3456E-03	0.1000E+01
12	0.7242E+03	0.1251E+03	0.1028E+01	0.4496E+00	0.3444E-03	0.1000E+01
13	0.7242E+03	0.6684E+02	0.1030E+01	0.4982E+00	0.4452E-03	0.1000E+01
14	0.7242E+03	0.6473E+02	0.1030E+01	0.5001E+00	0.4459E-03	0.1000E+01
15	0.8981E+02	0.5712E+02	0.1004E+01	0.6458E-01	0.5772E-04	0.1000E+01
16	0.8981E+02	0.5785E+02	0.1004E+01	0.6449E-01	0.5763E-04	0.1000E+01
17	0.7228E+03	0.1242E+03	0.1028E+01	0.4495E+00	0.2152E-03	0.1000E+01
18	0.7226E+03	0.1197E+03	0.1028E+01	0.4529E+00	0.2168E-03	0.1000E+01
19	0.7214E+03	0.1121E+03	0.1028E+01	0.4581E+00	0.2631E-03	0.1000E+01
20	0.7211E+03	0.1028E+03	0.1028E+01	0.4654E+00	0.2673E-03	0.1000E+01
21	0.8981E+02	0.9315E+02	0.1004E+01	0.6044E-01	-0.8307E-19	0.1000E+01
22	0.7923E+02	0.8313E+02	0.1003E+01	0.5432E-01	0.9231E-19	0.1000E+01
23	0.7115E+02	0.7488E+02	0.1003E+01	0.4954E-01	0.4426E-04	0.1000E+01
24	0.6728E+02	0.6846E+02	0.1003E+01	0.4742E-01	0.4237E-04	0.1000E+01
25	0.6215E+02	0.6376E+02	0.1003E+01	0.4419E-01	0.3949E-04	0.1000E+01
26	0.5782E+02	0.6047E+02	0.1003E+01	0.4138E-01	0.3697E-04	0.1000E+01
27	0.5058E+02	0.5805E+02	0.1002E+01	0.3637E-01	0.2810E-19	0.1000E+01
28	0.5058E+02	0.5642E+02	0.1002E+01	0.3648E-01	0.6338E-20	0.1000E+01
29	0.5058E+02	0.7220E+02	0.1002E+01	0.3540E-01	0.5354E+00	0.1000E+01
31	0.5368E+02	0.7000E+02	0.3154E-01	0.5151E+02	0.1468E+05	0.0000E+00
32	0.2686E+02	0.6997E+02	0.1578E-01	0.5151E+02	0.0000E+00	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
33	0.1058E+04	0.7104E+02	0.6171E+00	0.5179E+02	0.0000E+00	0.0000E+00
35	0.7329E+03	0.1201E+03	0.1028E+01	0.4587E+00	0.0000E+00	0.1000E+01
36	0.7319E+03	0.1198E+03	0.1028E+01	0.4584E+00	0.0000E+00	0.1000E+01
37	0.7280E+03	0.1193E+03	0.1028E+01	0.4565E+00	0.0000E+00	0.1000E+01
38	0.7280E+03	0.8366E+02	0.1030E+01	0.4857E+00	0.7385E-03	0.1000E+01
39	0.7280E+03	0.8082E+02	0.1030E+01	0.4881E+00	0.7423E-03	0.1000E+01
40	0.1536E+03	0.7999E+02	0.1006E+01	0.1055E+00	0.2625E-03	0.1000E+01
41	0.1536E+03	0.8431E+02	0.1006E+01	0.1047E+00	0.2604E-03	0.1000E+01
42	0.7241E+03	0.1189E+03	0.1028E+01	0.4543E+00	0.1759E-02	0.1000E+01
43	0.7223E+03	0.1189E+03	0.1028E+01	0.4531E+00	0.1754E-02	0.1000E+01
44	0.7183E+03	0.1194E+03	0.1028E+01	0.4503E+00	0.9340E-03	0.1000E+01
45	0.7174E+03	0.1204E+03	0.1028E+01	0.4489E+00	0.9311E-03	0.1000E+01
46	0.1536E+03	0.1226E+03	0.1006E+01	0.9777E-01	0.9983E-20	0.1000E+01
47	0.1352E+03	0.1242E+03	0.1005E+01	0.8586E-01	-0.1018E-19	0.1000E+01
48	0.1188E+03	0.1258E+03	0.1005E+01	0.7533E-01	0.1354E-03	0.1000E+01
49	0.1137E+03	0.1271E+03	0.1005E+01	0.7195E-01	0.1294E-03	0.1000E+01
50	0.9764E+02	0.1284E+03	0.1004E+01	0.6169E-01	0.1791E-03	0.1000E+01
51	0.8761E+02	0.1293E+03	0.1004E+01	0.5528E-01	0.1605E-03	0.1000E+01
52	0.6971E+02	0.1301E+03	0.1003E+01	0.4396E-01	0.1000E-21	0.1000E+01
53	0.6971E+02	0.1306E+03	0.1003E+01	0.4393E-01	-0.3219E-20	0.1000E+01
54	0.6970E+02	-0.2526E+03	0.1006E+01	0.1248E+00	0.3144E+01	0.1000E+01
56	0.7548E+02	-0.3000E+03	0.1966E-01	0.7173E+02	0.3406E+05	0.0000E+00
57	0.4337E+02	-0.3001E+03	0.1130E-01	0.7171E+02	0.0000E+00	0.0000E+00
58	0.9197E+03	-0.2977E+03	0.2349E+00	0.7213E+02	0.0000E+00	0.0000E+00
60	0.7411E+03	0.1200E+03	0.1028E+01	0.4638E+00	0.3384E-02	0.1000E+01
61	0.7410E+03	0.1200E+03	0.1028E+01	0.4637E+00	0.3384E-02	0.1000E+01
62	0.7362E+03	0.1200E+03	0.1028E+01	0.4608E+00	0.0000E+00	0.1000E+01
63	0.7290E+03	0.1200E+03	0.1028E+01	0.4564E+00	0.4166E-02	0.1000E+01
64	0.6429E+03	0.1202E+03	0.1025E+01	0.4037E+00	0.5128E-02	0.1000E+01
2	0.0000E+00	0.5634E+01	0.1455E-04	0.2672E-04	0.1244E+01	0.1670E+01
3	0.0000E+00	0.5648E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01
4	0.0000E+00	0.5648E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01
5	0.0000E+00	0.5648E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01
6	0.0000E+00	0.5652E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01
7	0.0000E+00	0.5654E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01
8	0.0000E+00	0.5653E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01
9	0.0000E+00	0.5655E+01	0.1455E-04	0.2672E-04	0.1244E+01	0.1670E+01
10	0.0000E+00	0.5660E+01	0.1456E-04	0.2674E-04	0.1244E+01	0.1670E+01
11	0.0000E+00	0.5666E+01	0.1460E-04	0.2681E-04	0.1244E+01	0.1670E+01
12	0.0000E+00	0.5670E+01	0.1463E-04	0.2687E-04	0.1244E+01	0.1670E+01
13	0.0000E+00	0.5539E+01	0.1359E-04	0.2502E-04	0.1244E+01	0.1671E+01
14	0.0000E+00	0.5534E+01	0.1356E-04	0.2495E-04	0.1244E+01	0.1671E+01
15	0.0000E+00	0.6554E+01	0.1331E-04	0.2452E-04	0.1242E+01	0.1667E+01

16	0.0000E+00	0.6556E+01	0.1332E-04	0.2454E-04	0.1242E+01	0.1667E+01
17	0.0000E+00	0.5669E+01	0.1461E-04	0.2684E-04	0.1244E+01	0.1670E+01
18	0.0000E+00	0.5659E+01	0.1453E-04	0.2669E-04	0.1244E+01	0.1670E+01
19	0.0000E+00	0.5644E+01	0.1440E-04	0.2645E-04	0.1244E+01	0.1670E+01
20	0.0000E+00	0.5623E+01	0.1423E-04	0.2615E-04	0.1244E+01	0.1670E+01
21	0.0000E+00	0.6637E+01	0.1397E-04	0.2566E-04	0.1242E+01	0.1667E+01
22	0.0000E+00	0.6677E+01	0.1378E-04	0.2533E-04	0.1241E+01	0.1667E+01
23	0.0000E+00	0.6711E+01	0.1363E-04	0.2507E-04	0.1241E+01	0.1667E+01
24	0.0000E+00	0.6724E+01	0.1351E-04	0.2487E-04	0.1241E+01	0.1667E+01
25	0.0000E+00	0.6752E+01	0.1343E-04	0.2472E-04	0.1241E+01	0.1667E+01
26	0.0000E+00	0.6781E+01	0.1336E-04	0.2462E-04	0.1241E+01	0.1667E+01
27	0.0000E+00	0.6841E+01	0.1332E-04	0.2453E-04	0.1241E+01	0.1667E+01
28	0.0000E+00	0.6837E+01	0.1329E-04	0.2448E-04	0.1241E+01	0.1667E+01
29	0.0000E+00	0.6875E+01	0.1358E-04	0.2499E-04	0.1241E+01	0.1667E+01
31	0.0000E+00	0.0000E+00	0.1251E-02	0.2352E-04	0.4437E+00	0.1381E+01
32	0.0000E+00	0.0000E+00	0.1249E-02	0.2351E-04	0.4438E+00	0.1381E+01
33	0.0000E+00	0.0000E+00	0.1346E-02	0.2392E-04	0.4429E+00	0.1375E+01
35	0.0000E+00	0.5653E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01
36	0.0000E+00	0.5653E+01	0.1454E-04	0.2670E-04	0.1244E+01	0.1670E+01
37	0.0000E+00	0.5655E+01	0.1453E-04	0.2668E-04	0.1244E+01	0.1670E+01
38	0.0000E+00	0.5576E+01	0.1389E-04	0.2554E-04	0.1244E+01	0.1670E+01
39	0.0000E+00	0.5569E+01	0.1384E-04	0.2545E-04	0.1244E+01	0.1670E+01
40	0.0000E+00	0.6341E+01	0.1374E-04	0.2526E-04	0.1242E+01	0.1668E+01
41	0.0000E+00	0.6351E+01	0.1382E-04	0.2540E-04	0.1242E+01	0.1667E+01
42	0.0000E+00	0.5657E+01	0.1452E-04	0.2667E-04	0.1244E+01	0.1670E+01
43	0.0000E+00	0.5658E+01	0.1452E-04	0.2667E-04	0.1244E+01	0.1670E+01
44	0.0000E+00	0.5662E+01	0.1453E-04	0.2669E-04	0.1244E+01	0.1670E+01
45	0.0000E+00	0.5665E+01	0.1455E-04	0.2672E-04	0.1244E+01	0.1670E+01
46	0.0000E+00	0.6436E+01	0.1452E-04	0.2664E-04	0.1242E+01	0.1667E+01
47	0.0000E+00	0.6503E+01	0.1455E-04	0.2668E-04	0.1242E+01	0.1667E+01
48	0.0000E+00	0.6570E+01	0.1458E-04	0.2673E-04	0.1242E+01	0.1667E+01
49	0.0000E+00	0.6595E+01	0.1460E-04	0.2677E-04	0.1242E+01	0.1667E+01
50	0.0000E+00	0.6673E+01	0.1462E-04	0.2681E-04	0.1242E+01	0.1667E+01
51	0.0000E+00	0.6729E+01	0.1464E-04	0.2684E-04	0.1241E+01	0.1667E+01
52	0.0000E+00	0.6844E+01	0.1465E-04	0.2686E-04	0.1241E+01	0.1667E+01
53	0.0000E+00	0.6845E+01	0.1466E-04	0.2687E-04	0.1241E+01	0.1667E+01
54	0.0000E+00	0.5544E+01	0.7210E-05	0.1331E-04	0.1243E+01	0.1669E+01
56	0.0000E+00	0.6963E+00	0.1416E-03	0.2073E-04	0.4202E+00	0.1730E+01
57	0.0000E+00	0.6962E+00	0.1414E-03	0.2072E-04	0.4204E+00	0.1731E+01
58	0.0000E+00	0.6971E+00	0.1468E-03	0.2093E-04	0.4143E+00	0.1705E+01
60	0.0000E+00	0.5648E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01
61	0.0000E+00	0.5648E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01
62	0.0000E+00	0.5651E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01
63	0.0000E+00	0.5656E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01
64	0.0000E+00	0.5719E+01	0.1453E-04	0.2669E-04	0.1243E+01	0.1670E+01

BRANCHES

BRANCH	$(LBF-S^2/(LBM-FT))^2$	KFACTOR	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
1001	0.684E+03	0.306E+01	0.803E+00	0.182E+03	0.649E+06	0.525E-01	0.110E+00	0.164E-02	0.740E+03
1002	0.464E+04	0.208E+02	0.803E+00	0.381E+03	0.937E+06	0.286E-01	0.286E-01	0.112E-01	0.504E+04
1003	0.700E+02	0.874E-01	0.424E+00	0.992E+02	0.343E+06	0.286E-01	0.286E-01	0.255E-04	0.115E+02
1004	0.964E+02	0.120E+00	0.424E+00	0.207E+03	0.495E+06	0.597E-01	0.597E-01	0.351E-04	0.159E+02
1005	0.477E+04	0.596E+01	0.424E+00	0.100E+03	0.343E+06	0.288E-01	0.288E-01	0.174E-02	0.785E+03
1006	0.165E+04	0.206E+01	0.837E-01	0.198E+02	0.677E+05	0.571E-02	0.571E-02	0.605E-03	0.273E+03
1007	0.717E+02	0.349E-02	0.837E-01	0.198E+02	0.677E+05	0.571E-02	0.571E-02	0.204E-06	0.919E-01
1008	0.733E+04	0.357E+00	0.838E-01	0.119E+03	0.166E+06	0.344E-01	0.344E-01	0.208E-04	0.939E+01
1009	0.139E+06	0.677E+01	0.839E-01	0.942E+02	0.147E+06	0.349E-01	0.349E-01	0.395E-03	0.178E+03
1010	0.247E+05	0.121E+01	0.839E-01	0.121E+03	0.166E+06	0.272E-02	0.272E-02	0.712E-04	0.321E+02
1011	0.765E+04	0.375E+00	0.839E-01	0.121E+03	0.166E+06	0.349E-01	0.349E-01	0.221E-04	0.100E+02
1012	0.340E+05	0.185E-03	0.883E-03	0.128E+01	0.174E+04	0.369E-03	0.369E-03	0.115E-09	0.521E-04
1013	0.218E+05	0.357E-04	0.486E-03	0.637E+00	0.103E+04	0.193E-03	0.193E-03	0.123E-10	0.502E-05
1014	0.179E+14	0.634E+03	0.714E-04	0.206E+04	0.226E+05	0.624E+00	0.624E+00	0.320E-04	0.131E+02
1015	0.610E+07	0.729E-05	0.131E-04	0.132E+00	0.284E+02	0.405E-04	0.405E-04	0.530E-12	0.213E-06
1021	0.240E+09	-0.329E-02	-0.444E-04	-0.135E+02	0.486E+03	0.412E-02	0.412E-02	0.810E-09	0.348E-03
1016	0.298E+05	0.143E+01	0.831E-01	0.121E+03	0.164E+06	0.346E-01	0.346E-01	0.836E-04	0.380E+02
1017	0.480E+04	0.230E+00	0.831E-01	0.121E+03	0.164E+06	0.347E-01	0.347E-01	0.135E-04	0.613E+01
1018	0.247E+05	0.119E+01	0.831E-01	0.935E+02	0.146E+06	0.270E-01	0.270E-01	0.695E-04	0.313E+02
1019	0.565E+04	0.271E+00	0.831E-01	0.118E+03	0.166E+06	0.344E-01	0.344E-01	0.159E-04	0.707E+01
1020	0.229E+07	0.631E+03	0.830E-01	0.887E+03	0.464E+06	0.260E+00	0.260E+00	0.644E-02	0.282E+04
1022	0.222E+06	0.106E+02	0.829E-01	0.895E+03	0.171E+06	0.265E+00	0.265E+00	0.487E-02	0.209E+04
1023	0.169E+06	0.808E+01	0.829E-01	0.975E+03	0.172E+06	0.291E+00	0.291E+00	0.421E-02	0.178E+04
1024	0.811E+05	0.387E+01	0.829E-01	0.109E+04	0.175E+06	0.328E+00	0.328E+00	0.224E-02	0.933E+03
1025	0.108E+06	0.514E+01	0.829E-01	0.601E+03	0.128E+06	0.182E+00	0.182E+00	0.315E-02	0.129E+04
1026	0.908E+05	0.433E+01	0.828E-01	0.122E+04	0.178E+06	0.372E+00	0.372E+00	0.287E-02	0.117E+04
1027	0.152E+06	0.724E+01	0.828E-01	0.131E+04	0.179E+06	0.398E+00	0.398E+00	0.515E-02	0.209E+04
1028	0.000E+00	0.000E+00	0.828E-01	0.464E+02	0.317E+05	0.142E-01	0.142E-01	0.000E+00	0.000E+00
1029	0.173E+02	0.822E-03	0.828E-01	0.867E+01	0.137E+05	0.265E-02	0.265E-02	0.669E-06	0.269E+00
1030	0.000E+00	0.000E+00	0.641E+02	0.450E-01	0.110E+05	0.978E-04	0.978E-04	0.000E+00	0.000E+00
1031	0.940E+00	0.268E+02	0.641E+02	0.126E+02	0.184E+06	0.273E-01	0.273E-01	0.117E-01	0.481E+04
1032	0.000E+00	-0.103E+04	0.641E+02	0.126E+02	0.184E+06	0.274E-01	0.274E-01	0.000E+00	0.000E+00
1033	0.142E+02	0.406E+03	0.641E+02	0.125E+02	0.171E+06	0.272E-01	0.272E-01	0.175E+00	0.724E+05
1034	0.708E+02	0.570E-01	0.340E+00	0.805E+02	0.275E+06	0.232E-01	0.232E-01	0.135E-04	0.609E+01
1035	0.120E+04	0.962E+00	0.340E+00	0.805E+02	0.275E+06	0.232E-01	0.232E-01	0.228E-03	0.103E+03
1036	0.482E+04	0.388E+01	0.340E+00	0.168E+03	0.398E+06	0.485E-01	0.485E-01	0.921E-03	0.415E+03
1037	0.607E+04	0.433E-04	0.101E-02	0.670E+00	0.136E+04	0.193E-03	0.193E-03	0.306E-10	0.138E-04
1038	0.339E+04	0.721E-05	0.559E-03	0.347E+00	0.787E+03	0.103E-03	0.103E-03	0.283E-11	0.120E-05
1039	0.183E+14	0.574E+03	0.672E-04	0.198E+04	0.208E+05	0.592E+00	0.592E+00	0.271E-04	0.114E+02
1040	0.966E+05	-0.142E-04	-0.145E-03	-0.419E+00	0.206E+03	0.125E-03	0.125E-03	0.671E-11	0.284E-05
1046	0.293E+08	-0.232E-01	-0.337E-03	-0.282E+02	0.237E+04	0.839E-02	0.839E-02	0.254E-07	0.115E-01
1041	0.494E+04	0.395E+01	0.339E+00	0.224E+03	0.458E+06	0.647E-01	0.647E-01	0.940E-03	0.423E+03
1042	0.227E+04	0.182E+01	0.339E+00	0.225E+03	0.458E+06	0.650E-01	0.650E-01	0.435E-03	0.196E+03
1043	0.488E+04	0.390E+01	0.339E+00	0.169E+03	0.397E+06	0.489E-01	0.489E-01	0.935E-03	0.421E+03
1044	0.123E+04	0.983E+00	0.339E+00	0.227E+03	0.457E+06	0.655E-01	0.655E-01	0.237E-03	0.107E+03

1045	0.192E+06	0.564E+03	0.339E+00	0.107E+04	0.990E+06	0.308E+00	0.371E-01	0.168E+05
1047	0.231E+05	0.184E+02	0.339E+00	0.105E+04	0.457E+06	0.301E+00	0.203E-01	0.920E+04
1048	0.205E+05	0.163E+02	0.339E+00	0.103E+04	0.424E+06	0.295E+00	0.204E-01	0.929E+04
1049	0.637E+04	0.509E+01	0.339E+00	0.136E+04	0.456E+06	0.390E+00	0.723E-02	0.329E+04
1050	0.202E+05	0.161E+02	0.339E+00	0.864E+03	0.355E+06	0.248E+00	0.239E-01	0.109E+05
1051	0.126E+05	0.100E+02	0.339E+00	0.166E+04	0.454E+06	0.475E+00	0.173E-01	0.794E+04
1052	0.224E+05	0.179E+02	0.339E+00	0.185E+04	0.454E+06	0.529E+00	0.345E-01	0.158E+05
1055	0.000E+00	0.000E+00	0.139E+03	0.693E-01	0.209E+06	0.106E+00	0.000E+00	0.000E+00
1056	0.239E+00	0.321E+02	0.139E+03	0.196E+02	0.352E+07	0.299E-01	0.722E-01	0.896E+04
1057	0.000E+00	-0.876E+03	0.139E+03	0.196E+02	0.353E+07	0.299E-01	0.000E+00	0.000E+00
1058	0.200E+01	0.268E+03	0.139E+03	0.195E+02	0.340E+07	0.297E-01	0.590E+00	0.743E+05
1059	0.700E+02	0.698E-01	0.379E+00	0.886E+02	0.306E+06	0.256E-01	0.182E-04	0.821E+01
1060	0.109E+03	0.108E+00	0.379E+00	0.886E+02	0.306E+06	0.256E-01	0.282E-04	0.127E+02
1061	0.477E+04	0.476E+01	0.379E+00	0.185E+03	0.442E+06	0.533E-01	0.124E-02	0.560E+03
1062	0.727E+04	0.725E+01	0.379E+00	0.892E+02	0.306E+06	0.257E-01	0.190E-02	0.858E+03
1063	0.864E+05	0.861E+02	0.379E+00	0.542E+03	0.751E+06	0.156E+00	0.228E-01	0.103E+05
1064	0.280E+05	0.279E+02	0.379E+00	0.613E+03	0.751E+06	0.177E+00	0.835E-02	0.377E+04
1053	0.000E+00	0.000E+00	0.339E+00	0.157E+03	0.118E+06	0.449E-01	0.000E+00	0.000E+00
1054	0.143E+02	0.114E-01	0.339E+00	0.295E+02	0.510E+05	0.843E-02	0.277E-04	0.127E+02

NUMBER OF PRESSURIZATION SYSTEMS = 2

NODUL	NODPRP	QULPRP	QULWAL	QCOND	TNKTMT	VOLEPROP	VOLEULG
		BTU/Sec	BTU/Sec	R	R	Ft^3	Ft^3
29	31	0.0000	0.0000	0.0000	529.6700	284.8873	15.1242
54	56	0.0000	0.0000	0.0000	159.6700	474.8048	25.1952

SOLUTION DID NOT SATISFY CONVERGENCE CRITERION 0.100E-02 IN 91 ITERATIONS
DIFMAX IN SUCCESSIVE ITERATION = 0.212E-02

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:
:
:

ISTEP = 856 TAU = 0.60040E+02

BOUNDARY NODES	P (PSI)	TF (F)	Z (COMP)	RHO	CONCENTRATIONS		
NODE				(LBM/FT^3)	HE	O2	RP1

1	0.7650E+03	0.1200E+03	0.1029E+03	0.4783E+01	0.1000E+01	0.0000E+00	0.0000
30	0.5490E+02	0.7000E+02	0.2938E-01	0.5151E+02	0.0000E+00	0.0000E+00	1.0000
34	0.6520E+03	0.7000E+02	0.3817E+00	0.5170E+02	0.0000E+00	0.0000E+00	1.0000
55	0.7194E+02	-0.3000E+03	0.1745E-01	0.7172E+02	0.0000E+00	0.1000E+01	0.0000
59	0.6520E+03	-0.3000E+03	0.1686E+00	0.7226E+02	0.0000E+00	0.1000E+01	0.0000
65	0.6150E+03	0.1200E+03	0.1024E+01	0.3867E+00	0.1000E+01	0.0000E+00	0.0000

SOLUTION
INTERNAL
NODE

INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	CONC	RP1
2	0.7638E+03	0.1200E+03	0.1029E+01	0.4776E+00	0.4696E-01	0.1000E+01	0.0000
3	0.7562E+03	0.1200E+03	0.1029E+01	0.4730E+00	-0.2202E-19	0.1000E+01	0.0000
4	0.7562E+03	0.1199E+03	0.1029E+01	0.4730E+00	0.3088E-02	0.1000E+01	0.0000
5	0.7562E+03	0.1198E+03	0.1029E+01	0.4731E+00	0.3089E-02	0.1000E+01	0.0000
6	0.7559E+03	0.1181E+03	0.1029E+01	0.4743E+00	0.5246E-01	0.1000E+01	0.0000
7	0.7558E+03	0.1156E+03	0.1029E+01	0.4762E+00	0.5268E-01	0.1000E+01	0.0000
8	0.7558E+03	0.1160E+03	0.1029E+01	0.4760E+00	-0.3793E-20	0.1000E+01	0.0000
9	0.7555E+03	0.1161E+03	0.1029E+01	0.4757E+00	0.6711E-02	0.1000E+01	0.0000
10	0.7489E+03	0.1148E+03	0.1029E+01	0.4727E+00	0.6668E-02	0.1000E+01	0.0000
11	0.7477E+03	0.1164E+03	0.1029E+01	0.4706E+00	0.3605E-03	0.1000E+01	0.0000
12	0.7473E+03	0.1185E+03	0.1029E+01	0.4688E+00	0.3591E-03	0.1000E+01	0.0000
13	0.7473E+03	0.6647E+02	0.1031E+01	0.5138E+00	0.4592E-03	0.1000E+01	0.0000
14	0.7473E+03	0.6411E+02	0.1031E+01	0.5161E+00	0.4612E-03	0.1000E+01	0.0000
15	0.9315E+02	0.5830E+02	0.1004E+01	0.6682E-01	0.5971E-04	0.1000E+01	0.0000
16	0.9315E+02	0.5958E+02	0.1004E+01	0.6665E-01	0.5957E-04	0.1000E+01	0.0000
17	0.7459E+03	0.1206E+03	0.1029E+01	0.4662E+00	0.2232E-03	0.1000E+01	0.0000
18	0.7457E+03	0.1219E+03	0.1029E+01	0.4651E+00	0.2227E-03	0.1000E+01	0.0000
19	0.7445E+03	0.1210E+03	0.1029E+01	0.4651E+00	0.2672E-03	0.1000E+01	0.0000
20	0.7442E+03	0.1178E+03	0.1029E+01	0.4674E+00	0.2686E-03	0.1000E+01	0.0000
21	0.9314E+02	0.1137E+03	0.1004E+01	0.6037E-01	-0.1286E-19	0.1000E+01	0.0000
22	0.8215E+02	0.1068E+03	0.1003E+01	0.5392E-01	0.4135E-19	0.1000E+01	0.0000
23	0.7371E+02	0.9884E+02	0.1003E+01	0.4909E-01	0.4387E-04	0.1000E+01	0.0000
24	0.6965E+02	0.9032E+02	0.1003E+01	0.4711E-01	0.4210E-04	0.1000E+01	0.0000
25	0.6428E+02	0.8212E+02	0.1003E+01	0.4414E-01	0.3945E-04	0.1000E+01	0.0000
26	0.5977E+02	0.7489E+02	0.1003E+01	0.4161E-01	0.3718E-04	0.1000E+01	0.0000
27	0.5228E+02	0.6889E+02	0.1002E+01	0.3682E-01	0.1032E-19	0.1000E+01	0.0000
28	0.5228E+02	0.6425E+02	0.1002E+01	0.3714E-01	-0.7869E-20	0.1000E+01	0.0000
29	0.5228E+02	0.8373E+02	0.1002E+01	0.3583E-01	0.3213E+01	0.9996E+00	0.0004
31	0.5490E+02	0.7004E+02	0.3226E-01	0.5151E+02	0.1083E+05	0.0000E+00	0.0000
32	0.2803E+02	0.7001E+02	0.1647E-01	0.5150E+02	0.0000E+00	0.0000E+00	0.0000
33	0.1059E+04	0.7108E+02	0.6176E+00	0.5178E+02	0.0000E+00	0.0000E+00	0.0000
35	0.7558E+03	0.1149E+03	0.1029E+01	0.4768E+00	0.2752E-19	0.1000E+01	0.0000
36	0.7558E+03	0.1152E+03	0.1029E+01	0.4766E+00	0.2581E-19	0.1000E+01	0.0000
37	0.7558E+03	0.1155E+03	0.1029E+01	0.4764E+00	0.3904E-20	0.1000E+01	0.0000
38	0.7558E+03	0.8336E+02	0.1031E+01	0.5038E+00	0.7662E-03	0.1000E+01	0.0000
39	0.7558E+03	0.8031E+02	0.1003E+01	0.5066E+00	0.7704E-03	0.1000E+01	0.0000
40	0.6533E+02	0.8264E+02	0.1003E+01	0.4482E-01	0.1115E-03	0.1000E+01	0.0000
41	0.6533E+02	0.8823E+02	0.1003E+01	0.4436E-01	0.1104E-03	0.1000E+01	0.0000
42	0.7558E+03	0.1157E+03	0.1029E+01	0.4762E+00	0.1844E-02	0.1000E+01	0.0000
43	0.7558E+03	0.1160E+03	0.1029E+01	0.4759E+00	0.1843E-02	0.1000E+01	0.0000
44	0.6533E+02	0.1147E+03	0.1003E+01	0.4232E-01	0.8776E-04	0.1000E+01	0.0000
45	0.6533E+02	0.1141E+03	0.1003E+01	0.4237E-01	0.8786E-04	0.1000E+01	0.0000

NODE	H		ENTROPY		EMU		COND		CP		GAMA	
	BTU/LB		BTU/LB-R		LBM/FT-SEC		BTU/FT-S-R		BTU/LB-R			
46	0.6533E+02	0.1160E+03	0.1160E+03	0.1003E+01	0.4222E-01	0.1003E+01	0.4222E-01	0.1215E-18	0.1000E+01	0.0000	0.0000	0.0000
47	0.6533E+02	0.1168E+03	0.1168E+03	0.1003E+01	0.4217E-01	0.1003E+01	0.4217E-01	-0.1698E-19	0.1000E+01	0.0000	0.0000	0.0000
48	0.6533E+02	0.1178E+03	0.1178E+03	0.1003E+01	0.4209E-01	0.1003E+01	0.4209E-01	0.7566E-04	0.1000E+01	0.0000	0.0000	0.0000
49	0.6533E+02	0.1189E+03	0.1189E+03	0.1003E+01	0.4202E-01	0.1003E+01	0.4202E-01	0.7552E-04	0.1000E+01	0.0000	0.0000	0.0000
50	0.6533E+02	0.1201E+03	0.1201E+03	0.1003E+01	0.4192E-01	0.1003E+01	0.4192E-01	0.1217E-03	0.1000E+01	0.0000	0.0000	0.0000
51	0.6533E+02	0.1214E+03	0.1214E+03	0.1003E+01	0.4183E-01	0.1003E+01	0.4183E-01	0.1215E-03	0.1000E+01	0.0000	0.0000	0.0000
52	0.6533E+02	0.1227E+03	0.1227E+03	0.1003E+01	0.4174E-01	0.1003E+01	0.4174E-01	0.7260E-20	0.1000E+01	0.0000	0.0000	0.0000
53	0.6533E+02	0.1239E+03	0.1239E+03	0.1003E+01	0.4165E-01	0.1003E+01	0.4165E-01	-0.6819E-22	0.1000E+01	0.0000	0.0000	0.0000
54	0.6533E+02	-0.1054E+03	0.1004E+01	0.1004E+01	0.7903E-01	0.1004E+01	0.7903E-01	0.1117E+02	0.8484E+00	0.1516	0.0000	0.0000
56	0.7194E+02	-0.3000E+03	0.1874E-01	0.1874E-01	0.7172E+02	0.1874E-01	0.7172E+02	0.2573E+05	0.0000E+00	1.0000	0.0000	0.0000
57	0.4000E+02	-0.3001E+03	0.1043E-01	0.1043E-01	0.7170E+02	0.1043E-01	0.7170E+02	0.0000E+00	0.0000E+00	1.0000	0.0000	0.0000
58	0.9183E+03	-0.2977E+03	0.2345E+00	0.2345E+00	0.7212E+02	0.2345E+00	0.7212E+02	0.0000E+00	0.0000E+00	1.0000	0.0000	0.0000
60	0.7561E+03	0.1199E+03	0.1199E+03	0.1029E+01	0.4730E+00	0.1029E+01	0.4730E+00	0.3451E-02	0.1000E+01	0.0000	0.0000	0.0000
61	0.7560E+03	0.1199E+03	0.1199E+03	0.1029E+01	0.4729E+00	0.1029E+01	0.4729E+00	0.3451E-02	0.1000E+01	0.0000	0.0000	0.0000
62	0.7507E+03	0.1199E+03	0.1199E+03	0.1029E+01	0.4697E+00	0.1029E+01	0.4697E+00	0.0000E+00	0.1000E+01	0.0000	0.0000	0.0000
63	0.7426E+03	0.1199E+03	0.1199E+03	0.1029E+01	0.4648E+00	0.1029E+01	0.4648E+00	0.4243E-02	0.1000E+01	0.0000	0.0000	0.0000
64	0.6465E+03	0.1200E+03	0.1200E+03	0.1025E+01	0.4060E+00	0.1025E+01	0.4060E+00	0.5158E-02	0.1000E+01	0.0000	0.0000	0.0000
2	0.0000E+00	0.5633E+01	0.5633E+01	0.1454E-04	0.2672E-04	0.1454E-04	0.2672E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
3	0.0000E+00	0.5638E+01	0.5638E+01	0.1454E-04	0.2671E-04	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
4	0.0000E+00	0.5637E+01	0.5637E+01	0.1454E-04	0.2671E-04	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
5	0.0000E+00	0.5637E+01	0.5637E+01	0.1454E-04	0.2671E-04	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
6	0.0000E+00	0.5634E+01	0.5634E+01	0.1451E-04	0.2665E-04	0.1451E-04	0.2665E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
7	0.0000E+00	0.5628E+01	0.5628E+01	0.1447E-04	0.2657E-04	0.1447E-04	0.2657E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
8	0.0000E+00	0.5629E+01	0.5629E+01	0.1447E-04	0.2659E-04	0.1447E-04	0.2659E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
9	0.0000E+00	0.5630E+01	0.5630E+01	0.1448E-04	0.2659E-04	0.1448E-04	0.2659E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
10	0.0000E+00	0.5631E+01	0.5631E+01	0.1445E-04	0.2654E-04	0.1445E-04	0.2654E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
11	0.0000E+00	0.5636E+01	0.5636E+01	0.1448E-04	0.2660E-04	0.1448E-04	0.2660E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
12	0.0000E+00	0.5640E+01	0.5640E+01	0.1452E-04	0.2666E-04	0.1452E-04	0.2666E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
13	0.0000E+00	0.5523E+01	0.5523E+01	0.1359E-04	0.2502E-04	0.1359E-04	0.2502E-04	0.1244E+01	0.1671E+01	0.1671E+01	0.1671E+01	0.1671E+01
14	0.0000E+00	0.5517E+01	0.5517E+01	0.1355E-04	0.2494E-04	0.1355E-04	0.2494E-04	0.1244E+01	0.1671E+01	0.1671E+01	0.1671E+01	0.1671E+01
15	0.0000E+00	0.6539E+01	0.6539E+01	0.1333E-04	0.2456E-04	0.1333E-04	0.2456E-04	0.1242E+01	0.1667E+01	0.1667E+01	0.1667E+01	0.1667E+01
16	0.0000E+00	0.6542E+01	0.6542E+01	0.1336E-04	0.2460E-04	0.1336E-04	0.2460E-04	0.1242E+01	0.1667E+01	0.1667E+01	0.1667E+01	0.1667E+01
17	0.0000E+00	0.5646E+01	0.5646E+01	0.1455E-04	0.2673E-04	0.1455E-04	0.2673E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
18	0.0000E+00	0.5649E+01	0.5649E+01	0.1458E-04	0.2677E-04	0.1458E-04	0.2677E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
19	0.0000E+00	0.5647E+01	0.5647E+01	0.1456E-04	0.2674E-04	0.1456E-04	0.2674E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
20	0.0000E+00	0.5641E+01	0.5641E+01	0.1450E-04	0.2664E-04	0.1450E-04	0.2664E-04	0.1244E+01	0.1670E+01	0.1670E+01	0.1670E+01	0.1670E+01
21	0.0000E+00	0.6665E+01	0.6665E+01	0.1435E-04	0.2633E-04	0.1435E-04	0.2633E-04	0.1242E+01	0.1667E+01	0.1667E+01	0.1667E+01	0.1667E+01
22	0.0000E+00	0.6712E+01	0.6712E+01	0.1422E-04	0.2610E-04	0.1422E-04	0.2610E-04	0.1241E+01	0.1667E+01	0.1667E+01	0.1667E+01	0.1667E+01
23	0.0000E+00	0.6748E+01	0.6748E+01	0.1408E-04	0.2585E-04	0.1408E-04	0.2585E-04	0.1241E+01	0.1667E+01	0.1667E+01	0.1667E+01	0.1667E+01
24	0.0000E+00	0.6757E+01	0.6757E+01	0.1392E-04	0.2557E-04	0.1392E-04	0.2557E-04	0.1241E+01	0.1667E+01	0.1667E+01	0.1667E+01	0.1667E+01
25	0.0000E+00	0.6779E+01	0.6779E+01	0.1377E-04	0.2530E-04	0.1377E-04	0.2530E-04	0.1241E+01	0.1667E+01	0.1667E+01	0.1667E+01	0.1667E+01
26	0.0000E+00	0.6798E+01	0.6798E+01	0.1363E-04	0.2507E-04	0.1363E-04	0.2507E-04	0.1241E+01	0.1667E+01	0.1667E+01	0.1667E+01	0.1667E+01
27	0.0000E+00	0.6851E+01	0.6851E+01	0.1352E-04	0.2488E-04	0.1352E-04	0.2488E-04	0.1241E+01	0.1667E+01	0.1667E+01	0.1667E+01	0.1667E+01

BRANCHES	KFACTOR (LBF-S ² /LBM-FT) ²	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
28	0.0000E+00	0.6840E+01	0.1344E-04	0.2474E-04	0.1241E+01	0.1667E+01	0.377E-03	0.170E+03
29	0.0000E+00	0.6882E+01	0.1380E-04	0.2535E-04	0.1241E+01	0.1667E+01	0.251E-02	0.113E+04
31	0.0000E+00	0.0000E+00	0.1251E-02	0.2352E-04	0.4438E+00	0.1381E+01	0.197E-06	0.888E-01
32	0.0000E+00	0.0000E+00	0.1248E-02	0.2351E-04	0.4438E+00	0.1381E+01	0.313E-06	0.141E+00
33	0.0000E+00	0.0000E+00	0.1345E-02	0.2392E-04	0.4429E+00	0.1375E+01	0.132E-04	0.597E+01
35	0.0000E+00	0.5627E+01	0.1445E-04	0.2655E-04	0.1244E+01	0.1670E+01	0.529E-05	0.238E+01
36	0.0000E+00	0.5627E+01	0.1446E-04	0.2656E-04	0.1244E+01	0.1670E+01	0.195E-06	0.874E-01
37	0.0000E+00	0.5628E+01	0.1446E-04	0.2657E-04	0.1244E+01	0.1670E+01	0.200E-04	0.894E+01
38	0.0000E+00	0.5557E+01	0.1389E-04	0.2554E-04	0.1244E+01	0.1670E+01	0.378E-03	0.169E+03
39	0.0000E+00	0.5550E+01	0.1384E-04	0.2545E-04	0.1244E+01	0.1670E+01	0.676E-04	0.302E+02
40	0.0000E+00	0.6772E+01	0.1378E-04	0.2532E-04	0.1241E+01	0.1667E+01		
41	0.0000E+00	0.6785E+01	0.1388E-04	0.2550E-04	0.1241E+01	0.1667E+01		
42	0.0000E+00	0.5629E+01	0.1447E-04	0.2658E-04	0.1244E+01	0.1670E+01		
43	0.0000E+00	0.5629E+01	0.1447E-04	0.2659E-04	0.1244E+01	0.1670E+01		
44	0.0000E+00	0.6843E+01	0.1437E-04	0.2636E-04	0.1241E+01	0.1667E+01		
45	0.0000E+00	0.6844E+01	0.1435E-04	0.2634E-04	0.1241E+01	0.1667E+01		
46	0.0000E+00	0.6846E+01	0.1439E-04	0.2640E-04	0.1241E+01	0.1667E+01		
47	0.0000E+00	0.6848E+01	0.1440E-04	0.2642E-04	0.1241E+01	0.1667E+01		
48	0.0000E+00	0.6850E+01	0.1442E-04	0.2645E-04	0.1241E+01	0.1667E+01		
49	0.0000E+00	0.6852E+01	0.1444E-04	0.2649E-04	0.1241E+01	0.1667E+01		
50	0.0000E+00	0.6855E+01	0.1446E-04	0.2653E-04	0.1241E+01	0.1667E+01		
51	0.0000E+00	0.6858E+01	0.1449E-04	0.2657E-04	0.1241E+01	0.1667E+01		
52	0.0000E+00	0.6860E+01	0.1451E-04	0.2661E-04	0.1241E+01	0.1667E+01		
53	0.0000E+00	0.6863E+01	0.1453E-04	0.2665E-04	0.1241E+01	0.1667E+01		
54	0.0000E+00	0.5501E+01	0.1023E-04	0.1865E-04	0.1087E+01	0.1662E+01		
56	0.0000E+00	0.6964E+00	0.1415E-03	0.2073E-04	0.4202E+00	0.1731E+01		
57	0.0000E+00	0.6963E+00	0.1413E-03	0.2072E-04	0.4204E+00	0.1732E+01		
58	0.0000E+00	0.6972E+00	0.1468E-03	0.2092E-04	0.4143E+00	0.1705E+01		
60	0.0000E+00	0.5638E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01		
61	0.0000E+00	0.5638E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01		
62	0.0000E+00	0.5641E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01		
63	0.0000E+00	0.5646E+01	0.1454E-04	0.2671E-04	0.1244E+01	0.1670E+01		
64	0.0000E+00	0.5716E+01	0.1453E-04	0.2668E-04	0.1243E+01	0.1670E+01		

1011	0.733E+04	0.363E+00	0.845E-01	0.117E+03	0.168E+06	0.339E-01	0.209E-04	0.938E+01
1012	0.768E+05	0.290E-05	0.737E-04	0.103E+00	0.146E+03	0.296E-04	0.146E-12	0.656E-07
1013	0.139E+06	0.526E-05	0.737E-04	0.936E-01	0.156E+03	0.283E-04	0.265E-12	0.109E-06
1014	0.173E+14	0.654E+03	0.737E-04	0.206E+00	0.233E+05	0.624E+00	0.330E-04	0.135E+02
1015	0.106E+07	0.395E-04	0.734E-04	0.717E+00	0.159E+03	0.219E-03	0.155E-10	0.624E-05
1021	0.218E+09	0.807E-02	0.730E-04	0.201E+02	0.835E+03	0.613E-02	0.315E-08	0.127E-02
1016	0.268E+05	0.141E+01	0.844E-01	0.117E+03	0.168E+06	0.339E-01	0.814E-04	0.366E+02
1017	0.463E+04	0.229E+00	0.844E-01	0.118E+03	0.167E+06	0.341E-01	0.132E-04	0.596E+01
1018	0.241E+05	0.119E+01	0.844E-01	0.924E+02	0.147E+06	0.266E-01	0.687E-04	0.311E+02
1019	0.557E+04	0.275E+00	0.844E-01	0.118E+03	0.167E+06	0.341E-01	0.159E-04	0.719E+01
1020	0.228E+07	0.651E+03	0.844E-01	0.898E+03	0.463E+06	0.259E+00	0.654E-02	0.294E+04
1022	0.222E+06	0.110E+02	0.845E-01	0.913E+03	0.170E+06	0.265E+00	0.496E-02	0.221E+04
1023	0.170E+06	0.844E+01	0.845E-01	0.100E+04	0.169E+06	0.292E+00	0.432E-02	0.190E+04
1024	0.819E+05	0.406E+01	0.845E-01	0.112E+04	0.173E+06	0.330E+00	0.231E-02	0.100E+04
1025	0.108E+06	0.537E+01	0.845E-01	0.617E+03	0.127E+06	0.183E+00	0.324E-02	0.139E+04
1026	0.910E+05	0.451E+01	0.845E-01	0.125E+04	0.177E+06	0.373E+00	0.294E-02	0.124E+04
1027	0.151E+06	0.749E+01	0.844E-01	0.132E+04	0.179E+06	0.398E+00	0.526E-02	0.219E+04
1028	0.000E+00	0.000E+00	0.844E-01	0.467E+02	0.318E+05	0.141E-01	0.000E+00	0.000E+00
1029	0.170E+02	0.840E-03	0.844E-01	0.869E+01	0.139E+05	0.264E-02	0.675E-06	0.275E+00
1030	0.000E+00	0.000E+00	0.642E+02	0.450E-01	0.110E+05	0.979E-04	0.000E+00	0.000E+00
1031	0.940E+00	0.269E+02	0.642E+02	0.126E+02	0.184E+06	0.274E-01	0.117E-01	0.482E+04
1032	0.000E+00	-0.103E+04	0.642E+02	0.126E+02	0.184E+06	0.274E-01	0.000E+00	0.000E+00
1033	0.142E+02	0.407E+03	0.642E+02	0.125E+02	0.171E+06	0.273E-01	0.176E+00	0.726E+05
1034	0.128E+04	0.542E-07	0.782E-04	0.178E-01	0.635E+02	0.516E-05	0.286E-14	0.128E-08
1035	0.958E+04	0.407E-06	0.782E-04	0.178E-01	0.636E+02	0.515E-05	0.215E-13	0.960E-08
1036	0.464E+04	0.197E-06	0.782E-04	0.371E-01	0.918E+02	0.108E-04	0.104E-13	0.465E-08
1037	0.193E+05	0.755E-06	0.750E-04	0.475E-01	0.102E+03	0.137E-04	0.382E-13	0.171E-07
1038	0.239E+05	0.934E-06	0.750E-04	0.449E-01	0.106E+03	0.134E-04	0.474E-13	0.200E-07
1039	0.177E+14	0.691E+03	0.750E-04	0.213E+04	0.232E+05	0.637E+00	0.350E-04	0.147E+02
1040	0.416E+06	0.179E-04	0.786E-04	0.522E+00	0.112E+03	0.158E-03	0.107E-10	0.451E-05
1046	0.646E+08	0.303E-02	0.822E-04	0.151E+02	0.603E+03	0.448E-02	0.190E-08	0.809E-03
1041	0.349E+06	0.244E-07	0.317E-05	0.201E-02	0.430E+01	0.581E-06	0.524E-16	0.235E-10
1042	0.159E+07	0.111E-06	0.316E-05	0.200E-02	0.428E+01	0.580E-06	0.236E-15	0.106E-09
1043	0.100E+17	0.691E+03	0.315E-05	0.150E-02	0.370E+01	0.434E-06	0.147E-05	0.659E+00
1044	0.502E+07	0.125E-05	0.599E-05	0.427E-01	0.817E+01	0.124E-04	0.572E-13	0.256E-07
1045	0.204E+07	0.430E-05	0.884E-05	0.295E+00	0.261E+02	0.856E-04	0.744E-13	0.332E-07
1047	0.188E+06	0.108E-04	0.910E-04	0.650E+00	0.124E+03	0.188E-03	0.751E-11	0.336E-05
1048	0.417E+05	0.240E-05	0.910E-04	0.562E+00	0.115E+03	0.163E-03	0.166E-11	0.746E-06
1049	0.282E+06	0.171E-04	0.935E-04	0.669E+00	0.127E+03	0.194E-03	0.122E-10	0.547E-05
1050	0.345E+05	0.221E-05	0.959E-04	0.418E+00	0.101E+03	0.121E-03	0.161E-11	0.726E-06
1051	0.429E+06	0.297E-04	0.999E-04	0.718E+00	0.135E+03	0.207E-03	0.226E-10	0.102E-04
1052	0.672E+06	0.502E-05	0.104E-03	0.748E+00	0.140E+03	0.216E-03	0.397E-11	0.180E-05
1055	0.000E+00	0.000E+00	0.138E+03	0.690E-01	0.208E+06	0.105E-03	0.000E+00	0.000E+00
1056	0.239E+00	0.319E+02	0.139E+03	0.195E+02	0.351E+07	0.298E-01	0.716E-01	0.889E+04
1057	0.000E+00	-0.878E+03	0.139E+03	0.195E+02	0.352E+07	0.298E-01	0.000E+00	0.000E+00
1058	0.200E+01	0.266E+03	0.139E+03	0.194E+02	0.339E+07	0.296E-01	0.585E+00	0.737E+05
1059	0.687E+02	0.778E-01	0.404E+00	0.927E+02	0.326E+06	0.267E-01	0.212E-04	0.957E+01

1060	0.106E+03	0.120E+00	0.404E+00	0.927E+02	0.327E+06	0.267E-01	0.327E-04	0.148E+02
1061	0.468E+04	0.530E+01	0.404E+00	0.193E+03	0.472E+06	0.558E-01	0.145E-02	0.652E+03
1062	0.713E+04	0.809E+01	0.404E+00	0.933E+02	0.327E+06	0.269E-01	0.222E-02	0.100E+04
1063	0.847E+05	0.961E+02	0.404E+00	0.567E+03	0.801E+06	0.164E+00	0.267E-01	0.120E+05
1064	0.278E+05	0.315E+02	0.404E+00	0.650E+03	0.802E+06	0.187E+00	0.100E-01	0.452E+04
1053	0.000E+00	0.000E+00	0.104E-03	0.506E-01	0.364E+02	0.146E-04	0.000E+00	0.000E+00
1054	0.151E+02	0.113E-08	0.104E-03	0.952E-02	0.158E+02	0.274E-05	0.894E-15	0.406E-09

NUMBER OF PRESSURIZATION SYSTEMS = 2

NODUL	NODPRP	QULPRP	QULWAL	QCOND	TNKTU	VOLPROP	VOLJULG
		BTU/Sec	BTU/Sec	BTU/Sec	R	FT^3	FT^3
29	31	0.0709	0.4474	0.0005	529.7980	210.3289	89.6826
54	56	2.7834	23.1030	0.0298	168.7120	358.6981	141.3019

TIME OF ANALYSIS WAS 713.750000000000 SECS

APPENDIX S—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 13

Steady State & Transient Conduction Through a Circular Rod, with Convection

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```

GFSSP VERSION
604
GFSSP INSTALLATION PATH

ANALYST
Alok Majumdar
INPUT DATA FILE NAME
Ex13.dat
OUTPUT FILE NAME
Ex13.out
TITLE
Steady State & Transient Conduction Through a Circular Rod, With Convection
USERSETUP
F
DENCEN GRVITY ENERGY MIXTURE THRUST STEADY TRANSV SAVER
F T F F F T F F F F F F F F F
HEX HCOEF REACTING INERTIA CONDX ADDPROP PRINTI ROTATION
F F F F F F F F F F F F F F F
BUOYANCY HRATE INVAL MSORCE MOVBNB TPA VARGEO TVM
F F F F F F F F F F F F F F F
SHEAR PRNTIN PRNTADD OPVALVE TRANSQ CONJUG RADIAT WINPLOT
F T T F F F F F F F F F F F F F
PRESS INSUC VARROT CYCLIC CHKVALS WINFILE DALTON NOSTATS
F F F F F F F F F F F F F F F
NORMAL SIMUL SECONDL NRSOLVT IBDF NOFLT PRESREG FLOWREG
F T F F F F F F F F F F F F F F F
TRANS_MOM USERVARS ISOLVE PLOTADD SIUNITS MDGEN
F F F F F F F F F F F F F F F F
NUM_USER_VARS IFR_MIX PRINTD SATTABL MSORIN PRELVIV HSTAG
1 1 F F F F F F F F F F F F F F
NNODES NINT NBR NF
4 2 3 1
RELAX RELAXD RELAXH RELAXH RELAXNR RELAXHC RELAXTS
1 0.5 1 1 0.0001 500 1 1 1
NFLUID(1), I = 1, NF
11
NODE INDEX DESCRIPTION HEAT SOURC THRST AREA CONCENTRATION
11 2 " Node 11" 0 0 0
12 1 " Node 12" 0 0 0
13 1 " Node 13" 0 0 0
14 2 " Node 14" 0 0 0
NODE PRES (PSI) TEMP(DEGF) MASS SOURC HEAT SOURC THRST AREA CONCENTRATION
11 50 70 0 0 0 0
12 14.7 60 0 0 0 0
13 14.7 60 0 0 0 0
14 45 70 0 0 0 0
INODE NUMBER NAMEBR

```


12	13	1112	1213	1314	UPNODE	DNNODE	DESCRIPTION	EPD	ANGLE	AREA	2.3506161778
BRANCH	11	12	1	"Pipe 1112"							
BRANCH	12	13	1	"Pipe 1213"							
BRANCH	13	14	1	"Pipe 1314"							
BRANCH	OPTION -1	LENGTH	DIA	1.73							
BRANCH	OPTION -1	LENGTH	DIA	1.73							
BRANCH	OPTION -1	LENGTH	DIA	1.73							
NSOLID	NAMB	NSSC	NSFC	NSR							
8	2	7	8	2							
NODESL	MATRL	SMASS	TS	HLSrc	NUMSS	NUMSF	NUMSA	NUMSSR	DESCRIPTION		
2	41	1.0000000	70.0000000	0.0000000	1	1	1	0	"S Node 2"		
NAMESS											
23											
NAMESEF											
122											
NAMESEA											
12											
3	41	1.0000000	70.0000000	0.0000000	2	1	0	0	"S Node 3"		
NAMESS											
23											
NAMESEF											
123											
4	41	1.0000000	70.0000000	0.0000000	2	1	0	0	"S Node 4"		
NAMESS											
34											
NAMESEF											
124											
5	41	1.0000000	70.0000000	0.0000000	2	1	0	0	"S Node 5"		
NAMESS											
45											
NAMESEF											
125											
6	41	1.0000000	70.0000000	0.0000000	2	1	0	0	"S Node 6"		
NAMESS											
56											
NAMESEF											
136											
7	41	1.0000000	70.0000000	0.0000000	2	1	0	0	"S Node 7"		
NAMESS											
67											
NAMESEF											
137											

```

8      41      1.00000000      70.00000000      0.00000000      2      1      0      0      0      "S Node 8"
NAMESS
78
89
NAMESEF
138
9      41      1.00000000      70.00000000      0.00000000      1      1      1      1      0      "S Node 9"
NAMESS
89
NAMESEF
139
NAMESEA
910
NODEAM      TAMB      DESCRIPTION
1      32.00000      "A Node 1"      0
10      212.00000      "A Node 10"      0
ICONSS      ICNSI      ICNSJ      ARCSIJ      DISTSIJ      DESCRIPTION
23      2      3      3.14159      3.00000      "Conductor 23"
34      3      4      3.14159      3.00000      "Conductor 34"
45      4      5      3.14159      3.00000      "Conductor 45"
56      5      6      3.14159      3.00000      "Conductor 56"
67      6      7      3.14159      3.00000      "Conductor 67"
78      7      8      3.14159      3.00000      "Conductor 78"
89      8      9      3.14159      3.00000      "Conductor 89"
ICONSF      ICS      ICF      MODEL      ARSF      HCSF      RADSF      EMSFS      EMSFF      DESCRIPTION
122      2      12      0      1.88500e+01      3.17000e-04      F      0.00000e+00      0.00000e+00      "Convection 122"
123      3      12      0      1.88500e+01      3.17000e-04      F      0.00000e+00      0.00000e+00      "Convection 123"
124      4      12      0      1.88500e+01      3.17000e-04      F      0.00000e+00      0.00000e+00      "Convection 124"
125      5      12      0      1.88500e+01      3.17000e-04      F      0.00000e+00      0.00000e+00      "Convection 125"
136      6      13      0      1.88500e+01      3.17000e-04      F      0.00000e+00      0.00000e+00      "Convection 136"
137      7      13      0      1.88500e+01      3.17000e-04      F      0.00000e+00      0.00000e+00      "Convection 137"
138      8      13      0      1.88500e+01      3.17000e-04      F      0.00000e+00      0.00000e+00      "Convection 138"
139      9      13      0      1.88500e+01      3.17000e-04      F      0.00000e+00      0.00000e+00      "Convection 139"
ICONSA      ICSAA      ARSA      HCSA      RADSA      EMSAA      DESCRIPTION
12      2      1      3.14159e+00      2.00000e-02      F      0.00000e+00      0.00000e+00      "Convection 12"
910      9      10      3.14159e+00      2.00000e-02      F      0.00000e+00      0.00000e+00      "Convection 910"

```

EXAMPLE 13 PROPERTY FILES

USER1CP.PRP

2
0 0.1981
1000 0.1981

USER1K.PRP

2
0 0.002611
1000 0.002611

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/12/2012 15:25

TITLE :Steady State & Transient Conduction Through a Circular Rod, With Convection
 ANALYST :Alok Majumdar
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX13\Ex13.dat
 FILEOUT :Ex13.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	CONDX	F	CONJUG	T	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	F	HCOEF	F	HEX	F	HRATE	T	IFRMIX	1	INERTIA	F	INSUC	F
INVAL	F	MIXTURE	F	MOVBN	F	MSORCE	F	NORMAL	F	NRSOLVT	F	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRINTI	T	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	F	SHEAR	F	SIMULA	T	SIUNITS	F	STEADY	T	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	F	TRANSV	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F														

NNODES = 4
 NINT = 2
 NBR = 3
 NF = 1
 NVAR = 5
 NHREF = 2

FLUIDS: H2O

```

BOUNDARY NODES
NODE      P      T      RHO      AREA
(P      (F)      (LBM/FT^3)      (IN^2)
11      0.5000E+02  0.7000E+02  0.6231E+02  0.0000E+00
14      0.4500E+02  0.7000E+02  0.6231E+02  0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES
NODE      AREA      MASS      HEAT
(IN^2)      (LBM/S)      (BTU/S)
12      0.0000E+00  0.0000E+00  0.0000E+00
13      0.0000E+00  0.0000E+00  0.0000E+00

BRANCH      UPNODE      DNNODE      OPTION
1112      11      12      1
1213      12      13      1
1314      13      14      1
BRANCH      OPTION -1:      LENGTH      DIA      EPSD      ANGLE      AREA
1112      0.100E+00      0.173E+01      0.000E+00      0.000E+00      0.235E+01
BRANCH      OPTION -1:      LENGTH      DIA      EPSD      ANGLE      AREA
1213      0.120E+02      0.173E+01      0.000E+00      0.000E+00      0.235E+01
BRANCH      OPTION -1:      LENGTH      DIA      EPSD      ANGLE      AREA
1314      0.120E+02      0.173E+01      0.000E+00      0.000E+00      0.235E+01

INITIAL GUESS FOR INTERNAL NODES
NODE      P(P      TF(F)      Z(COMP)      RHO      QUALITY
(LBM/FT^3)
12      0.1470E+02  0.6000E+02  0.7616E-03  0.6237E+02  0.0000E+00
13      0.1470E+02  0.6000E+02  0.7616E-03  0.6237E+02  0.0000E+00

TRIAL SOLUTION
BRANCH      DELP(P      FLOWRATE(LBM/SEC)
1112      0.0000      0.0100
1213      0.0000      0.0100
1314      0.0000      0.0100

CONJUGATE HEAT TRANSFER
NSOLIDX = 8
NAME = 2
NSSC = 7
NSFC = 8
NSAC = 2
NSSR = 0
NODESL      MATRL      SMASS      TS      NUMSS      NUMSF      NUMSA
2      41      1.0000      70.0000      1      1      1

```

NAMESS									
23									
NAMESEF									
122									
NAMESEA									
12									
NODESL	MATRL	SMASS	TS	NUMSS	NUMSF	NUMSA			
3	41	1.0000	70.0000	2	1	0			
NAMESS									
23	34								
NAMESEF									
123									
NODESL	MATRL	SMASS	TS	NUMSS	NUMSF	NUMSA			
4	41	1.0000	70.0000	2	1	0			
NAMESS									
34	45								
NAMESEF									
124									
NODESL	MATRL	SMASS	TS	NUMSS	NUMSF	NUMSA			
5	41	1.0000	70.0000	2	1	0			
NAMESS									
45	56								
NAMESEF									
125									
NODESL	MATRL	SMASS	TS	NUMSS	NUMSF	NUMSA			
6	41	1.0000	70.0000	2	1	0			
NAMESS									
56	67								
NAMESEF									
136									
NODESL	MATRL	SMASS	TS	NUMSS	NUMSF	NUMSA			
7	41	1.0000	70.0000	2	1	0			
NAMESS									
67	78								
NAMESEF									
137									
NODESL	MATRL	SMASS	TS	NUMSS	NUMSF	NUMSA			
8	41	1.0000	70.0000	2	1	0			
NAMESS									
78	89								
NAMESEF									
138									
NODESL	MATRL	SMASS	TS	NUMSS	NUMSF	NUMSA			
9	41	1.0000	70.0000	1	1	1			
NAMESS									
89									
NAMESEF									

139

NAMESA
910

NODEAM TAMB
1 32.0000
10 212.0000

ICONSS ICNSI ICNSJ ARCSIJ ICNSI ICNSJ ARCSIJ ICNSI ICNSJ ARCSIJ ICNSI ICNSJ ARCSIJ

23 2 3 3.1416 3.0000
34 3 4 3.1416 3.0000
45 4 5 3.1416 3.0000
56 5 6 3.1416 3.0000
67 6 7 3.1416 3.0000
78 7 8 3.1416 3.0000
89 8 9 3.1416 3.0000

ICONSF ICS ICF ARSF EMSFS EMSFF

122 2 12 18.8500 0.0000 0.0000
123 3 12 18.8500 0.0000 0.0000
124 4 12 18.8500 0.0000 0.0000
125 5 12 18.8500 0.0000 0.0000
136 6 13 18.8500 0.0000 0.0000
137 7 13 18.8500 0.0000 0.0000
138 8 13 18.8500 0.0000 0.0000
139 9 13 18.8500 0.0000 0.0000

ICONSA ICSAS ICSAA ARSA HCSA EMSAS EMSAA

12 2 1 0.3142E+01 0.2000E-01 0.0000E+00 0.0000E+00
910 9 10 0.3142E+01 0.2000E-01 0.0000E+00 0.0000E+00

SOLUTION

INTERNAL NODES

INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
12	0.4998E+02	0.7000E+02	0.2543E-02	0.6231E+02	0.0000E+00	0.0000E+00
13	0.4749E+02	0.7001E+02	0.2416E-02	0.6231E+02	0.0000E+00	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
12	0.3823E+02	0.5555E-01	0.6557E-03	0.9663E-04	0.9998E+00	0.1007E+01
13	0.3823E+02	0.5555E-01	0.6557E-03	0.9663E-04	0.9998E+00	0.1007E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
1112	0.639E-03	0.207E-01	0.684E+02	0.672E+02	0.921E+06	0.554E-01	0.795E-05	0.328E+01
1213	0.767E-01	0.249E+01	0.684E+02	0.672E+02	0.921E+06	0.554E-01	0.955E-03	0.393E+03
1314	0.767E-01	0.249E+01	0.684E+02	0.673E+02	0.921E+06	0.555E-01	0.955E-03	0.393E+03

SOLID NODES
 NODESL CPSLD TS
 BTU/LB F
 2 0.000E+00 0.423E+02
 3 0.000E+00 0.569E+02
 4 0.000E+00 0.691E+02
 5 0.000E+00 0.812E+02
 6 0.000E+00 0.954E+02
 7 0.000E+00 0.114E+03
 8 0.000E+00 0.141E+03
 9 0.000E+00 0.181E+03

SOLID TO SOLID CONDUCTOR
 ICONSS CONDKIJ QDOTSS
 BTU/S FT F BTU/S
 23 0.261E-02 -0.333E-02
 34 0.261E-02 -0.279E-02
 45 0.261E-02 -0.276E-02
 56 0.261E-02 -0.322E-02
 67 0.261E-02 -0.428E-02
 78 0.261E-02 -0.611E-02
 89 0.261E-02 -0.906E-02

SOLID TO FLUID CONDUCTOR
 ICONSF QDOTSF HCSF HCSFR
 BTU/S BTU/S FT**2 F
 122 -0.115E-02 0.317E-03 0.000E+00
 123 -0.544E-03 0.317E-03 0.000E+00
 124 -0.356E-04 0.317E-03 0.000E+00
 125 0.466E-03 0.317E-03 0.000E+00
 136 0.105E-02 0.317E-03 0.000E+00
 137 0.183E-02 0.317E-03 0.000E+00
 138 0.294E-02 0.317E-03 0.000E+00
 139 0.459E-02 0.317E-03 0.000E+00

SOLID TO AMBIENT CONDUCTOR
 ICONSA QDOTSA HCSA HCSAR
 BTU/S BTU/S FT**2 F BTU/S FT**2 F
 12 0.448E-02 0.200E-01 0.000E+00
 910 -0.136E-01 0.200E-01 0.000E+00

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 10 ITERATIONS
 TAU = 100000000.000000 ISTEP = 1 DTAU =

TIME OF ANALYSIS WAS 1.5625000000000000E-002 SECS

APPENDIX T—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 14

Chilldown of a Short Cryogenic Pipeline

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Example 14 History File	187
Example 14 Output File (Partial)	188

GFSSP VERSION
604
GFSSP INSTALLATION PATH

ANALYST
Johnny Maroney
INPUT DATA FILE NAME
Ex14.dat
OUTPUT FILE NAME
Ex14.out
TITLE
Chilldown of a Short Cryogenic Pipeline
USERSETUP

F	DENCON	GRAVITY	ENERGY	MIXTURE	THRUST	STEADY	TRANSV	SAVER
F	F	F	T	F	F	F	T	F
F	HEX	HCOEF	REACTING	INERTIA	CONDX	ADDPROP	PRINTI	ROTATION
F	F	F	F	F	F	F	F	F
F	BUOYANCY	HRATE	INVAL	MSORCE	MOVBND	TPA	VARGEO	TVM
F	F	T	F	F	F	F	F	F
F	SHEAR	PRNTIN	PRNTADD	OPVALVE	TRANSQ	CONJUG	RADIAT	WINPLOT
F	F	F	F	F	F	T	F	T
F	PRESS	INSUC	VARROT	CYCLIC	CHKVALS	WINFILE	DALTON	NOSTATS
F	F	F	F	F	F	T	F	F
F	NORMAL	SIMUL	SECONDL	NRSOLVT	IBDF	NOPLT	PRESREG	FLOWREG
F	F	F	F	F	1	T	0	0
F	TRANS_MOM	USERVARS	PSMG	ISOLVE	PLOTADD	SIUNITS	TECPLOT	MDGEN
F	F	F	F	1	F	F	F	F
F	NUM_USER_VARS	IFR_MIX	PRINTD	SATTABL	MSORIN	PRELVIV	LAMINAR	HSTAG
1	1	1	F	F	F	F	T	T
F	NNODES	NINT	NBR	NF				
30	28	29	29	1				
RELAXK	RELAXD	RELAXH	RELAXH	CC	NITER	RELAXNR	RELAXHC	RELAXTS
1	0.5	1	1	0.0001	500	1	1	1
DPAU	TIMEF	TIMEL	TIMEL	NPSTEP	NPWSTEP	WPLSTEP	WPLBUFF	1.1
0.01	0	20	20	10	1	50	1.1	
NFLUID(1), I = 1, NF								
10								

NODE	INDEX	DESCRIPTION
1	2	" Node 1"
2	1	" Node 2"
3	1	" Node 3"
4	1	" Node 4"
5	1	" Node 5"
6	1	" Node 6"
7	1	" Node 7"
8	1	" Node 8"

26	14	60	0	0	0	0
27	14	60	0	0	0	0
28	14	60	0	0	0	0
29	14	60	0	0	0	0

ex14hs1.dat						
ex14hs30.dat						
INODE	NUMBR	NAMEBR				
2	2	12 23				
3	2	23 34				
4	2	34 45				
5	2	45 56				
6	2	56 67				
7	2	67 78				
8	2	78 89				
9	2	89 910				
10	2	910 1011				
11	2	1011 1112				
12	2	1112 1213				
13	2	1213 1314				
14	2	1314 1415				
15	2	1415 1516				
16	2	1516 1617				
17	2	1617 1718				
18	2	1718 1819				
19	2	1819 1920				
20	2	1920 2021				
21	2	2021 2122				
22	2	2122 2223				
23	2	2223 2324				
24	2	2324 2425				
25	2	2425 2526				
26	2	2526 2627				
27	2	2627 2728				
28	2	2728 2829				
29	2	2829 2930				
BRANCH	UPNODE	DNNODE	OPTION	DESCRIPTION		
12	1	2	1	"Pipe 12"		
23	2	3	1	"Pipe 23"		
34	3	4	1	"Pipe 34"		
45	4	5	1	"Pipe 45"		
56	5	6	1	"Pipe 56"		
67	6	7	1	"Pipe 67"		
78	7	8	1	"Pipe 78"		
89	8	9	1	"Pipe 89"		
910	9	10	1	"Pipe 910"		
1011	10	11	1	"Pipe 1011"		
1112	11	12	1	"Pipe 1112"		

635	35	6	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 635"
736	36	7	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 736"
837	37	8	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 837"
938	38	9	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 938"
1039	39	10	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 1039"
1140	40	11	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 1140"
1241	41	12	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 1241"
1342	42	13	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 1342"
1443	43	14	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 1443"
1544	44	15	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 1544"
1645	45	16	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 1645"
1746	46	17	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 1746"
1847	47	18	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 1847"
1948	48	19	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 1948"
2049	49	20	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 2049"
2150	50	21	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 2150"
2251	51	22	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 2251"
2352	52	23	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 2352"
2453	53	24	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 2453"
2554	54	25	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 2554"
2655	55	26	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 2655"
2756	56	27	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 2756"
2857	57	28	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 2857"
2958	58	29	2	5.283300e-01	0.000000e+00	F	0.000000e+00	0.000000e+00	"Convection 2958"

EXAMPLE 14 HISTORY AND PROPERTY FILES

EX14HS1.DAT

2
0 14.7 -425. 1.
1000 14.7 -425. 1.

EX14HS30.DAT

2
0 13.318 -425. 1.
1000 13.318 -425. 1.

USER2CP.PRP

2
0 0.161
1000 0.161

USER2K.PRP

2
0 0.002611
1000 0.002611

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/12/2012 15:31

TITLE :Chilldown of a Short Cryogenic Pipeline
 ANALYST :Johnny Maroney
 FILEIN :C:\Program Files (x86)\GFSSP604\TestInstalledExamples\EX14\Ex14.dat
 FILEOUT :Ex14.out

OPTION VARIABLES

ADDPROP	BUOYANCY	CONDX	CONJUG	CYCLIC	DALTON	DENCON	ENERGY
F	F	F	T	F	F	F	T
FLOWREG	GRAVITY	HCOEF	HEX	HRATE	IFRMIX	INERTIA	INSUC
0	F	F	F	T	1	F	F
INVAL	MIXTURE	MOVBND	MSORCE	NORMAL	NRSOLVT	OPVALVE	PLOTADD
F	F	F	F	F	F	F	F
PRESREG	PRESS	PRINTI	PRNTADD	PRNTIN	RADIATION	REACTING	ROTATION
0	F	F	F	F	F	F	F
SAVER	SECONDL	SHEAR	SIMULA	SIUNITS	STEADY	THRUST	TPA
F	F	F	F	F	F	F	F
TRANS_MOM	TRANSQ	TRANSV	TVM	TWOD	USRVAR	VARGEO	VARROT
F	F	T	F	F	F	F	F
RLFVLV							
F							

NNODES = 30
 NINT = 28
 NBR = 29
 NF = 1
 NVAR = 85
 NHREF = 2

FLUIDS: H2

BOUNDARY NODES

NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)
1	0.1470E+02	-0.4250E+03	0.4490E+01	0.0000E+00
30	0.1332E+02	-0.4250E+03	0.4489E+01	0.0000E+00

CONJUGATE HEAT TRANSFER

NSOLIDX = 28
 NAMB = 0
 NSSC = 27
 NSFC = 28
 NSAC = 0
 NSSR = 0

ISTEP = 10 TAU = 0.10000E+00

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.1470E+02	-0.4250E+03	0.0000E+00	0.4490E+01	0.0000E+00
30	0.1332E+02	-0.4250E+03	0.0000E+00	0.4489E+01	0.0000E+00

SOLUTION

INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.1469E+02	-0.4237E+03	0.1730E-01	0.4439E+01	0.9544E-04	0.0000E+00
3	0.1469E+02	-0.4232E+03	0.2513E-01	0.3011E+01	0.4315E-04	0.9012E-02
4	0.1469E+02	-0.4232E+03	0.4050E-01	0.1868E+01	0.2677E-04	0.2632E-01
5	0.1468E+02	-0.4232E+03	0.5604E-01	0.1350E+01	0.1934E-04	0.4382E-01
6	0.1468E+02	-0.4232E+03	0.7041E-01	0.1074E+01	0.1539E-04	0.6000E-01
7	0.1468E+02	-0.4232E+03	0.9226E-01	0.8195E+00	0.1175E-04	0.8461E-01
8	0.1467E+02	-0.4232E+03	0.1234E+00	0.6124E+00	0.8778E-05	0.1197E+00
9	0.1467E+02	-0.4232E+03	0.1620E+00	0.4666E+00	0.6687E-05	0.1631E+00
10	0.1467E+02	-0.4232E+03	0.2080E+00	0.3633E+00	0.5207E-05	0.2149E+00
11	0.1466E+02	-0.4232E+03	0.2623E+00	0.2880E+00	0.4128E-05	0.2761E+00
12	0.1466E+02	-0.4232E+03	0.3267E+00	0.2312E+00	0.3314E-05	0.3485E+00
13	0.1465E+02	-0.4232E+03	0.4035E+00	0.1871E+00	0.2682E-05	0.4350E+00
14	0.1465E+02	-0.4232E+03	0.4965E+00	0.1520E+00	0.2178E-05	0.5397E+00
15	0.1464E+02	-0.4232E+03	0.6111E+00	0.1234E+00	0.1769E-05	0.6686E+00
16	0.1463E+02	-0.4232E+03	0.7560E+00	0.9971E-01	0.1429E-05	0.8317E+00
17	0.1461E+02	-0.4198E+03	0.9254E+00	0.7448E-01	0.1067E-05	0.1000E+01
18	0.1459E+02	-0.3979E+03	0.9771E+00	0.4545E-01	0.6514E-06	0.1000E+01
19	0.1456E+02	-0.3762E+03	0.9907E+00	0.3309E-01	0.4743E-06	0.1000E+01
20	0.1451E+02	-0.3554E+03	0.9958E+00	0.2626E-01	0.3763E-06	0.1000E+01

BRANCHES	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
21	0.1445E+02	-0.3361E+03	0.9981E+00	0.2201E-01	0.3155E-06	0.1000E+01		
22	0.1437E+02	-0.3185E+03	0.9992E+00	0.1915E-01	0.2744E-06	0.1000E+01		
23	0.1428E+02	-0.3026E+03	0.9999E+00	0.1709E-01	0.2449E-06	0.1000E+01		
24	0.1418E+02	-0.2881E+03	0.1000E+01	0.1552E-01	0.2225E-06	0.1000E+01		
25	0.1406E+02	-0.2748E+03	0.1001E+01	0.1429E-01	0.2048E-06	0.1000E+01		
26	0.1394E+02	-0.2626E+03	0.1001E+01	0.1327E-01	0.1903E-06	0.1000E+01		
27	0.1380E+02	-0.2512E+03	0.1001E+01	0.1242E-01	0.1781E-06	0.1000E+01		
28	0.1365E+02	-0.2405E+03	0.1001E+01	0.1169E-01	0.1675E-06	0.1000E+01		
29	0.1349E+02	-0.2305E+03	0.1001E+01	0.1105E-01	0.2375E-06	0.1000E+01		

BRANCHES	DELTA (LBF-S^2/(LBM-FT)^2)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.828E+04	0.669E-02	0.108E-01	0.125E+02	0.901E+05	0.106E-01	0.232E-02
23	0.893E+04	0.352E-02	0.754E-02	0.885E+01	0.669E+05	0.722E-02	0.861E-03
34	0.136E+05	0.306E-02	0.568E-02	0.985E+01	0.567E+05	0.790E-02	0.832E-03
45	0.222E+05	0.331E-02	0.463E-02	0.129E+02	0.540E+05	0.104E-01	0.118E-02
56	0.310E+05	0.323E-02	0.387E-02	0.150E+02	0.519E+05	0.120E-01	0.134E-02
67	0.397E+05	0.282E-02	0.320E-02	0.155E+02	0.480E+05	0.124E-01	0.121E-02
78	0.521E+05	0.271E-02	0.274E-02	0.174E+02	0.477E+05	0.139E-01	0.131E-02
89	0.685E+05	0.292E-02	0.248E-02	0.211E+02	0.517E+05	0.169E-01	0.170E-02
910	0.872E+05	0.338E-02	0.236E-02	0.264E+02	0.594E+05	0.211E-01	0.247E-02
1011	0.108E+06	0.407E-02	0.233E-02	0.335E+02	0.705E+05	0.266E-01	0.376E-02
1112	0.131E+06	0.498E-02	0.234E-02	0.424E+02	0.849E+05	0.336E-01	0.583E-02
1213	0.156E+06	0.611E-02	0.237E-02	0.535E+02	0.103E+06	0.423E-01	0.902E-02
1314	0.186E+06	0.747E-02	0.241E-02	0.671E+02	0.125E+06	0.529E-01	0.138E-01
1415	0.220E+06	0.911E-02	0.244E-02	0.838E+02	0.152E+06	0.658E-01	0.211E-01
1516	0.260E+06	0.111E-01	0.248E-02	0.105E+03	0.185E+06	0.816E-01	0.319E-01
1617	0.309E+06	0.135E-01	0.250E-02	0.131E+03	0.228E+06	0.102E+00	0.486E-01
1718	0.406E+06	0.181E-01	0.253E-02	0.177E+03	0.250E+06	0.132E+00	0.888E-01
1819	0.719E+06	0.326E-01	0.256E-02	0.294E+03	0.170E+06	0.182E+00	0.265E+00
1920	0.104E+07	0.476E-01	0.257E-02	0.405E+03	0.133E+06	0.217E+00	0.533E+00
2021	0.135E+07	0.626E-01	0.258E-02	0.513E+03	0.111E+06	0.248E+00	0.886E+00
2122	0.166E+07	0.771E-01	0.259E-02	0.613E+03	0.981E+05	0.277E+00	0.130E+01
2223	0.195E+07	0.908E-01	0.259E-02	0.706E+03	0.890E+05	0.304E+00	0.177E+01
2324	0.222E+07	0.104E+00	0.260E-02	0.792E+03	0.824E+05	0.328E+00	0.227E+01
2425	0.247E+07	0.116E+00	0.260E-02	0.873E+03	0.773E+05	0.350E+00	0.279E+01
2526	0.271E+07	0.127E+00	0.260E-02	0.949E+03	0.746E+05	0.371E+00	0.333E+01
2627	0.294E+07	0.138E+00	0.260E-02	0.102E+04	0.715E+05	0.390E+00	0.391E+01
2728	0.317E+07	0.149E+00	0.260E-02	0.109E+04	0.689E+05	0.408E+00	0.451E+01
2829	0.339E+07	0.160E+00	0.261E-02	0.116E+04	0.666E+05	0.426E+00	0.514E+01
2930	0.361E+07	0.171E+00	0.261E-02	0.123E+04	0.647E+05	0.443E+00	0.580E+01

SOLID NODES
NODESL CPSLD TS
BTU/LB F F
31 0.161E+00 0.794E+02

32	0.161E+00	0.795E+02
33	0.161E+00	0.795E+02
34	0.161E+00	0.794E+02
35	0.161E+00	0.794E+02
36	0.161E+00	0.794E+02
37	0.161E+00	0.794E+02
38	0.161E+00	0.793E+02
39	0.161E+00	0.793E+02
40	0.161E+00	0.792E+02
41	0.161E+00	0.791E+02
42	0.161E+00	0.789E+02
43	0.161E+00	0.787E+02
44	0.161E+00	0.785E+02
45	0.161E+00	0.782E+02
46	0.161E+00	0.778E+02
47	0.161E+00	0.771E+02
48	0.161E+00	0.769E+02
49	0.161E+00	0.768E+02
50	0.161E+00	0.766E+02
51	0.161E+00	0.765E+02
52	0.161E+00	0.763E+02
53	0.161E+00	0.761E+02
54	0.161E+00	0.759E+02
55	0.161E+00	0.755E+02
56	0.161E+00	0.754E+02
57	0.161E+00	0.753E+02
58	0.161E+00	0.752E+02

SOLID TO SOLID CONDUCTOR

ICONSS	CONDKIJ BTU/S FT F	QDOTSS BTU/S
3132	0.261E-02	-0.300E-05
3233	0.261E-02	-0.112E-05
3334	0.261E-02	0.134E-05
3435	0.261E-02	0.498E-06
3536	0.261E-02	0.158E-05
3637	0.261E-02	0.142E-05
3738	0.261E-02	0.735E-06
3839	0.261E-02	0.283E-05
3940	0.261E-02	0.291E-05
4041	0.261E-02	0.596E-05
4142	0.261E-02	0.693E-05
4243	0.261E-02	0.811E-05
4344	0.261E-02	0.973E-05
4445	0.261E-02	0.121E-04
4546	0.261E-02	0.162E-04
4647	0.261E-02	0.272E-04

SOLID TO FLUID CONDUCTOR				
ICONSF	QDOTSF	HCSF	HCSF	HCSFR
	BTU/S	BTU/S	FT**2 F	
4748	0.261E-02	0.867E-05		
4849	0.261E-02	0.520E-05		
4950	0.261E-02	0.513E-05		
5051	0.261E-02	0.559E-05		
5152	0.261E-02	0.710E-05		
5253	0.261E-02	0.821E-05		
5354	0.261E-02	0.105E-04		
5455	0.261E-02	0.156E-04		
5556	0.261E-02	0.435E-05		
5657	0.261E-02	0.479E-05		
5758	0.261E-02	0.337E-05		
231	0.114E-01	0.619E-02		0.000E+00
332	0.119E-01	0.645E-02		0.000E+00
433	0.953E-02	0.517E-02		0.000E+00
534	0.632E-02	0.343E-02		0.000E+00
635	0.169E-02	0.918E-03		0.000E+00
736	0.586E-02	0.318E-02		0.000E+00
837	0.114E-01	0.620E-02		0.000E+00
938	0.165E-01	0.894E-02		0.000E+00
1039	0.219E-01	0.119E-01		0.000E+00
1140	0.278E-01	0.151E-01		0.000E+00
1241	0.345E-01	0.187E-01		0.000E+00
1342	0.423E-01	0.230E-01		0.000E+00
1443	0.520E-01	0.282E-01		0.000E+00
1544	0.645E-01	0.350E-01		0.000E+00
1645	0.817E-01	0.444E-01		0.000E+00
1746	0.110E+00	0.596E-01		0.000E+00
1847	0.154E+00	0.855E-01		0.000E+00
1948	0.149E+00	0.861E-01		0.000E+00
2049	0.143E+00	0.864E-01		0.000E+00
2150	0.137E+00	0.866E-01		0.000E+00
2251	0.132E+00	0.866E-01		0.000E+00
2352	0.127E+00	0.866E-01		0.000E+00
2453	0.122E+00	0.866E-01		0.000E+00
2554	0.117E+00	0.866E-01		0.000E+00
2655	0.113E+00	0.865E-01		0.000E+00
2756	0.109E+00	0.864E-01		0.000E+00
2857	0.106E+00	0.864E-01		0.000E+00
2958	0.102E+00	0.863E-01		0.000E+00
			:	
			:	
			:	
			:	

ISTEP = 1000 TAU = 0.10000E+02

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO	QUALITY
			(LBM/FT^3)		
1	0.1470E+02	-0.4250E+03	0.0000E+00	0.4490E+01	0.0000E+00
30	0.1332E+02	-0.4250E+03	0.0000E+00	0.4489E+01	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO	EM (LBM)	QUALITY
				(LBM/FT^3)		
2	0.1469E+02	-0.4246E+03	0.1760E-01	0.4475E+01	0.9621E-04	0.0000E+00
3	0.1468E+02	-0.4242E+03	0.1746E-01	0.4460E+01	0.6393E-04	0.0000E+00
4	0.1467E+02	-0.4239E+03	0.1732E-01	0.4445E+01	0.6372E-04	0.0000E+00
5	0.1466E+02	-0.4235E+03	0.1719E-01	0.4431E+01	0.6350E-04	0.0000E+00
6	0.1465E+02	-0.4232E+03	0.1783E-01	0.4235E+01	0.6071E-04	0.8295E-03
7	0.1465E+02	-0.4232E+03	0.2253E-01	0.3349E+01	0.4800E-04	0.6140E-02
8	0.1463E+02	-0.4232E+03	0.2803E-01	0.2690E+01	0.3856E-04	0.1234E-01
9	0.1462E+02	-0.4232E+03	0.3436E-01	0.2193E+01	0.3143E-04	0.1948E-01
10	0.1460E+02	-0.4232E+03	0.4155E-01	0.1812E+01	0.2597E-04	0.2759E-01
11	0.1458E+02	-0.4232E+03	0.4959E-01	0.1516E+01	0.2173E-04	0.3666E-01
12	0.1456E+02	-0.4232E+03	0.5847E-01	0.1284E+01	0.1840E-04	0.4667E-01
13	0.1453E+02	-0.4233E+03	0.6815E-01	0.1100E+01	0.1576E-04	0.5759E-01
14	0.1449E+02	-0.4233E+03	0.7855E-01	0.9524E+00	0.1365E-04	0.6931E-01
15	0.1446E+02	-0.4233E+03	0.8958E-01	0.8333E+00	0.1194E-04	0.8174E-01
16	0.1441E+02	-0.4233E+03	0.1011E+00	0.7366E+00	0.1056E-04	0.9471E-01
17	0.1437E+02	-0.4233E+03	0.1129E+00	0.6575E+00	0.9424E-05	0.1081E+00
18	0.1431E+02	-0.4233E+03	0.1250E+00	0.5923E+00	0.8490E-05	0.1216E+00
19	0.1426E+02	-0.4234E+03	0.1370E+00	0.5384E+00	0.7718E-05	0.1352E+00
20	0.1419E+02	-0.4234E+03	0.1488E+00	0.4940E+00	0.7080E-05	0.1484E+00
21	0.1413E+02	-0.4234E+03	0.1603E+00	0.4569E+00	0.6549E-05	0.1613E+00
22	0.1405E+02	-0.4235E+03	0.1714E+00	0.4254E+00	0.6097E-05	0.1738E+00
23	0.1398E+02	-0.4235E+03	0.1824E+00	0.3981E+00	0.5705E-05	0.1861E+00
24	0.1390E+02	-0.4235E+03	0.1931E+00	0.3741E+00	0.5362E-05	0.1981E+00
25	0.1381E+02	-0.4236E+03	0.2036E+00	0.3529E+00	0.5059E-05	0.2099E+00
26	0.1372E+02	-0.4236E+03	0.2140E+00	0.3341E+00	0.4788E-05	0.2215E+00
27	0.1363E+02	-0.4236E+03	0.2240E+00	0.3172E+00	0.4546E-05	0.2327E+00
28	0.1353E+02	-0.4237E+03	0.2339E+00	0.3020E+00	0.4329E-05	0.2437E+00
29	0.1343E+02	-0.4237E+03	0.2435E+00	0.2882E+00	0.6197E-05	0.2544E+00

BRANCHES

BRANCH	KFACTOR	DELTA	FLOW RATE	VELOCITY	REYN. NO.	MACH NO.	ENTROPY GEN.	LOST WORK
	(LBF-S^2/(LBM-FT)^2)	(PSI)	(LBM/SEC)	(FT/SEC)			BTU/(R-SEC)	LBF-FT/SEC
12	0.799E+04	0.911E-02	0.128E-01	0.149E+02	0.107E+06	0.126E-01	0.139E-06	0.374E-02
23	0.799E+04	0.910E-02	0.128E-01	0.149E+02	0.109E+06	0.125E-01	0.138E-06	0.375E-02
34	0.798E+04	0.910E-02	0.128E-01	0.150E+02	0.111E+06	0.124E-01	0.137E-06	0.376E-02

45	0.798E+04	0.909E-02	0.128E-01	0.150E+02	0.113E+06	0.123E-01	0.136E-06	0.377E-02
56	0.798E+04	0.909E-02	0.128E-01	0.151E+02	0.115E+06	0.122E-01	0.135E-06	0.379E-02
67	0.831E+04	0.947E-02	0.128E-01	0.158E+02	0.117E+06	0.127E-01	0.146E-06	0.412E-02
78	0.104E+05	0.118E-01	0.128E-01	0.199E+02	0.124E+06	0.199E-01	0.230E-06	0.652E-02
89	0.145E+05	0.145E-01	0.128E-01	0.248E+02	0.132E+06	0.199E-01	0.352E-06	0.997E-02
910	0.155E+05	0.176E-01	0.128E-01	0.305E+02	0.141E+06	0.244E-01	0.523E-06	0.148E-01
1011	0.185E+05	0.210E-01	0.128E-01	0.369E+02	0.151E+06	0.296E-01	0.756E-06	0.214E-01
1112	0.217E+05	0.247E-01	0.128E-01	0.440E+02	0.162E+06	0.353E-01	0.106E-05	0.301E-01
1213	0.253E+05	0.288E-01	0.128E-01	0.520E+02	0.175E+06	0.417E-01	0.146E-05	0.413E-01
1314	0.291E+05	0.331E-01	0.128E-01	0.607E+02	0.189E+06	0.487E-01	0.196E-05	0.555E-01
1415	0.331E+05	0.377E-01	0.128E-01	0.701E+02	0.203E+06	0.562E-01	0.258E-05	0.729E-01
1516	0.373E+05	0.424E-01	0.128E-01	0.801E+02	0.219E+06	0.642E-01	0.332E-05	0.938E-01
1617	0.416E+05	0.473E-01	0.128E-01	0.906E+02	0.236E+06	0.727E-01	0.419E-05	0.118E+00
1718	0.460E+05	0.523E-01	0.128E-01	0.102E+03	0.252E+06	0.814E-01	0.519E-05	0.147E+00
1819	0.504E+05	0.573E-01	0.128E-01	0.113E+03	0.270E+06	0.904E-01	0.632E-05	0.178E+00
1920	0.548E+05	0.623E-01	0.128E-01	0.124E+03	0.287E+06	0.994E-01	0.757E-05	0.213E+00
2021	0.591E+05	0.672E-01	0.128E-01	0.135E+03	0.304E+06	0.108E+00	0.890E-05	0.251E+00
2122	0.632E+05	0.719E-01	0.128E-01	0.146E+03	0.320E+06	0.117E+00	0.103E-04	0.290E+00
2223	0.673E+05	0.765E-01	0.128E-01	0.157E+03	0.336E+06	0.126E+00	0.118E-04	0.332E+00
2324	0.713E+05	0.811E-01	0.128E-01	0.168E+03	0.352E+06	0.135E+00	0.134E-04	0.375E+00
2425	0.753E+05	0.856E-01	0.128E-01	0.178E+03	0.367E+06	0.143E+00	0.150E-04	0.422E+00
2526	0.792E+05	0.900E-01	0.128E-01	0.189E+03	0.382E+06	0.152E+00	0.168E-04	0.470E+00
2627	0.831E+05	0.944E-01	0.128E-01	0.200E+03	0.397E+06	0.161E+00	0.186E-04	0.521E+00
2728	0.869E+05	0.988E-01	0.128E-01	0.210E+03	0.412E+06	0.169E+00	0.205E-04	0.574E+00
2829	0.907E+05	0.103E+00	0.128E-01	0.221E+03	0.426E+06	0.178E+00	0.225E-04	0.629E+00
2930	0.945E+05	0.107E+00	0.128E-01	0.231E+03	0.440E+06	0.186E+00	0.246E-04	0.686E+00

SOLID NODES

NODESL	CPSLD	TS	
		BTU/LB F	F
31	0.161E+00	0.451E+02	
32	0.161E+00	0.452E+02	
33	0.161E+00	0.452E+02	
34	0.161E+00	0.444E+02	
35	0.161E+00	0.400E+02	
36	0.161E+00	0.314E+02	
37	0.161E+00	0.216E+02	
38	0.161E+00	0.106E+02	
39	0.161E+00	-0.159E+01	
40	0.161E+00	-0.150E+02	
41	0.161E+00	-0.296E+02	
42	0.161E+00	-0.454E+02	
43	0.161E+00	-0.623E+02	
44	0.161E+00	-0.805E+02	
45	0.161E+00	-0.100E+03	
46	0.161E+00	-0.120E+03	
47	0.161E+00	-0.141E+03	

48	0.161E+00	-0.163E+03
49	0.161E+00	-0.186E+03
50	0.161E+00	-0.208E+03
51	0.161E+00	-0.225E+03
52	0.161E+00	-0.240E+03
53	0.161E+00	-0.252E+03
54	0.161E+00	-0.263E+03
55	0.161E+00	-0.273E+03
56	0.161E+00	-0.283E+03
57	0.161E+00	-0.292E+03
58	0.161E+00	-0.300E+03

SOLID TO SOLID CONDUCTOR

ICONSS	CONDKIJ	QDOTSS
BTU/S FT F	BTU/S	BTU/S
3132	0.261E-02	-0.342E-05
3233	0.261E-02	0.141E-05
3334	0.261E-02	0.300E-04
3435	0.261E-02	0.183E-03
3536	0.261E-02	0.350E-03
3637	0.261E-02	0.402E-03
3738	0.261E-02	0.450E-03
3839	0.261E-02	0.499E-03
3940	0.261E-02	0.548E-03
4041	0.261E-02	0.598E-03
4142	0.261E-02	0.646E-03
4243	0.261E-02	0.694E-03
4344	0.261E-02	0.744E-03
4445	0.261E-02	0.802E-03
4546	0.261E-02	0.824E-03
4647	0.261E-02	0.848E-03
4748	0.261E-02	0.885E-03
4849	0.261E-02	0.951E-03
4950	0.261E-02	0.889E-03
5051	0.261E-02	0.720E-03
5152	0.261E-02	0.591E-03
5253	0.261E-02	0.506E-03
5354	0.261E-02	0.452E-03
5455	0.261E-02	0.418E-03
5556	0.261E-02	0.391E-03
5657	0.261E-02	0.367E-03
5758	0.261E-02	0.320E-03

SOLID TO FLUID CONDUCTOR

ICONSF	QDOTSF	HCSF	HCSFR
BTU/S	BTU/S FT**2 F		
231	0.107E-01	0.620E-02	0.000E+00

BOUNDARY NODES		ISTEP = 2000 TAU = 0.20000E+02						
NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	EM (LBM)	QUALITY	QUALITY	
332	0.107E-01	0.620E-02	0.000E+00					
433	0.107E-01	0.619E-02	0.000E+00					
534	0.106E-01	0.619E-02	0.000E+00					
635	0.109E-01	0.640E-02	0.000E+00					
736	0.129E-01	0.773E-02	0.000E+00					
837	0.151E-01	0.922E-02	0.000E+00					
938	0.173E-01	0.109E-01	0.000E+00					
1039	0.196E-01	0.127E-01	0.000E+00					
1140	0.220E-01	0.147E-01	0.000E+00					
1241	0.242E-01	0.168E-01	0.000E+00					
1342	0.264E-01	0.190E-01	0.000E+00					
1443	0.283E-01	0.214E-01	0.000E+00					
1544	0.300E-01	0.238E-01	0.000E+00					
1645	0.313E-01	0.264E-01	0.000E+00					
1746	0.322E-01	0.289E-01	0.000E+00					
1847	0.326E-01	0.315E-01	0.000E+00					
1948	0.325E-01	0.340E-01	0.000E+00					
2049	0.318E-01	0.364E-01	0.000E+00					
2150	0.307E-01	0.388E-01	0.000E+00					
2251	0.298E-01	0.410E-01	0.000E+00					
2352	0.292E-01	0.432E-01	0.000E+00					
2453	0.285E-01	0.453E-01	0.000E+00					
2554	0.279E-01	0.474E-01	0.000E+00					
2655	0.273E-01	0.494E-01	0.000E+00					
2756	0.265E-01	0.514E-01	0.000E+00					
2857	0.258E-01	0.532E-01	0.000E+00					
2958	0.251E-01	0.550E-01	0.000E+00					

SOLUTION INTERNAL NODES		ISTEP = 2000 TAU = 0.20000E+02						
NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY	QUALITY	
2	0.1468E+02	-0.4247E+03	0.1761E-01	0.4477E+01	0.9626E-04	0.0000E+00	0.0000E+00	
3	0.1467E+02	-0.4244E+03	0.1748E-01	0.4465E+01	0.6399E-04	0.0000E+00	0.0000E+00	
4	0.1465E+02	-0.4240E+03	0.1736E-01	0.4452E+01	0.6382E-04	0.0000E+00	0.0000E+00	
5	0.1464E+02	-0.4237E+03	0.1724E-01	0.4440E+01	0.6364E-04	0.0000E+00	0.0000E+00	

BRANCHES	KFACTOR (LBF-S ² /(LBM-FT) ²)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
6	0.1462E+02	-0.4234E+03	0.1712E-01	0.4427E+01	0.6346E-04	0.0000E+00		
7	0.1461E+02	-0.4232E+03	0.1814E-01	0.4150E+01	0.5948E-04	0.1244E-02		
8	0.1459E+02	-0.4232E+03	0.2184E-01	0.3445E+01	0.4937E-04	0.5419E-02		
9	0.1457E+02	-0.4232E+03	0.2588E-01	0.2903E+01	0.4161E-04	0.9991E-02		
10	0.1455E+02	-0.4232E+03	0.3024E-01	0.2482E+01	0.3557E-04	0.1492E-01		
11	0.1452E+02	-0.4233E+03	0.3485E-01	0.2150E+01	0.3081E-04	0.2014E-01		
12	0.1449E+02	-0.4233E+03	0.3968E-01	0.1885E+01	0.2702E-04	0.2559E-01		
13	0.1446E+02	-0.4233E+03	0.4464E-01	0.1672E+01	0.2397E-04	0.3121E-01		
14	0.1442E+02	-0.4233E+03	0.4968E-01	0.1499E+01	0.2149E-04	0.3691E-01		
15	0.1437E+02	-0.4233E+03	0.5472E-01	0.1358E+01	0.1946E-04	0.4261E-01		
16	0.1433E+02	-0.4233E+03	0.5969E-01	0.1241E+01	0.1779E-04	0.4825E-01		
17	0.1428E+02	-0.4234E+03	0.6455E-01	0.1145E+01	0.1640E-04	0.5374E-01		
18	0.1422E+02	-0.4234E+03	0.6922E-01	0.1064E+01	0.1525E-04	0.5904E-01		
19	0.1416E+02	-0.4234E+03	0.7367E-01	0.9961E+00	0.1428E-04	0.6408E-01		
20	0.1410E+02	-0.4234E+03	0.7784E-01	0.9393E+00	0.1346E-04	0.6881E-01		
21	0.1404E+02	-0.4235E+03	0.8173E-01	0.8912E+00	0.1277E-04	0.7322E-01		
22	0.1397E+02	-0.4235E+03	0.8537E-01	0.8496E+00	0.1218E-04	0.7736E-01		
23	0.1389E+02	-0.4235E+03	0.8882E-01	0.8132E+00	0.1166E-04	0.8127E-01		
24	0.1382E+02	-0.4236E+03	0.9209E-01	0.7808E+00	0.1119E-04	0.8498E-01		
25	0.1374E+02	-0.4236E+03	0.9520E-01	0.7518E+00	0.1078E-04	0.8851E-01		
26	0.1366E+02	-0.4236E+03	0.9815E-01	0.7256E+00	0.1040E-04	0.9187E-01		
27	0.1358E+02	-0.4237E+03	0.1010E+00	0.7018E+00	0.1006E-04	0.9507E-01		
28	0.1350E+02	-0.4237E+03	0.1037E+00	0.6801E+00	0.9747E-05	0.9812E-01		
29	0.1341E+02	-0.4237E+03	0.1062E+00	0.6599E+00	0.1419E-04	0.1011E+00		
12	0.752E+04	0.155E-01	0.173E-01	0.200E+02	0.144E+06	0.170E-01	0.320E-06	0.860E-02
23	0.751E+04	0.155E-01	0.173E-01	0.201E+02	0.146E+06	0.169E-01	0.317E-06	0.862E-02
34	0.751E+04	0.155E-01	0.173E-01	0.202E+02	0.149E+06	0.168E-01	0.315E-06	0.865E-02
45	0.751E+04	0.155E-01	0.173E-01	0.202E+02	0.151E+06	0.166E-01	0.313E-06	0.867E-02
56	0.751E+04	0.155E-01	0.173E-01	0.203E+02	0.153E+06	0.165E-01	0.311E-06	0.869E-02
67	0.751E+04	0.155E-01	0.173E-01	0.203E+02	0.155E+06	0.164E-01	0.310E-06	0.872E-02
78	0.798E+04	0.165E-01	0.173E-01	0.217E+02	0.159E+06	0.174E-01	0.349E-06	0.987E-02
89	0.953E+04	0.197E-01	0.173E-01	0.261E+02	0.166E+06	0.210E-01	0.502E-06	0.142E-01
910	0.112E+05	0.232E-01	0.173E-01	0.310E+02	0.173E+06	0.249E-01	0.700E-06	0.198E-01
1011	0.130E+05	0.268E-01	0.173E-01	0.363E+02	0.182E+06	0.291E-01	0.949E-06	0.269E-01
1112	0.148E+05	0.307E-01	0.173E-01	0.418E+02	0.191E+06	0.336E-01	0.125E-05	0.355E-01
1213	0.168E+05	0.347E-01	0.172E-01	0.477E+02	0.200E+06	0.383E-01	0.162E-05	0.457E-01
1314	0.187E+05	0.387E-01	0.172E-01	0.538E+02	0.209E+06	0.432E-01	0.204E-05	0.575E-01
1415	0.207E+05	0.428E-01	0.172E-01	0.600E+02	0.219E+06	0.482E-01	0.251E-05	0.709E-01
1516	0.227E+05	0.469E-01	0.172E-01	0.662E+02	0.229E+06	0.533E-01	0.304E-05	0.857E-01
1617	0.246E+05	0.509E-01	0.172E-01	0.725E+02	0.238E+06	0.583E-01	0.361E-05	0.102E+00
1718	0.265E+05	0.548E-01	0.172E-01	0.786E+02	0.247E+06	0.632E-01	0.421E-05	0.119E+00
1819	0.283E+05	0.585E-01	0.172E-01	0.845E+02	0.256E+06	0.680E-01	0.485E-05	0.137E+00
1920	0.301E+05	0.621E-01	0.172E-01	0.903E+02	0.265E+06	0.727E-01	0.550E-05	0.155E+00

2021	0.317E+05	0.655E-01	0.172E-01	0.957E+02	0.273E+06	0.771E-01	0.615E-05	0.173E+00
2122	0.332E+05	0.686E-01	0.172E-01	0.101E+03	0.280E+06	0.814E-01	0.680E-05	0.191E+00
2223	0.347E+05	0.716E-01	0.172E-01	0.106E+03	0.287E+06	0.854E-01	0.745E-05	0.209E+00
2324	0.361E+05	0.745E-01	0.172E-01	0.111E+03	0.294E+06	0.893E-01	0.811E-05	0.228E+00
2425	0.374E+05	0.773E-01	0.172E-01	0.115E+03	0.300E+06	0.930E-01	0.876E-05	0.246E+00
2526	0.387E+05	0.800E-01	0.172E-01	0.120E+03	0.306E+06	0.967E-01	0.942E-05	0.264E+00
2627	0.400E+05	0.826E-01	0.172E-01	0.124E+03	0.312E+06	0.100E+00	0.101E-04	0.282E+00
2728	0.412E+05	0.851E-01	0.172E-01	0.128E+03	0.318E+06	0.104E+00	0.108E-04	0.301E+00
2829	0.424E+05	0.875E-01	0.172E-01	0.132E+03	0.323E+06	0.107E+00	0.114E-04	0.319E+00
2930	0.436E+05	0.899E-01	0.172E-01	0.136E+03	0.328E+06	0.111E+00	0.121E-04	0.338E+00

SOLID NODES

NODESL	CPSLD	TS	BTU/LB F	BTU/LB F	TS
31	0.161E+00	-0.241E+01			
32	0.161E+00	-0.229E+01			
33	0.161E+00	-0.236E+01			
34	0.161E+00	-0.338E+01			
35	0.161E+00	-0.796E+01			
36	0.161E+00	-0.208E+02			
37	0.161E+00	-0.377E+02			
38	0.161E+00	-0.558E+02			
39	0.161E+00	-0.748E+02			
40	0.161E+00	-0.945E+02			
41	0.161E+00	-0.115E+03			
42	0.161E+00	-0.135E+03			
43	0.161E+00	-0.156E+03			
44	0.161E+00	-0.177E+03			
45	0.161E+00	-0.197E+03			
46	0.161E+00	-0.217E+03			
47	0.161E+00	-0.237E+03			
48	0.161E+00	-0.256E+03			
49	0.161E+00	-0.274E+03			
50	0.161E+00	-0.291E+03			
51	0.161E+00	-0.304E+03			
52	0.161E+00	-0.315E+03			
53	0.161E+00	-0.325E+03			
54	0.161E+00	-0.333E+03			
55	0.161E+00	-0.340E+03			
56	0.161E+00	-0.347E+03			
57	0.161E+00	-0.353E+03			
58	0.161E+00	-0.357E+03			

SOLID TO SOLID CONDUCTOR

ICONSS	CONDKIJ	QDOTSS
	BTU/S FT F	BTU/S
3132	0.261E-02	-0.479E-05

3233	0.261E-02	0.250E-05
3334	0.261E-02	0.419E-04
3435	0.261E-02	0.188E-03
3536	0.261E-02	0.526E-03
3637	0.261E-02	0.690E-03
3738	0.261E-02	0.741E-03
3839	0.261E-02	0.779E-03
3940	0.261E-02	0.808E-03
4041	0.261E-02	0.830E-03
4142	0.261E-02	0.842E-03
4243	0.261E-02	0.847E-03
4344	0.261E-02	0.848E-03
4445	0.261E-02	0.843E-03
4546	0.261E-02	0.818E-03
4647	0.261E-02	0.791E-03
4748	0.261E-02	0.771E-03
4849	0.261E-02	0.754E-03
4950	0.261E-02	0.677E-03
5051	0.261E-02	0.554E-03
5152	0.261E-02	0.453E-03
5253	0.261E-02	0.382E-03
5354	0.261E-02	0.333E-03
5455	0.261E-02	0.299E-03
5556	0.261E-02	0.272E-03
5657	0.261E-02	0.244E-03
5758	0.261E-02	0.190E-03

SOLID TO FLUID CONDUCTOR

ICONSF	QDOTSF BTU/S	HCSF BTU/S FT**2 F	HCSFR
231	0.122E-01	0.787E-02	0.000E+00
332	0.122E-01	0.786E-02	0.000E+00
433	0.121E-01	0.785E-02	0.000E+00
534	0.121E-01	0.784E-02	0.000E+00
635	0.119E-01	0.783E-02	0.000E+00
736	0.121E-01	0.823E-02	0.000E+00
837	0.135E-01	0.955E-02	0.000E+00
938	0.148E-01	0.110E-01	0.000E+00
1039	0.159E-01	0.124E-01	0.000E+00
1140	0.168E-01	0.139E-01	0.000E+00
1241	0.175E-01	0.155E-01	0.000E+00
1342	0.180E-01	0.170E-01	0.000E+00
1443	0.182E-01	0.185E-01	0.000E+00
1544	0.181E-01	0.200E-01	0.000E+00
1645	0.178E-01	0.215E-01	0.000E+00
1746	0.173E-01	0.229E-01	0.000E+00
1847	0.166E-01	0.242E-01	0.000E+00

1948	0.157E-01	0.255E-01	0.000E+00
2049	0.146E-01	0.266E-01	0.000E+00
2150	0.135E-01	0.276E-01	0.000E+00
2251	0.125E-01	0.286E-01	0.000E+00
2352	0.117E-01	0.295E-01	0.000E+00
2453	0.110E-01	0.303E-01	0.000E+00
2554	0.104E-01	0.311E-01	0.000E+00
2655	0.975E-02	0.318E-01	0.000E+00
2756	0.917E-02	0.325E-01	0.000E+00
2857	0.863E-02	0.331E-01	0.000E+00
2958	0.822E-02	0.337E-01	0.000E+00

TIME OF ANALYSIS WAS 97.50000000000000 SECS

*

APPENDIX U—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 15

Simulation of Fluid Transient Following Sudden Valve Closure

<u>Contents</u>	<u>Page</u>
Example 15 Input File	202
Example 15 History File	204
Example 15 Output File (Partial)	206

GFSSP VERSION
604
GFSSP INSTALLATION PATH

ANALYST
Alok Majumdar
INPUT DATA FILE NAME
Ex15.dat
OUTPUT FILE NAME
Ex15.out

TITLE
Simulation of Fluid Transient Following Sudden Valve Closure
USERSETUP

F	DENCON	GRAVITY	ENERGY	MIXTURE	THRUST	STEADY	TRANSP	SAVER
F	F	F	T	F	F	F	T	F
F	HEX	HCOEF	REACTING	INERTIA	CONDX	ADDPROP	PRINTI	ROTATION
F	F	F	F	F	F	F	T	F
F	BUOYANCY	HRATE	INVAL	MSORCE	MOVBND	TPA	VARGEO	TVM
F	F	T	T	F	F	F	F	F
F	SHEAR	PRNTIN	PRNTADD	OPVALVE	TRANSQ	CONJUG	RADIAT	WINPLOT
F	F	T	T	T	F	F	F	T
F	PRESS	INSUC	VARROT	CYCLIC	CHKVALS	WINFILE	DALTON	NOSTATS
F	F	F	F	F	F	F	F	F
F	NORMAL	SIMUL	SECONDL	NRSOLVT	IBDF	NOPLT	PRESREG	FLOWREG
F	F	T	F	F	1	T	0	0
T	TRANS_MOM	USERSVARS	PSMG	ISOLVE	PLOTADD	SIUNITS	TECPLOT	MDGEN
T	F	F	F	1	F	F	F	F
1	NUM_USER_VARS	IFR_MIX	PRINTD	SATTABL	MSORIN	PRELVLV	LAMINAR	HSTAG
1	1	F	F	F	F	F	T	T
NNODES	NINT	NBR	NF	NF				
7	5	6	1	1				
RELAXK	RELAXD	RELAXH	CC	CC	NITER	RELAXNR	RELAXHC	RELAXTS
1	0.5	1	0.0001	0.0001	500	1	1	1
DTAU	TIMEF	TIMEL	NPSTEP	NPSTEP	NPWSTEP	WPLSTEP	WPLBUFF	
0.02	0	1	1	1	1	1	50	1.1

NFLUID(1), I = 1, NF
6

NODE	INDEX	DESCRIPTION	TEMP (DEGF)	MASS SOURC	HEAT SOURC	THRST AREA	NODE-VOLUME	CONCENTRATION
1	2	" Node 1"						
2	1	" Node 2"						
3	1	" Node 3"						
4	1	" Node 4"						
5	1	" Node 5"						
6	1	" Node 6"						
7	2	" Node 7"						

```

2      14.7      60      0      0      0      0      0
3      14.7      60      0      0      0      0      0
4      14.7      60      0      0      0      0      0
5      14.7      60      0      0      0      0      0
6      14.7      60      0      0      0      0      0
ex15hs1.dat
ex15hs7.dat
INODE      NUMBER      DNNODE      OPTION      DESCRIPTION
2          2          12          23      "Pipe 12"
3          2          23          34      "Pipe 23"
4          2          34          45      "Pipe 34"
5          2          45          56      "Pipe 45"
6          2          56          67      "Pipe 56"
7          2          67          67      "Restrict 67"
BRANCH      UPNODE      DNNODE      OPTION      DESCRIPTION
12          1          2          -1          LENGTH      DIA      0.25
23          2          3          -1          LENGTH      DIA      0.25
34          3          4          -1          LENGTH      DIA      0.25
45          4          5          -1          LENGTH      DIA      0.25
56          5          6          -1          LENGTH      DIA      0.25
67          6          7          -1          LENGTH      DIA      0.25
BRANCH      UPNODE      DNNODE      OPTION      DESCRIPTION
12          1          2          -1          LENGTH      DIA      0.25
23          2          3          -1          LENGTH      DIA      0.25
34          3          4          -1          LENGTH      DIA      0.25
45          4          5          -1          LENGTH      DIA      0.25
56          5          6          -1          LENGTH      DIA      0.25
67          6          7          -1          LENGTH      DIA      0.25
BRANCH      UPNODE      DNNODE      OPTION      DESCRIPTION
12          1          2          -2          FLOW COEFF  AREA
67          6          7          -2          FLOW COEFF  AREA
0.6
INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW
12 0
23 0
34 0
45 0
56 0
67 0
NUMBER OF CLOSING/OPENING VALVES IN THE CIRCUIT
1
BRANCH
67
FILE NAME
ex15vlv.dat
RESTART NODE INFORMATION FILE
FNDEX15.DAT

```

RESTART BRANCH INFORMATION FILE
FBREX15.DAT

EXAMPLE 15 HISTORY AND RESTART FILES

EX15HS1.DAT

```
2
0 500.0 -260.0 0.0
1000 500.0 -260.0 0.0
```

EX15HS7.DAT

```
2
0 450.0 -260.0 0.0
1000 450.0 -260.0 0.0
```

EX15VLV.DAT

```
7
0.00 0.0491
0.02 0.0164
0.04 0.00545
0.06 0.00182
0.08 0.00061
0.1 1.E-16
100 1.E-16
```

FNDEX15.DAT

```

NODE P (PSE) TF (R) H (BTU/LB) CONC RHO (LB/FT^3)
EMU (LB/FT-S) Z R (LBF-FT/LB-R) EM (LB) CP (BTU/LB-R) ENTROPY (BTU/LB-R)
2 70570.99 199.6258 77.07056 1.000000 0.000000E+00
64.96349 8.4011677E-05 0.1126991 48.28000 0.000000E+00
0.4173057 1.524868 69141.62 77.07056 1.000000
3 199.6527 48.28000 0.000000E+00
64.94235 8.3891122E-05 0.1104375 48.28000 0.000000E+00
0.4175506 1.524851 67712.23 77.07058 1.000000
4 199.6797 48.28000 0.000000E+00
64.92119 8.3770668E-05 0.1081750 48.28000 0.000000E+00
0.4178011 1.524851 66282.80 77.07059 1.000000
5 199.7065 48.28000 0.000000E+00
64.90001 8.3650339E-05 0.1059117 48.28000 0.000000E+00
```

0.4180055	1.524851				
6	64853.37	199.7332	77.07063	1.000000	
64.87878	8.3530074E-05	0.1036477	48.28000	0.0000000E+00	
0.4182283	1.524851				

FBREX15 .DAT

BRANCH	AK	FLOWR (LB/S)	VEL (FT/S)
12	153259.8	9.6560813E-02	4.358272
23	153280.5	9.6560813E-02	4.360718
34	153282.9	9.6560813E-02	4.362138
45	153285.4	9.6560813E-02	4.363560
56	153287.8	9.6560813E-02	4.364984
67	5722.974	9.6560813E-02	4.369652

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 January 2013

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:01/25/2013 15:35

TITLE :Simulation of Fluid Transient Following Sudden Valve Closure
 ANALYST :Alok Majumdar
 FILEIN :D:\GFSSP604Intel\ExamplesJan25\EX15\EX15.dat
 FILEOUT :Ex15.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	CONDX	F	CONJUG	F	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	F	HCOEF	F	HEX	F	HRATE	T	IFRMIX	1	INERTIA	F	INSUC	F
INVAL	T	MIXTURE	F	MOVBN	F	MSORCE	F	NORMAL	F	NRSOLVT	F	OPVALVE	T	PLOTADD	F
PRESREG	0	PRESS	F	PRINTI	T	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	F	SHEAR	F	SIMULA	T	SIUNITS	F	STEADY	F	THRUST	F	TPA	F
TRANS_MOM	T	TRANSQ	F	TRANSV	T	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F														

NNODES = 7
 NINT = 5
 NBR = 6
 NF = 1
 NVAR = 16
 NHREF = 2

FLUIDS: O2

BOUNDARY NODES	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)
1	0.5000E+03	-0.2600E+03	0.6498E+02	0.0000E+00
7	0.4500E+03	-0.2600E+03	0.6490E+02	0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)	EPSP	ANGLE	AREA
2	0.0000E+00	0.0000E+00	0.0000E+00	0.000E+00	0.000E+00	0.491E-01
3	0.0000E+00	0.0000E+00	0.0000E+00	0.000E+00	0.000E+00	0.491E-01
4	0.0000E+00	0.0000E+00	0.0000E+00	0.000E+00	0.000E+00	0.491E-01
5	0.0000E+00	0.0000E+00	0.0000E+00	0.000E+00	0.000E+00	0.491E-01
6	0.0000E+00	0.0000E+00	0.0000E+00	0.000E+00	0.000E+00	0.491E-01

BRANCH	UPNODE	DNNODE	OPTION	EPSP	ANGLE	AREA
12	1	2	1	0.000E+00	0.000E+00	0.491E-01
23	2	3	1	0.000E+00	0.000E+00	0.491E-01
34	3	4	1	0.000E+00	0.000E+00	0.491E-01
45	4	5	1	0.000E+00	0.000E+00	0.491E-01
56	5	6	1	0.000E+00	0.000E+00	0.491E-01
67	6	7	2	0.000E+00	0.000E+00	0.491E-01

BRANCH	OPTION -1:	LENGTH	DIA	EPSP	ANGLE	AREA
12	OPTION -1:	0.960E+03	0.250E+00	0.000E+00	0.000E+00	0.491E-01
23	OPTION -1:	0.960E+03	0.250E+00	0.000E+00	0.000E+00	0.491E-01
34	OPTION -1:	0.960E+03	0.250E+00	0.000E+00	0.000E+00	0.491E-01
45	OPTION -1:	0.960E+03	0.250E+00	0.000E+00	0.000E+00	0.491E-01
56	OPTION -1:	0.960E+03	0.250E+00	0.000E+00	0.000E+00	0.491E-01
67	OPTION -2:	FLOW COEF	AREA	0.000E+00	0.000E+00	0.491E-01

INITIAL GUESS FOR INTERNAL NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
2	0.4901E+03	-0.2600E+03	0.1127E+00	0.6496E+02	0.0000E+00
3	0.4802E+03	-0.2600E+03	0.1104E+00	0.6494E+02	0.0000E+00
4	0.4702E+03	-0.2600E+03	0.1082E+00	0.6492E+02	0.0000E+00
5	0.4603E+03	-0.2600E+03	0.1059E+00	0.6490E+02	0.0000E+00
6	0.4504E+03	-0.2599E+03	0.1036E+00	0.6488E+02	0.0000E+00

TRIAL SOLUTION

BRANCH	DELTA P (PSI)	FLOWRATE (LBM/SEC)
12	0.0000	0.0966
23	0.0000	0.0966
34	0.0000	0.0966
45	0.0000	0.0966
56	0.0000	0.0966
67	0.0000	0.0966

ISTEP = 1 TAU = 0.20000E-01

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.5000E+03	-0.2600E+03	0.0000E+00	0.6498E+02	0.0000E+00
7	0.4500E+03	-0.2600E+03	0.0000E+00	0.6490E+02	0.0000E+00

SOLUTION

INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.4832E+03	-0.2601E+03	0.1111E+00	0.6497E+02	0.2657E+01	0.0000E+00
3	0.4725E+03	-0.2600E+03	0.1087E+00	0.6494E+02	0.1771E+01	0.0000E+00
4	0.4640E+03	-0.2600E+03	0.1068E+00	0.6492E+02	0.1771E+01	0.0000E+00
5	0.4645E+03	-0.2599E+03	0.1069E+00	0.6491E+02	0.1770E+01	0.0000E+00
6	0.4995E+03	-0.2597E+03	0.1148E+00	0.6493E+02	0.8853E+00	0.0000E+00

INTERNAL NODES

NODE	H (BTU/LB)	ENTROPY (BTU/LB-R)	EMU (LBM/FT-SEC)	COND (BTU/FT-S-R)	CP (BTU/LB-R)	GAMA
2	0.7705E+02	0.1525E+01	0.8398E-04	0.1819E-04	0.4174E+00	0.2026E+01
3	0.7705E+02	0.1525E+01	0.8386E-04	0.1818E-04	0.4177E+00	0.2028E+01
4	0.7705E+02	0.1525E+01	0.8374E-04	0.1817E-04	0.4179E+00	0.2029E+01
5	0.7708E+02	0.1525E+01	0.8367E-04	0.1816E-04	0.4179E+00	0.2030E+01
6	0.7721E+02	0.1525E+01	0.8376E-04	0.1817E-04	0.4174E+00	0.2028E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA P (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. (BTU/(R-SEC))	LOST WORK (LBF-FT/SEC)
12	0.152E+06	0.168E+02	0.998E-01	0.451E+01	0.726E+05	0.569E-02	0.150E-04	0.233E+01
23	0.153E+06	0.107E+02	0.968E-01	0.437E+01	0.705E+05	0.552E-02	0.138E-04	0.214E+01
34	0.153E+06	0.847E+01	0.960E-01	0.434E+01	0.700E+05	0.547E-02	0.135E-04	0.209E+01
45	0.155E+06	-0.482E+00	0.927E-01	0.419E+01	0.677E+05	0.528E-02	0.122E-04	0.190E+01
56	0.162E+06	-0.350E+02	0.748E-01	0.338E+01	0.547E+05	0.426E-02	0.673E-05	0.105E+01
67	0.513E+05	0.495E+02	0.409E-01	0.553E+01	0.516E+05	0.697E-02	0.347E-06	0.540E-01

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 284 ITERATIONS
 TAU = 2.000000000000000E-002 ISTEP = 1 DTAU =
 2.000000000000000E-002 :

ISTEP = 25 TAU = 0.500000E+00

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP) (LBM/FT^3)	RHO	QUALITY
1	0.5000E+03	-0.2600E+03	0.0000E+00	0.6498E+02	0.0000E+00
7	0.4500E+03	-0.2600E+03	0.0000E+00	0.6490E+02	0.0000E+00

SOLUTION

INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.4828E+03	-0.2601E+03	0.1110E+00	0.6497E+02	0.2657E+01	0.0000E+00
3	0.4544E+03	-0.2601E+03	0.1046E+00	0.6493E+02	0.1771E+01	0.0000E+00
4	0.4348E+03	-0.2601E+03	0.1001E+00	0.6490E+02	0.1770E+01	0.0000E+00
5	0.4211E+03	-0.2601E+03	0.9702E-01	0.6488E+02	0.1769E+01	0.0000E+00
6	0.4175E+03	-0.2601E+03	0.9618E-01	0.6486E+02	0.8843E+00	0.0000E+00

INTERNAL NODES

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.7705E+02	0.1525E+01	0.8398E-04	0.1819E-04	0.4174E+00	0.2026E+01
3	0.7700E+02	0.1525E+01	0.8377E-04	0.1817E-04	0.4180E+00	0.2029E+01
4	0.7697E+02	0.1525E+01	0.8361E-04	0.1816E-04	0.4184E+00	0.2031E+01
5	0.7696E+02	0.1525E+01	0.8347E-04	0.1815E-04	0.4187E+00	0.2033E+01
6	0.7698E+02	0.1525E+01	0.8338E-04	0.1814E-04	0.4188E+00	0.2034E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.201E+06	0.172E+02	-0.295E-01	-0.133E+01	0.215E+05	0.168E-02	0.511E-06	0.793E-01
23	0.214E+06	0.283E+02	-0.230E-01	-0.104E+01	0.168E+05	0.131E-02	0.258E-06	0.401E-01
34	0.234E+06	0.196E+02	-0.162E-01	-0.733E+00	0.119E+05	0.924E-03	0.989E-07	0.153E-01
45	0.272E+06	0.137E+02	-0.927E-02	-0.419E+00	0.679E+04	0.528E-03	0.215E-07	0.334E-02
56	0.230E+06	0.365E+01	-0.301E-02	-0.136E+00	0.220E+04	0.171E-03	0.621E-09	0.964E-04
67	0.138E+34	-0.325E+02	-0.111E-11	-0.246E+05	0.180E+02	0.310E+02	0.187E-09	0.290E-04

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 102 ITERATIONS
 TAU = 0.500000000000000
 2.000000000000000E-002 ISTEP = 25 DTAU =

```

STEP = 50          TAU = 0.10000E+01
BOUNDARY NODES
NODE  P (PSI)      TF (F)      Z (COMP)      RHO          QUALITY
1  0.5000E+03    -0.2600E+03    0.0000E+00    0.6498E+02    0.0000E+00
7  0.4500E+03    -0.2600E+03    0.0000E+00    0.6490E+02    0.0000E+00

SOLUTION
INTERNAL NODES
NODE  P (PSI)      TF (F)      Z          RHO          EM (LBM)      QUALITY
                (LBM/FT^3)
2  0.5083E+03    -0.2600E+03    0.1168E+00    0.6499E+02    0.2658E+01    0.0000E+00
3  0.5192E+03    -0.2599E+03    0.1193E+00    0.6498E+02    0.1772E+01    0.0000E+00
4  0.5261E+03    -0.2598E+03    0.1208E+00    0.6497E+02    0.1772E+01    0.0000E+00
5  0.5304E+03    -0.2597E+03    0.1218E+00    0.6496E+02    0.1771E+01    0.0000E+00
6  0.5314E+03    -0.2596E+03    0.1220E+00    0.6495E+02    0.8855E+00    0.0000E+00

NODE  H          ENTROPY      EMU          COND          CP          GAMA
      BTU/LB    BTU/LB-R    LBM/FT-SEC  BTU/FT-S-R    BTU/LB-R

2  0.7712E+02    0.1525E+01    0.8410E-04    0.1820E-04    0.4170E+00    0.2025E+01
3  0.7718E+02    0.1525E+01    0.8407E-04    0.1819E-04    0.4169E+00    0.2025E+01
4  0.7723E+02    0.1525E+01    0.8403E-04    0.1819E-04    0.4168E+00    0.2025E+01
5  0.7727E+02    0.1525E+01    0.8398E-04    0.1819E-04    0.4168E+00    0.2025E+01
6  0.7730E+02    0.1525E+01    0.8391E-04    0.1818E-04    0.4168E+00    0.2026E+01

BRANCHES
BRANCH  KFACTOR      DELP      FLOW RATE      VELOCITY      REYN. NO.      MACH NO.      ENTROPY GEN.      LOST WORK
        (LBF-S^2/(LBM-FT)^2) (PSI)      (LBM/SEC)      (FT/SEC)
12  0.188E+06    -0.833E+01    -0.387E-01    -0.175E+01    0.281E+05    0.221E-02    0.108E-05    0.168E+00
23  0.194E+06    -0.109E+02    -0.342E-01    -0.154E+01    0.248E+05    0.195E-02    0.766E-06    0.119E+00
34  0.206E+06    -0.696E+01    -0.269E-01    -0.121E+01    0.195E+05    0.153E-02    0.394E-06    0.613E-01
45  0.231E+06    -0.426E+01    -0.171E-01    -0.771E+00    0.124E+05    0.972E-03    0.113E-06    0.176E-01
56  0.310E+06    -0.105E+01    -0.581E-02    -0.262E+00    0.423E+04    0.331E-03    0.602E-08    0.937E-03
67  0.138E+34    0.815E+02    -0.111E-11    -0.246E+05    0.180E+02    0.310E+02    0.186E-09    0.290E-04

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 129 ITERATIONS
TAU = 1.0000000000000000          ISTEP = 50          DTAU =
2.0000000000000000E-002
*****
TIME OF ANALYSIS WAS 1.9843750000000000          SECS
*****

```

APPENDIX V—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 16

Simulation of a Pressure Regulator Downstream of a Pressurized Tank

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Example 16 History File	214
Example 16 Output File (Partial)	215

```

GFSSP VERSION
604
GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST
Alok Majumdar
INPUT DATA FILE NAME
D:\GFSSP604\Intel\Examples\Ex16\EX16.dat
OUTPUT FILE NAME
EX16.out
TITLE
Simulation of a pressure regulator downstream of a Pressurized Tank
USERSETUP
F
DENCON          GRAVITY          ENERGY          MIXTURE          THRUST          STEADY          TRANSV          SAVER
F                F                T                F                F                F                T                F
HEX             HCOEF             REACTING         INERTIA           CONDX            ADPPROP          PRINTI          ROTATION
F                F                F                F                F                T                T                F
BUOYANCY        HRATE             INVAL            MSORCE            MOVBN            TPA              VARGEO          TVM
F                F                F                F                F                F                F                F
SHEAR           PRNTIN            PRNTADD          OPVALVE           TRANSQ           CONJUG           RADIAT          WINPLOT
F                T                T                F                F                F                F                T
PRESS           INSUC             VARROT           CYCLIC            CHKVALS          WINFILE          DALTON          NOSTATS
F                F                F                F                F                T                F                F
NORMAL          SIMUL             SECONDL          NRSOLVT           IBDP             NOPLT            PRESREG         FLOWREG
F                T                T                F                F                T                1                0
TRANS_MOM       USRVAR            PSMG             ISOLVE            PLOTADD          SIUNITS          TECPILOT        MDGEN
F                F                F                1                F                F                F                F
NUM_USER_VARS  IFR_MIX           PRINTD           SATTABL           MSORIN           PRELIVL         LAMINAR         HSTAG
1                1                F                F                F                F                T                T
NNODES          NINT              NBR              NF
3                2                2                1
RELAXK          RELAXD            RELAXH           RELAXH            NITER            RELAXNR          RELAXHC         RELAXTS
1                0.5              1                CC                1e-05            500 1            1                1
DTAU            TIMEF             TIMEL            NPSTEP            NPWSTEP          WPLSTEP         WPLBUFF         WPLBUFF
0.1             0                15              5                1                50              1.1             1.1
NFLUID(I), I = 1, NF
33
RREF            CPREF            GAMREF           EMUREF            AKREF            PREF             TREF            HREF            SREF
53.34           0.24             1.3999          1.26e-05          4.133e-06       14.7            -459            0                0
NODE            INDEX            DESCRIPTION
1                1                " Node 1"
3                2                " Node 3"
2                1                " Node 2"

```

```

NODE PRES (PSI) TEMP (DEGF) MASS SOURC HEAT SOURC THIRST AREA NODE-VOLUME CONCENTRATION
1 100 80 0 0 0 17280
2 14.7 60 0 0 0 100
ex16hs3.dat
INODE NUMBR NAMEBR
1 1 12
2 2 12 23
BRANCH UPNODE DNNODE OPTION DESCRIPTION
12 1 2 2 "Restrict 12"
23 2 3 2 "Restrict 23"
BRANCH OPTION -2 FLOW COEFF AREA
12 1 0.04
23 1 0.00785
INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW
12 0
23 0
NUMBER OF PRESSURE REGULATOR ASSEMBLY IN THE CIRCUIT
1
PRESS REG BR HIST FILE MAX AREA PRESSURE RELAXATION CONVERGENCE MAX_ITERATIONS MIN_AREA
12 1 1.44 40 0.3 0.0001 50 1e-16
PRESSURE REGULATOR HISTORY FILE
preg_hist.dat

```

EXAMPLE 16 HISTORY FILES**EX16HS3.DAT**

```
2
0 14.700 80.00 1.00
1000 14.700 80.00 1.00
```

PREG_HIST.DAT

```
4
0 35.00
10 35.00
10.01 40.00
1000 40.00
```

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/28/2012 08:54

TITLE :Simulation of a pressure regulator downstream of a Pressurized Tank
 ANALYST :Alok Majumdar
 FILEIN :D:\GFSSP604Intel\Examples\EX16\EX16.dat
 FILEOUT :EX16.out

OPTION VARIABLES

ADDPROP	BUOYANCY	CONDX	CONJUG	CYCLIC	DALTON	DENCON	ENERGY
T	F	F	F	F	F	F	T
FLOWREG	GRAVITY	HCOEF	HEX	HRATE	IFRMIX	INERTIA	INSUC
0	F	F	F	T	1	F	F
INVAL	MIXTURE	MOVBNB	MSORCE	NORMAL	NRSOLVT	OPVALVE	PLOTADD
F	F	F	F	F	F	F	F
PRESREG	PRESS	PRINTI	PRNTADD	PRNTIN	RADIATION	REACTING	ROTATION
1	F	T	T	T	F	F	F
SAVER	SECONDL	SHEAR	SIMULA	SIUNITS	STEADY	THRUST	TPA
F	T	F	T	F	F	F	F
TRANS_MOM	TRANSQ	TRANSV	TVM	TWOD	USRVAR	VARGEO	VARROT
F	F	T	F	F	F	F	F
RLFVLV							
F							

NNODES = 3
 NINT = 2
 NBR = 2
 NF = 1
 NVAR = 6
 NHREF = 2

FLUIDS: IDEL

BOUNDARY NODES
 NODE P (PSI) T (F) RHO (LBM/FT^3) AREA (IN^2)
 3 0.1470E+02 0.8000E+02 0.7354E-01 0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE AREA (IN^2) MASS (LBM/S) HEAT (BTU/S)
 1 0.0000E+00 0.0000E+00 0.0000E+00
 2 0.0000E+00 0.0000E+00 0.0000E+00

BRANCH UPNODE DNNODE OPTION
 12 1 2
 23 2 3 2

BRANCH OPTION -2: FLOW COEF AREA
 12 0.100E+01 0.400E-01
 23 0.100E+01 0.785E-02

INITIAL GUESS FOR INTERNAL NODES

NODE P (PSI) TF (F) Z (COMP) RHO (LBM/FT^3) QUALITY
 1 0.1000E+03 0.8000E+02 0.1000E+01 0.5002E+00 0.0000E+00
 2 0.1470E+02 0.6000E+02 0.1000E+01 0.7637E-01 0.0000E+00

TRIAL SOLUTION

BRANCH DELP (PSI) FLOWRATE (LBM/SEC)
 12 0.0000 0.0000
 23 0.0000 0.0000

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-04 IN 501 ITERATIONS
 TAU = 0.1000000000000000
 ISTEP = 1 DTAU =

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-04 IN 505 ITERATIONS
 TAU = 0.2000000000000000
 ISTEP = 2 DTAU =

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-04 IN 409 ITERATIONS
 TAU = 0.3000000000000000
 ISTEP = 3 DTAU =

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-04 IN 294 ITERATIONS
 TAU = 0.4000000000000000 ISTEP = 4 DTAU =
 0.1000000000000000

ISTEP = 5 TAU = 0.50000E+00

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
3	0.1470E+02	0.8000E+02	0.1000E+01	0.7354E-01	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
1	0.9969E+02	0.7952E+02	0.1000E+01	0.4991E+00	0.4991E+01	0.0000E+00
2	0.3477E+02	0.6359E+02	0.1000E+01	0.1794E+00	0.1038E-01	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
------	----------	------------------	----------------	-----------------	-------------	------

1	0.1294E+03	0.1475E+01	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01
2	0.1246E+03	0.1540E+01	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.997E+08	0.649E+02	0.968E-02	0.110E+04	0.206E+06	0.965E+00	0.432E-03	0.181E+03
23	0.292E+08	0.201E+02	0.996E-02	0.102E+04	0.121E+06	0.908E+00	0.394E-03	0.160E+03

***** TOTAL ENTROPY GENERATION = 0.826E-03 BTU/(R-SEC) *****

***** TOTAL WORK LOST = 0.621E+00 HP *****

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-04 IN 287 ITERATIONS
 TAU = 0.5000000000000000 ISTEP = 5 DTAU =
 0.1000000000000000

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-04 IN 299 ITERATIONS
 TAU = 0.6000000000000000 ISTEP = 6 DTAU =
 0.1000000000000000

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-04 IN 254 ITERATIONS
 TAU = 0.7000000000000000 ISTEP = 7 DTAU =
 0.1000000000000000

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-04 IN 253 ITERATIONS
 TAU = 0.8000000000000000 ISTEP = 8 DTAU =
 0.1000000000000000

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-04 IN 253 ITERATIONS
 TAU = 0.9000000000000000 ISTEP = 9 DTAU =
 0.1000000000000000

.
 .
 .

ISTEP = 70 TAU = 0.700000E+01

BOUNDARY NODES
 NODE P (PSI) TF (F) Z (COMP) RHO QUALITY
 (LBM/FT^3)

3	0.1470E+02	0.8000E+02	0.1000E+01	0.7354E-01	0.0000E+00
---	------------	------------	------------	------------	------------

SOLUTION INTERNAL NODES
 NODE P (PSI) TF (F) Z RHO EM (LBM) QUALITY
 (LBM/FT^3)

1	0.9778E+02	0.7655E+02	0.1000E+01	0.4923E+00	0.4923E+01	0.0000E+00
2	0.3500E+02	0.2094E+02	0.1000E+01	0.1966E+00	0.1138E-01	0.0000E+00

COND CP GAMA
 BTU/LB-R LBM/FT-SEC BTU/FT-S-R BTU/LB-R

1	0.1294E+03	0.1475E+01	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01
2	0.1246E+03	0.1519E+01	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES
 BRANCH KFACTOR DELP FLOW RATE VELOCITY REYN. NO. MACH NO. ENTROPY GEN. LOST WORK
 (LBF-S^2/(LBM-FT)^2) (PSI) (LBM/SEC) (FT/SEC) (BTU/(R-SEC)) (LBF-FT/SEC)

12	0.822E+08	0.628E+02	0.105E-01	0.109E+04	0.212E+06	0.958E+00	0.462E-03	0.193E+03
23	0.266E+08	0.203E+02	0.105E-01	0.978E+03	0.127E+06	0.910E+00	0.417E-03	0.156E+03

***** TOTAL ENTROPY GENERATION = 0.878E-03 BTU/ (R-SEC) *****

**** TOTAL WORK LOST = 0.634E+00 HP *****

.
.
.
.

ISTEP = 150 TAU = 0.15000E+02

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
3	0.1470E+02	0.8000E+02	0.1000E+01	0.7354E-01	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
1	0.9516E+02	0.7240E+02	0.1000E+01	0.4828E+00	0.4828E+01	0.0000E+00
2	0.4000E+02	0.3080E+02	0.1000E+01	0.2201E+00	0.1274E-01	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
------	----------	------------------	----------------	-----------------	-------------	------

1	0.1294E+03	0.1475E+01	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01
2	0.1246E+03	0.1514E+01	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.517E+08	0.552E+02	0.124E-01	0.103E+04	0.222E+06	0.910E+00	0.492E-03	0.204E+03
23	0.238E+08	0.253E+02	0.124E-01	0.103E+04	0.150E+06	0.951E+00	0.537E-03	0.205E+03

***** TOTAL ENTROPY GENERATION = 0.103E-02 BTU/ (R-SEC) *****

**** TOTAL WORK LOST = 0.743E+00 HP *****

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-04 IN 92 ITERATIONS

TAU = 15.0000000000000000
 ISTEP = 150
 DTAU = 0.100000000000000000

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-04 IN 92 ITERATIONS
TAU = 15.1000000000000 ISTEP = 151 DTAU =
0.100000000000000

TIME OF ANALYSIS WAS 0.109375000000000 SECS

APPENDIX W—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 17

Simulation of a Flow Regulator Downstream of a Pressurized Tank

<u>Contents</u>	<u>Page</u>
Example 17 Input File	222
Example 17 History File	224
Example 17 Output File (Partial)	225

```

GFSSP VERSION
604
GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST
Alok Majumdar
INPUT DATA FILE NAME
D:\GFSSP604\Intel\Examples\Ex17\Ex17.dat
OUTPUT FILE NAME
Ex17.out
TITLE
Simulation of a flow regulator downstream of a Pressurized Tank
SETUP
F
DENCON          GRAVITY          ENERGY          MIXTURE          THRUST          STEADY          TRANSV          SAVER
F              F              T              F              F              F              T              F
HEX             HCOEF             REACTING         INERTIA          CONDX           ADPPROP         PRINTI         ROTATION
F              F              F              F              F              T              T              F
BUOYANCY       HRATE             INVAL           MSORCE           MOVBN          TPA             VARGEO         TVM
F              F              F              F              F              F              F              F
SHEAR          PRNTIN           PRNTADD         OPVALVE         TRANSQ         CONJUG          RADIAT         WINPLOT
F              T              T              F              F              F              F              T
PRESS          INSUC            VARROT          CYCLIC           CHKVALS        WINFILE         DALTON         NOSTATS
F              F              F              F              F              F              F              F
NORMAL         SIMUL            SECONDL         NRSOLVT         IBDP           NOPLT           PRESREG        FLOWREG
F              T              F              F              F              F              0              1
TRANS_MOM     USERVARS         PSMG            ISOLVE          PLOTADD        SIUNITS         TECPILOT       MDGEN
F              F              F              1              F              F              F              F
NUM_USER_VARS IFR_MIX          PRINTD          SATTABL         MSORIN         PRELIVLV       LAMINAR        HSTAG
1              1              F              F              F              F              T              T
NNODES        NINT             NBR             NF              NF              NF              NF              NF
2              1              1              1              1              1              1              1
RELAXK        RELAXD           RELAXH          RELAXH          RELAXH          RELAXNR         RELAXHC        RELAXTS
1              0.5             1              1              1              500            1              1
DTAU          TIMEF            TIMEL           NPSTEP          NPSTEP         NEWSTEP        WPLBUFF        WPLBUFF
0.5           0              20             5              5              1              50            1.1
NFLUID(I), I = 1, NF
33
RREF          CPREF           GAMREF          EMUREF          AKREF           NITER          RELAXNR        RELAXTS
53.34        0.24           1.3999         1.26e-05        4.133e-06      500            1              1
NODE          INDEX           DESCRIPTION
1              1              " Node 1"
2              2              " Node 2"
NODE PRES (PSI) TEMP (DEGF) MASS SOURC  HEAT SOURC  THRST AREA  NODE-VOLUME  CONCENTRATION
1              100           80             0              0              0              17280
Ex17hs3.dat

```



```

INODE      NUMBER  NAMEBR
1          1      12
BRANCH  UPNODE  DNNODE  OPTION  DESCRIPTION
12      1      2      22      "Orifice 12"
BRANCH  OPTION -22  AREA    FLOW COEF
12      0.00785  1
INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW
12 0
NUMBER OF FLOW REGULATOR ASSEMBLY IN THE CIRCUIT
1
FLOW REG BR  HIST FILE  AREA  REGULATOR FLOW  RELAXATION  CONVERGENCE
12      1      0.3      0.012      1      0.001
FLOW REGULATOR HISTORY FILE
freq_hist.dat

```

EXAMPLE 17 HISTORY FILES**Ex17hs3.dat**

2				
0	14.700	80.00	1.00	
1000	14.700	80.00	1.00	

FREQ_HIST.DAT

4				
0	35.00			
10	35.00			
10.01	40.00			
1000	40.00			

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

RUN DATE:09/28/2012 10:00

TITLE :Simulation of a flow regulator downstream of a Pressurized Tank
 ANALYST :Alok Majumdar
 FILEIN :D:\GFSSP604Intel\Examples\Ex17\Ex17.dat
 FILEOUT :Ex17.out

OPTION VARIABLES

ADDPROP	BUOYANCY	CONDX	CONJUG	CYCLIC	DALTON	DENCON	ENERGY
T	F	F	F	F	F	F	T
FLOWREG	GRAVITY	HCOEF	HEX	HRATE	IFRMIX	INERTIA	INSUC
1	F	F	F	F	1	F	F
INVAL	MIXTURE	MOVBN	MSORCE	NORMAL	NRSOLVT	OPVALVE	PLOTADD
F	F	F	F	F	F	F	F
PRESREG	PRESS	PRINTI	PRNTADD	PRNTIN	RADIATION	REACTING	ROTATION
0	F	T	T	T	F	F	F
SAVER	SECONDL	SHEAR	SIMULA	SIUNITS	STEADY	THRUST	TPA
F	F	F	T	F	F	F	F
TRANS_MOM	TRANSQ	TRANSV	TVM	TWOD	USRVAR	VARGEO	VARROT
F	F	T	F	F	F	F	F
RLFVLV							
F							

NNODES = 2
 NINT = 1
 NBR = 1
 NF = 1
 NVAR = 3
 NHREF = 2

FLUIDS: IDEL

```

BOUNDARY NODES
NODE      P      T      RHO      AREA
(P      (F)      (LBM/FT^3)      (IN^2)
2      0.1470E+02      0.8000E+02      0.7354E-01      0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES
NODE      AREA      MASS      HEAT
(IN^2)      (LBM/S)      (BTU/LBM)
1      0.0000E+00      0.0000E+00      0.0000E+00

BRANCH      UPNODE      DNNODE      OPTION
12      1      2      22
BRANCH OPTION -22 FLOW COEF AREA
12      0.100E+01      0.785E-02

INITIAL GUESS FOR INTERNAL NODES
NODE      P(P      TF(F)      Z(COMP)      RHO      QUALITY
(LBM/FT^3)
1      0.1000E+03      0.8000E+02      0.1000E+01      0.5002E+00      0.0000E+00

TRIAL SOLUTION
BRANCH      DELP(P      FLOWRATE(LBM/SEC)
12      0.0000      0.0000

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 108 ITERATIONS
TAU = 0.5000000000000000 ISTEP = 1 DTAU =
0.5000000000000000

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 7 ITERATIONS
TAU = 1.0000000000000000 ISTEP = 2 DTAU =
0.5000000000000000

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 22 ITERATIONS
TAU = 1.5000000000000000 ISTEP = 3 DTAU =
0.5000000000000000

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 22 ITERATIONS
TAU = 2.0000000000000000 ISTEP = 4 DTAU =
0.5000000000000000

```


SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 28 ITERATIONS
 TAU = 12.00000000000000 ISTEP = 24 DTAU = 0.5000000000000000

.
 .
 .

ISTEP = 40 TAU = 0.20000E+02
 BOUNDARY NODES
 NODE P (PSI) TF (F) Z (COMP) RHO QUALITY
 (LBM/FT^3)
 2 0.1470E+02 0.8000E+02 0.1000E+01 0.7354E-01 0.0000E+00

SOLUTION INTERNAL NODES
 NODE P (PSI) TF (F) Z RHO EM (LBM) QUALITY
 (LBM/FT^3)
 1 0.9117E+02 0.6595E+02 0.1000E+01 0.4683E+00 0.4683E+01 0.0000E+00
 NODE H ENTROPY EMU COND CP GAMA
 BTU/LB BTU/LB-R LBM/FT-SEC BTU/FT-S-R BTU/LB-R
 1 0.1260E+03 0.1475E+01 0.1260E-04 0.4133E-05 0.2400E+00 0.1400E+01

BRANCHES
 BRANCH KFACTOR DELP FLOW RATE VELOCITY REYN. NO. MACH NO. ENTROPY GEN. LOST WORK
 (LBF-S^2/(LBM-FT)^2) (PSI) (LBM/SEC) (FT/SEC) (BTU/(R-SEC)) (LBF-FT/SEC)
 12 0.771E+07 0.765E+02 0.200E-01 0.650E+03 0.221E+06 0.579E+00 0.321E-03 0.131E+03

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 28 ITERATIONS
 TAU = 20.00000000000000 ISTEP = 40 DTAU = 0.5000000000000000

TIME OF ANALYSIS WAS 1.562500000000000E-002 SECS

APPENDIX X—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 18

Subsonic Fanno Flow

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Example 18 Input File	230
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Example 18 Output File	239

```

GFSSP VERSION
604
GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST
Dr. Alok Majumdar
INPUT DATA FILE NAME
D:\GFSSP604\Intel\Examples\Ex18\Ex18.dat
OUTPUT FILE NAME
Fanno_Flow.out
TITLE
Subsonic Fanno Flow
USERVAR
F
DENCON          GRAVITY          ENERGY          MIXTURE          THRUST          STEADY          TRANSV          SAVER
F               F               T               F               F               T               F               F
HEX             HCOEF          REACTING         INERTIA          CONDX           ADPPROP         PRINTI         ROTATION
F               F               F               T               F               F               T               F
BUOYANCY       HRATE          INVAL           MSORCE          MOVBNB         TPA            VARGEO         TVM
F               F               F               F               F               F               F               F
SHEAR          PRNTIN        PRNTADD         OPVALVE         TRANSQ         CONJUG         RADIAT         WINPLOT
F               T               T               F               F               F               F               F
PRESS          INSUC         VARROT          CYCLIC          CHKVALS        WINFILE        DALTON         NOSTATS
F               F               F               F               F               T               T               F
NORMAL         SIMUL         SECONDL        NRSOLVT         IBDP           NOPLT          PRESREG        FLOWREG
F               T               T               F               1               T               0               0
TRANS_MOM     USERVARS     PSMG           ISOLVE          PLOTADD        SIUNITS        TECPILOT       MDGEN
F               F               F               1               F               F               F               F
NUM_USER_VARS IFR_MIX      PRINTD         SATTABL        MSORIN         PRELIVLV      LAMINAR       HSTAG
1               1               F               F               F               F               T               T
NNODES        NINT          NBR            NF              NF              NF              NF              NF
21            19            20             1               1               1               1               1
RELAXK        RELAXD       RELAXH        RELAXH         RELAXH         RELAXH         RELAXH         RELAXH
1              0.5          1              1               1               1               1               1
NFLUID(I), I = 1, NF
4
NODE          INDEX          DESCRIPTION
1              2              " Node 1"
2              1              "
3              1              "
4              1              "
5              1              "
6              1              "
7              1              "
8              1              "
9              1              "
NITER          500
RELAXNR        1
RELAXHC        1
RELAXXTS      1
0.0001

```


INODE	10	11	12	13	14	15	16	17	18	19	20	21	NAMEBR
2	1	"	1	"	1	"	1	"	1	"	1	"	12
3	1	"	1	"	1	"	1	"	1	"	1	"	23
4	1	"	1	"	1	"	1	"	1	"	1	"	34
5	1	"	1	"	1	"	1	"	1	"	1	"	45
6	1	"	1	"	1	"	1	"	1	"	1	"	56
7	1	"	1	"	1	"	1	"	1	"	1	"	67
8	1	"	1	"	1	"	1	"	1	"	1	"	78
9	1	"	1	"	1	"	1	"	1	"	1	"	89
10	2	"	2	"	2	"	2	"	2	"	2	"	910
11	2	"	2	"	2	"	2	"	2	"	2	"	1011
12	2	"	2	"	2	"	2	"	2	"	2	"	1112
13	2	"	2	"	2	"	2	"	2	"	2	"	1213
													1314

INODE	2	3	4	5	6	7	8	9	10	11	12	13
2	50	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	23.4
3	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
4	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
5	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
6	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
7	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
8	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
9	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
10	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
11	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
12	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
13	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
14	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
15	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
16	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
17	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
18	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
19	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
20	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	
21	60	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	

INODE	2	3	4	5	6	7	8	9	10	11	12	13
2	80	0	0	0	0	0	0	0	0	0	0	0
3	60	0	0	0	0	0	0	0	0	0	0	0
4	60	0	0	0	0	0	0	0	0	0	0	0
5	60	0	0	0	0	0	0	0	0	0	0	0
6	60	0	0	0	0	0	0	0	0	0	0	0
7	60	0	0	0	0	0	0	0	0	0	0	0
8	60	0	0	0	0	0	0	0	0	0	0	0
9	60	0	0	0	0	0	0	0	0	0	0	0
10	60	0	0	0	0	0	0	0	0	0	0	0
11	60	0	0	0	0	0	0	0	0	0	0	0
12	60	0	0	0	0	0	0	0	0	0	0	0
13	60	0	0	0	0	0	0	0	0	0	0	0
14	60	0	0	0	0	0	0	0	0	0	0	0
15	60	0	0	0	0	0	0	0	0	0	0	0
16	60	0	0	0	0	0	0	0	0	0	0	0
17	60	0	0	0	0	0	0	0	0	0	0	0
18	60	0	0	0	0	0	0	0	0	0	0	0
19	60	0	0	0	0	0	0	0	0	0	0	0
20	60	0	0	0	0	0	0	0	0	0	0	0
21	60	0	0	0	0	0	0	0	0	0	0	0

56	1	67
67	1	78
78	1	89
89	1	910
910	1	1011
1011	1	1112
1112	1	1213
1213	1	1314
1314	1	1415
1415	1	1516
1516	1	1617
1617	1	1718
1718	1	1819
1819	1	1920
1920	1	2021
2021	0	
BRANCH		
12		
UPSTRM BR.		ANGLE
DNSTRM BR.		ANGLE
23	0.00000	
BRANCH		
23		
UPSTRM BR.		ANGLE
12	0.00000	
DNSTRM BR.		ANGLE
34	0.00000	
BRANCH		
34		
UPSTRM BR.		ANGLE
23	0.00000	
DNSTRM BR.		ANGLE
45	0.00000	
BRANCH		
45		
UPSTRM BR.		ANGLE
34	0.00000	
DNSTRM BR.		ANGLE
56	0.00000	
BRANCH		
56		
UPSTRM BR.		ANGLE
45	0.00000	
DNSTRM BR.		ANGLE
67	0.00000	
BRANCH		
67		

UPSTRM BR. ANGLE
 56 0.00000
 DNSTRM BR. ANGLE
 78 0.00000
 BRANCH
 78
 UPSTRM BR. ANGLE
 67 0.00000
 DNSTRM BR. ANGLE
 89 0.00000
 BRANCH
 89
 UPSTRM BR. ANGLE
 78 0.00000
 DNSTRM BR. ANGLE
 910 0.00000
 BRANCH
 910
 UPSTRM BR. ANGLE
 89 0.00000
 DNSTRM BR. ANGLE
 1011 0.00000
 BRANCH
 1011
 UPSTRM BR. ANGLE
 910 0.00000
 DNSTRM BR. ANGLE
 1112 0.00000
 BRANCH
 1112
 UPSTRM BR. ANGLE
 1011 0.00000
 DNSTRM BR. ANGLE
 1213 0.00000
 BRANCH
 1213
 UPSTRM BR. ANGLE
 1112 0.00000
 DNSTRM BR. ANGLE
 1314 0.00000
 BRANCH
 1314
 UPSTRM BR. ANGLE
 1213 0.00000
 DNSTRM BR. ANGLE
 1415 0.00000
 BRANCH
 1415

1415
UPSTRM BR. ANGLE
1314 0.00000
DNSTRM BR. ANGLE
1516 0.00000
BRANCH
1516
UPSTRM BR. ANGLE
1415 0.00000
DNSTRM BR. ANGLE
1617 0.00000
BRANCH
1617
UPSTRM BR. ANGLE
1516 0.00000
DNSTRM BR. ANGLE
1718 0.00000
BRANCH
1718
UPSTRM BR. ANGLE
1617 0.00000
DNSTRM BR. ANGLE
1819 0.00000
BRANCH
1819
UPSTRM BR. ANGLE
1718 0.00000
DNSTRM BR. ANGLE
1920 0.00000
BRANCH
1920
UPSTRM BR. ANGLE
1819 0.00000
DNSTRM BR. ANGLE
2021 0.00000
BRANCH
2021
UPSTRM BR. ANGLE
1920 0.00000
DNSTRM BR. ANGLE
NUMBER OF BRANCHES WITH INERTIA
20
12
23
34
45
56

67
78
89
910
1011
1112
1213
1314
1415
1516
1617
1718
1819
1920
2021

Example 18 User Subroutines

```

C
C ***** GFSSP USER SUBROUTINES *****
C
C *****
C *****
:
:
:
:
*****
SUBROUTINE KFADJUST (I,RHOU,EMU,EMUL,RHOUV,EMUV,ISATU,
& AKNEW)
C PURPOSE: ADJUST RESISTANCE IN A BRANCH
C *****
C INCLUDE 'COMBLK.FOR'
C *****
C ADD CODE HERE
IF(IOPT(I).EQ.1) THEN
PIPEL=BRPR1(I)
PIPED=BRPR2(I)
F=0.002
AKNEW=8.*F*PIPEL/(RHOU*GC*PI*PI*PIPED**5)
ENDIF
RETURN
END
C *****

```

NOTE: All other user subroutines are not used in Example 18

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

RUN DATE:09/28/2012 10:38

TITLE :Subsonic Fanno Flow
 ANALYST :Dr. Alok Majumdar
 FILEIN :D:\GFSSP604Intel\Examples\Ex18\Ex18.dat
 FILEOUT :Fanno_Flow.out

OPTION VARIABLES

ADDPROP	BUOYANCY	CONDX	CONJUG	CYCLIC	DALTON	DENCON	ENERGY
F	F	F	F	F	T	F	T
FLOWREG	GRAVITY	HCOEF	HEX	HRATE	IFRMIX	INERTIA	INSUC
0	F	F	F	T	1	T	F
INVAL	MIXTURE	MOVEND	MSORCE	NORMAL	NRSOLVT	OPVALVE	PLOTADD
F	F	F	F	F	F	F	F
PRESREG	PRESS	PRINTI	PRNTADD	PRNTIN	RADIATION	REACTING	ROTATION
0	F	F	T	F	F	F	F
SAVER	SECONDNL	SHEAR	SIMULA	SIUNITS	STEADY	THRUST	TPA
F	T	F	T	F	T	F	F
TRANS_MOM	TRANSQ	TRANSV	TVM	TWOD	USRVAR	VARGEO	VARROT
F	F	F	F	F	F	F	F
RLFVLV							
F							

NNODES = 21
 NNINT = 19
 NBR = 20
 NF = 1
 NVAR = 39
 Nhref = 2

FLUIDS: N2

BOUNDARY NODES

NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)
1	0.5000E+02	0.8000E+02	0.2420E+00	0.0000E+00
21	0.2340E+02	0.6000E+02	0.1176E+00	0.0000E+00

SOLUTION INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.4981E+02	0.7998E+02	0.9999E+00	0.2410E+00	0.0000E+00	0.1000E+01
3	0.4950E+02	0.7974E+02	0.9999E+00	0.2396E+00	0.0000E+00	0.1000E+01
4	0.4911E+02	0.7939E+02	0.9999E+00	0.2379E+00	0.0000E+00	0.1000E+01
5	0.4863E+02	0.7894E+02	0.9999E+00	0.2358E+00	0.0000E+00	0.1000E+01
6	0.4805E+02	0.7837E+02	0.9999E+00	0.2332E+00	0.0000E+00	0.1000E+01
7	0.4734E+02	0.7765E+02	0.9999E+00	0.2301E+00	0.0000E+00	0.1000E+01
8	0.4646E+02	0.7673E+02	0.9999E+00	0.2262E+00	0.0000E+00	0.1000E+01
9	0.4538E+02	0.7554E+02	0.9999E+00	0.2214E+00	0.0000E+00	0.1000E+01
10	0.4404E+02	0.7396E+02	0.9999E+00	0.2155E+00	0.0000E+00	0.1000E+01
11	0.4234E+02	0.7182E+02	0.9999E+00	0.2080E+00	0.0000E+00	0.1000E+01
12	0.4041E+02	0.6883E+02	0.9999E+00	0.1997E+00	0.0000E+00	0.1000E+01
13	0.3845E+02	0.6506E+02	0.9998E+00	0.1913E+00	0.0000E+00	0.1000E+01
14	0.3655E+02	0.6086E+02	0.9998E+00	0.1834E+00	0.0000E+00	0.1000E+01
15	0.3472E+02	0.5629E+02	0.9998E+00	0.1757E+00	0.0000E+00	0.1000E+01
16	0.3294E+02	0.5133E+02	0.9997E+00	0.1684E+00	0.0000E+00	0.1000E+01
17	0.3119E+02	0.4590E+02	0.9997E+00	0.1611E+00	0.0000E+00	0.1000E+01
18	0.2942E+02	0.3983E+02	0.9997E+00	0.1539E+00	0.0000E+00	0.1000E+01
19	0.2760E+02	0.3284E+02	0.9996E+00	0.1464E+00	0.0000E+00	0.1000E+01
20	0.2564E+02	0.2447E+02	0.9996E+00	0.1384E+00	0.0000E+00	0.1000E+01

GAMA

NODE	H (BTU/LB)	ENTROPY (BTU/LB-R)	EMU (LBM/FT-SEC)	COND (BTU/FT-S-R)	CP (BTU/LB-R)
2	0.1986E+03	0.9697E+00	0.1209E-04	0.4190E-05	0.2496E+00
3	0.1985E+03	0.9700E+00	0.1208E-04	0.4188E-05	0.2496E+00
4	0.1984E+03	0.9704E+00	0.1208E-04	0.4185E-05	0.2496E+00
5	0.1983E+03	0.9709E+00	0.1207E-04	0.4182E-05	0.2496E+00
6	0.1982E+03	0.9715E+00	0.1206E-04	0.4178E-05	0.2496E+00
7	0.1980E+03	0.9722E+00	0.1205E-04	0.4173E-05	0.2496E+00
8	0.1978E+03	0.9732E+00	0.1203E-04	0.4166E-05	0.2495E+00
9	0.1975E+03	0.9743E+00	0.1201E-04	0.4158E-05	0.2495E+00
10	0.1971E+03	0.9757E+00	0.1199E-04	0.4146E-05	0.2495E+00
11	0.1966E+03	0.9775E+00	0.1195E-04	0.4131E-05	0.2494E+00
12	0.1958E+03	0.9794E+00	0.1190E-04	0.4109E-05	0.2494E+00

BRANCH	KFACTOR (LBF-S ² /(LBM-FT) ²)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
13	0.1949E+03	0.9812E+00	0.1184E-04	0.4082E-05	0.2494E+00	0.1404E+01		
14	0.1939E+03	0.9828E+00	0.1176E-04	0.4051E-05	0.2493E+00	0.1404E+01		
15	0.1927E+03	0.9843E+00	0.1169E-04	0.4017E-05	0.2493E+00	0.1404E+01		
16	0.1915E+03	0.9856E+00	0.1160E-04	0.3981E-05	0.2492E+00	0.1404E+01		
17	0.1902E+03	0.9868E+00	0.1151E-04	0.3941E-05	0.2492E+00	0.1404E+01		
18	0.1887E+03	0.9880E+00	0.1141E-04	0.3896E-05	0.2491E+00	0.1404E+01		
19	0.1869E+03	0.9890E+00	0.1129E-04	0.3844E-05	0.2491E+00	0.1404E+01		
20	0.1849E+03	0.9900E+00	0.1114E-04	0.3781E-05	0.2491E+00	0.1404E+01		
12	0.344E-01	0.193E+00	0.284E+02	0.599E+03	0.599E+07	0.516E+00	0.780E-02	0.327E+04
23	0.413E-01	0.306E+00	0.284E+02	0.601E+03	0.599E+07	0.518E+00	0.938E-02	0.394E+04
34	0.499E-01	0.389E+00	0.284E+02	0.605E+03	0.599E+07	0.521E+00	0.114E-01	0.479E+04
45	0.604E-01	0.478E+00	0.284E+02	0.609E+03	0.600E+07	0.525E+00	0.139E-01	0.584E+04
56	0.729E-01	0.583E+00	0.284E+02	0.614E+03	0.600E+07	0.530E+00	0.170E-01	0.712E+04
67	0.887E-01	0.714E+00	0.284E+02	0.621E+03	0.601E+07	0.536E+00	0.209E-01	0.875E+04
78	0.107E+00	0.874E+00	0.284E+02	0.630E+03	0.601E+07	0.544E+00	0.257E-01	0.107E+05
89	0.131E+00	0.108E+01	0.284E+02	0.640E+03	0.602E+07	0.554E+00	0.320E-01	0.134E+05
910	0.161E+00	0.135E+01	0.284E+02	0.654E+03	0.603E+07	0.566E+00	0.403E-01	0.168E+05
1011	0.199E+00	0.170E+01	0.284E+02	0.672E+03	0.604E+07	0.583E+00	0.512E-01	0.212E+05
1112	0.205E+00	0.194E+01	0.284E+02	0.696E+03	0.606E+07	0.605E+00	0.549E-01	0.227E+05
1213	0.179E+00	0.196E+01	0.284E+02	0.726E+03	0.609E+07	0.632E+00	0.502E-01	0.206E+05
1314	0.155E+00	0.190E+01	0.284E+02	0.757E+03	0.612E+07	0.662E+00	0.457E-01	0.187E+05
1415	0.135E+00	0.183E+01	0.284E+02	0.790E+03	0.616E+07	0.694E+00	0.418E-01	0.169E+05
1516	0.119E+00	0.178E+01	0.284E+02	0.824E+03	0.620E+07	0.727E+00	0.384E-01	0.154E+05
1617	0.102E+00	0.175E+01	0.284E+02	0.860E+03	0.624E+07	0.763E+00	0.351E-01	0.140E+05
1718	0.892E-01	0.176E+01	0.284E+02	0.899E+03	0.629E+07	0.801E+00	0.324E-01	0.127E+05
1819	0.777E-01	0.182E+01	0.284E+02	0.941E+03	0.635E+07	0.844E+00	0.299E-01	0.116E+05
1920	0.679E-01	0.196E+01	0.284E+02	0.989E+03	0.642E+07	0.893E+00	0.279E-01	0.107E+05
2021	0.602E-01	0.224E+01	0.284E+02	0.105E+04	0.650E+07	0.954E+00	0.266E-01	0.100E+05

BRANCHES

**** TOTAL ENTROPY GENERATION = 0.612E+00 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.453E+03 HP *****

TIME OF ANALYSIS WAS 1.562500000000000E-002 SECS

APPENDIX Y—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 19

Subsonic Rayleigh Flow

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```

GFSSP VERSION
604
GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST
Dr. Alok Majumdar
INPUT DATA FILE NAME
D:\GFSSP604\Intel\Examples\Ex19\Ex19.dat
OUTPUT FILE NAME
Ex19.out
TITLE
Subsonic Rayleigh Flow
USERSETUP
F
DENCON          GRAVITY          ENERGY          MIXTURE          THRUST          STEADY          TRANSV          SAVER
F              F              T              F              F              T              F              F
HEX             HCOEF             REACTING         INERTIA          CONDX           ADDPROP         PRINTI         ROTATION
F              F              F              T              F              F              T              F
BUOYANCY       HRATE             INVAL           MSORCE          MOVBN          TPA            VARGEO         TVM
F              F              F              F              F              F              F              F
SHEAR          PRNTIN           PRNTADD         OPVALVE         TRANSQ         CONJUG         RADIAT         WINPLOT
F              T              T              F              F              F              F              F
PRESS          INSUC            VARROT          CYCLIC          CHKVALS        WINFILE        DALTON         NOSTATS
F              F              F              F              F              T              F              F
NORMAL         SIMUL            SECONDL         NRSOLVT        IBD           NOPLT          PRESREG        FLOWREG
F              T              T              F              F              T              0              0
TRANS_MOM     USERVARS         PSMG            ISOLVE          PLOTADD        SIUNITS        TECPILOT       MDGEN
F              F              F              1              F              F              F              F
NUM_USER_VARS IFR_MIX         PRINTD          SATTABL        MSORIN         PRELIVLV      LAMINAR       HSTAG
1              1              F              F              F              F              T              T
NNODES        NINT             NBR             NF              NF              NF              NF              NF
21            19              20              1              1              1              1              1
RELAXK        RELAXD           RELAXH          RELAXH          RELAXH          RELAXH          RELAXH          RELAXH
1              0.5             1              1              1              1              1              1
NFLUID(I), I = 1, NF
4
NODE          INDEX          DESCRIPTION
1              2              " Node 1"
2              1              " Node 2"
3              1              " Node 3"
4              1              " Node 4"
5              1              " Node 5"
6              1              " Node 6"
7              1              " Node 7"
8              1              " Node 8"
9              1              " Node 9"

```


56	1	67
67	1	78
78	1	89
89	1	910
910	1	1011
1011	1	1112
1112	1	1213
1213	1	1314
1314	1	1415
1415	1	1516
1516	1	1617
1617	1	1718
1718	1	1819
1819	1	1920
1920	1	2021
2021	0	
BRANCH		
12		
UPSTRM BR.	ANGLE	
DNSTRM BR.	ANGLE	
23	0.00000	
BRANCH		
23		
UPSTRM BR.	ANGLE	
12	0.00000	
DNSTRM BR.	ANGLE	
34	0.00000	
BRANCH		
34		
UPSTRM BR.	ANGLE	
23	0.00000	
DNSTRM BR.	ANGLE	
45	0.00000	
BRANCH		
45		
UPSTRM BR.	ANGLE	
34	0.00000	
DNSTRM BR.	ANGLE	
56	0.00000	
BRANCH		
56		
UPSTRM BR.	ANGLE	
45	0.00000	
DNSTRM BR.	ANGLE	
67	0.00000	
BRANCH		
67		

UPSTRM BR. ANGLE
56 0.00000
DNSTRM BR. ANGLE
78 0.00000
BRANCH
78
UPSTRM BR. ANGLE
67 0.00000
DNSTRM BR. ANGLE
89 0.00000
BRANCH
89
UPSTRM BR. ANGLE
78 0.00000
DNSTRM BR. ANGLE
910 0.00000
BRANCH
910
UPSTRM BR. ANGLE
89 0.00000
DNSTRM BR. ANGLE
1011 0.00000
BRANCH
1011
UPSTRM BR. ANGLE
910 0.00000
DNSTRM BR. ANGLE
1112 0.00000
BRANCH
1112
UPSTRM BR. ANGLE
1011 0.00000
DNSTRM BR. ANGLE
1213 0.00000
BRANCH
1213
UPSTRM BR. ANGLE
1112 0.00000
DNSTRM BR. ANGLE
1314 0.00000
BRANCH
1314
UPSTRM BR. ANGLE
1213 0.00000
DNSTRM BR. ANGLE
1415 0.00000
BRANCH

1415
UPSTRM BR. ANGLE
1314 0.00000
DNSTRM BR. ANGLE
1516 0.00000
BRANCH
1516
UPSTRM BR. ANGLE
1415 0.00000
DNSTRM BR. ANGLE
1617 0.00000
BRANCH
1617
UPSTRM BR. ANGLE
1516 0.00000
DNSTRM BR. ANGLE
1718 0.00000
BRANCH
1718
UPSTRM BR. ANGLE
1617 0.00000
DNSTRM BR. ANGLE
1819 0.00000
BRANCH
1819
UPSTRM BR. ANGLE
1718 0.00000
DNSTRM BR. ANGLE
1920 0.00000
BRANCH
1920
UPSTRM BR. ANGLE
1819 0.00000
DNSTRM BR. ANGLE
2021 0.00000
BRANCH
2021
UPSTRM BR. ANGLE
1920 0.00000
DNSTRM BR. ANGLE
NUMBER OF BRANCHES WITH INERTIA
20
12
23
34
45
56

67
78
89
910
1011
1112
1213
1314
1415
1516
1617
1718
1819
1920
2021

Example 19 User Subroutines

```

C
C
C ***** GFSSP USER SUBROUTINES *****
C
C *****
C *****
C *****
:
:
:
:
*****
SUBROUTINE KFADJUST (I,RHOU,EMU,EMUL,RHOU,EMUV,ISATU,
& AKNEW)
C PURPOSE: ADJUST RESISTANCE IN A BRANCH
C *****
C INCLUDE 'COMBLK.FOR'
C *****
C ADD CODE HERE
IF(IOPT(I).EQ.1) THEN
PIPEL=BRPR1(I)
PIPED=BRPR2(I)
F=0.00000001
AKNEW=8.*F*PIPEL/(RHOU*GC*PI*PI*PIPED**5)
ENDIF
RETURN
ENDC*****

```

NOTE: All other user subroutines are not used in Example 19

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/28/2012 12:57

TITLE :Subsonic Rayleigh Flow
 ANALYST :Dr. Alok Majumdar
 FILEIN :D:\GFSSP604Intel\Examples\Ex19\Ex19.dat
 FILEOUT :Ex19.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	CONDX	F	CONJUG	F	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	F	HCOEF	F	HEX	F	HRATE	T	IFRMIX	1	INERTIA	T	INSUC	F
INVAL	F	MIXTURE	F	MOVEND	F	MSORCE	F	NORMAL	F	NRSOLVT	F	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRINTI	F	PRNTADD	T	PRNTIN	F	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	F	SHEAR	F	SIMULA	T	SIUNITS	F	STEADY	T	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	F	TRANSV	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F														

NNODES = 21
 NINT = 19
 NBR = 20
 NF = 1
 NVAR = 39
 Nhref = 2

FLUIDS: N2

BOUNDARY NODES

NODE	P (PSI)	T (F)	Z	RHO (LBM/FT^3)	AREA (IN^2)
1	0.5000E+02	0.8000E+02	0.2420E+00	0.0000E+00	
21	0.3500E+02	0.4000E+02	0.1830E+00	0.0000E+00	

SOLUTION INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.5000E+02	0.8862E+02	0.1000E+01	0.2381E+00	0.0000E+00	0.1000E+01
3	0.4975E+02	0.9494E+02	0.1000E+01	0.2342E+00	0.0000E+00	0.1000E+01
4	0.4949E+02	0.1027E+03	0.1000E+01	0.2297E+00	0.0000E+00	0.1000E+01
5	0.4918E+02	0.1119E+03	0.1000E+01	0.2246E+00	0.0000E+00	0.1000E+01
6	0.4881E+02	0.1229E+03	0.1000E+01	0.2187E+00	0.0000E+00	0.1000E+01
7	0.4835E+02	0.1360E+03	0.1001E+01	0.2118E+00	0.0000E+00	0.1000E+01
8	0.4779E+02	0.1516E+03	0.1001E+01	0.2040E+00	0.0000E+00	0.1000E+01
9	0.4710E+02	0.1701E+03	0.1001E+01	0.1951E+00	0.0000E+00	0.1000E+01
10	0.4625E+02	0.1920E+03	0.1001E+01	0.1851E+00	0.0000E+00	0.1000E+01
11	0.4518E+02	0.2150E+03	0.1001E+01	0.1746E+00	0.0000E+00	0.1000E+01
12	0.4392E+02	0.2348E+03	0.1001E+01	0.1649E+00	0.0000E+00	0.1000E+01
13	0.4261E+02	0.2498E+03	0.1001E+01	0.1566E+00	0.0000E+00	0.1000E+01
14	0.4136E+02	0.2614E+03	0.1001E+01	0.1496E+00	0.0000E+00	0.1000E+01
15	0.4021E+02	0.2703E+03	0.1001E+01	0.1436E+00	0.0000E+00	0.1000E+01
16	0.3916E+02	0.2771E+03	0.1001E+01	0.1386E+00	0.0000E+00	0.1000E+01
17	0.3819E+02	0.2821E+03	0.1001E+01	0.1343E+00	0.0000E+00	0.1000E+01
18	0.3731E+02	0.2857E+03	0.1001E+01	0.1305E+00	0.0000E+00	0.1000E+01
19	0.3651E+02	0.2882E+03	0.1001E+01	0.1273E+00	0.0000E+00	0.1000E+01
20	0.3578E+02	0.2922E+03	0.1001E+01	0.1240E+00	0.0000E+00	0.1000E+01

GAMA

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R
2	0.2007E+03	0.9734E+00	0.1223E-04	0.4251E-05	0.2496E+00
3	0.2023E+03	0.9766E+00	0.1233E-04	0.4296E-05	0.2496E+00
4	0.2042E+03	0.9804E+00	0.1246E-04	0.4351E-05	0.2496E+00
5	0.2065E+03	0.9849E+00	0.1261E-04	0.4400E-05	0.2496E+00
6	0.2093E+03	0.9902E+00	0.1279E-04	0.4461E-05	0.2496E+00
7	0.2125E+03	0.9965E+00	0.1300E-04	0.4534E-05	0.2496E+00
8	0.2164E+03	0.1004E+01	0.1325E-04	0.4620E-05	0.2496E+00
9	0.2211E+03	0.1012E+01	0.1355E-04	0.4722E-05	0.2497E+00
10	0.2265E+03	0.1022E+01	0.1390E-04	0.4841E-05	0.2498E+00
11	0.2323E+03	0.1032E+01	0.1419E-04	0.4965E-05	0.2499E+00
12	0.2372E+03	0.1042E+01	0.1448E-04	0.5071E-05	0.2500E+00

BRANCH	KFACTOR (LBF-S ² /(LBM-FT) ²)	DCLP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
13	0.2410E+03	0.1049E+01	0.1470E-04	0.5151E-05	0.2502E+00	0.1400E+01		
14	0.2439E+03	0.1055E+01	0.1486E-04	0.5212E-05	0.2503E+00	0.1399E+01		
15	0.2461E+03	0.1060E+01	0.1499E-04	0.5259E-05	0.2503E+00	0.1399E+01		
16	0.2478E+03	0.1065E+01	0.1509E-04	0.5294E-05	0.2504E+00	0.1399E+01		
17	0.2491E+03	0.1068E+01	0.1516E-04	0.5320E-05	0.2504E+00	0.1398E+01		
18	0.2500E+03	0.1071E+01	0.1521E-04	0.5339E-05	0.2505E+00	0.1398E+01		
19	0.2506E+03	0.1073E+01	0.1525E-04	0.5353E-05	0.2505E+00	0.1398E+01		
20	0.2517E+03	0.1076E+01	0.1531E-04	0.5375E-05	0.2505E+00	0.1398E+01		
12	0.172E-07	0.783E-07	0.256E+02	0.539E+03	0.539E+07	0.464E+00	0.284E-08	0.119E-02
23	0.209E-07	0.250E+00	0.256E+02	0.547E+03	0.533E+07	0.468E+00	0.345E-08	0.147E-02
34	0.255E-07	0.262E+00	0.256E+02	0.557E+03	0.528E+07	0.473E+00	0.423E-08	0.183E-02
45	0.313E-07	0.309E+00	0.256E+02	0.567E+03	0.523E+07	0.479E+00	0.522E-08	0.228E-02
56	0.383E-07	0.374E+00	0.256E+02	0.580E+03	0.517E+07	0.486E+00	0.643E-08	0.286E-02
67	0.473E-07	0.456E+00	0.256E+02	0.596E+03	0.510E+07	0.495E+00	0.800E-08	0.363E-02
78	0.584E-07	0.559E+00	0.256E+02	0.615E+03	0.501E+07	0.505E+00	0.996E-08	0.462E-02
89	0.728E-07	0.688E+00	0.256E+02	0.639E+03	0.492E+07	0.518E+00	0.126E-07	0.598E-02
910	0.916E-07	0.855E+00	0.256E+02	0.668E+03	0.481E+07	0.534E+00	0.161E-07	0.787E-02
1011	0.116E-06	0.107E+01	0.256E+02	0.704E+03	0.469E+07	0.553E+00	0.207E-07	0.105E-01
1112	0.122E-06	0.126E+01	0.256E+02	0.746E+03	0.459E+07	0.576E+00	0.224E-07	0.117E-01
1213	0.108E-06	0.131E+01	0.256E+02	0.790E+03	0.450E+07	0.604E+00	0.204E-07	0.110E-01
1314	0.948E-07	0.125E+01	0.256E+02	0.832E+03	0.443E+07	0.627E+00	0.184E-07	0.101E-01
1415	0.826E-07	0.115E+01	0.256E+02	0.871E+03	0.438E+07	0.651E+00	0.165E-07	0.926E-02
1516	0.720E-07	0.105E+01	0.256E+02	0.907E+03	0.435E+07	0.674E+00	0.148E-07	0.840E-02
1617	0.620E-07	0.963E+00	0.256E+02	0.940E+03	0.432E+07	0.695E+00	0.131E-07	0.750E-02
1718	0.535E-07	0.878E+00	0.256E+02	0.971E+03	0.430E+07	0.716E+00	0.116E-07	0.668E-02
1819	0.458E-07	0.802E+00	0.256E+02	0.998E+03	0.428E+07	0.734E+00	0.101E-07	0.588E-02
1920	0.390E-07	0.731E+00	0.256E+02	0.102E+04	0.427E+07	0.752E+00	0.883E-08	0.514E-02
2021	0.336E-07	0.780E+00	0.256E+02	0.105E+04	0.426E+07	0.770E+00	0.775E-08	0.454E-02

BRANCHES

**** TOTAL ENTROPY GENERATION = 0.233E-06 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.223E-03 HP *****

TIME OF ANALYSIS WAS 3.125000000000000E-002 SECS

APPENDIX Z—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 20

Lithium Loop Model

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```

GFSSP VERSION
604
GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST
Alok Majumdar
INPUT DATA FILE NAME
D:\GFSSP604\Intel\Examples\Ex20\Ex20.dat
OUTPUT FILE NAME
Ex20.out
TITLE
Lithium Loop Model
USERUP
F
DENCON          GRAVITY          ENERGY          MIXTURE          THRUST          STEADY          TRANSV          SAVER
F              F              T              T              F              T              F              F
HEX             HCOEF             REACTING         INERTIA          CONDX            ADDPROP         PRINTI         ROTATION
T              F              F              T              F              F              T              F
BUOYANCY       HRATE             INVAL           MSORCE          MOVBN           TPA            VARGEO         TVM
F              F              F              F              F              F              F              F
SHEAR          PRNTIN           PRNTADD         OPVALVE         TRANSQ          CONJUG         RADIAT        WINPLOT
F              T              T              F              F              F              F              T
PRESS          INSUC            VARROT          CYCLIC          CHKVALS         WINFILE        DALTON         NOSTATS
F              F              F              T              F              T              F              F
NORMAL         SIMUL            SECONDL         NRSOLVT         IBDP            NOPLT          PRESREG        FLOWREG
F              T              F              F              1              T              0              0
TRANS_MOM     USERVARS         PSMG            ISOLVE          PLOTADD         SIUNITS        TECPILOT       MDGEN
F              F              F              1              F              F              F              F
NUM_USER_VARS IFR_MIX         PRINTD          SATTABL         MSORIN          PRELIVLV       LAMINAR       HSTAG
1              1              F              F              F              F              T              T
NNODES        NINT             NBR             NF              NF              NF              NF              NF
28            25              27              2              2              2              2              2
RELAXK        RELAXD           RELAXH          CC              CC              CC              CC              CC
1              0.5             0.01           1e-06           500             1              1              1
NFLUID(I), I = 1, NF
37 4
FLUID 1 PROPERTY FILES
23
AKNAK.DAT
RHONAK.DAT
EMUNAK.DAT
GAMNAK.DAT
HNAK.DAT
SNAK.DAT
CPNAK.DAT
NODE          INDEX          DESCRIPTION

```


1 0
1 0
1 0
1 0
0 1
0 1
0 1
0 1
0 1
0 1

0
0
0
0
0
0
0
0
0
0

0
0
0
5
0
0
0
0
0
0

0
0
0
0
0
0
0
0
0
0

932
932
932
930
477
60
932
932
932
932

7.02
7.02
7.02
7.02
200
14.7
7.02
7.02
7.02
7.02

INODE	BRANCH	UPNODE	NUMBER	NAMEBR	OPTION	DNNODE	DESCRIPTION
2		1	2	12	23	2	" "
3		7	2	67	56	8	" "
4		6	2	78	67	7	" "
5		7	2	78	89	1	" "
7		8	2	89	910	1	" "
8		9	2	910	1011	13	" "
9		10	2	1011	1112	1	" "
10		11	2	1011	1112	1	" "
11		12	2	1112	1213	1	" "
12		13	2	1213	1314	1	" "
13		14	2	1314	1415	1	" "
14		15	2	1415	1516	1	" "
15		16	2	1516	1617	1	" "
16		17	2	1617	1718	1	" "
17		18	2	1718	1819	1	" "
18		19	2	1819	1920	1	" "
19		20	2	1920	2021	1	" "
20		21	2	2021	2122	1	" "
21		22	2	2122	221	1	" "
22		3	2	221	222	1	" "
3		4	2	34	23	2	" "
4		5	2	34	45	2	" "
5		6	2	56	45	2	" "
31		32	2	3031	3132	2	" "
32		33	2	3132	3233	2	" "
33		34	2	3334	3233	2	" "
34			2	3334	3435	2	" "
12		1	2	OPTION		8	" "
78		7	8			7	" "
2122		21	22			1	" "
67		6	7			1	" "
89		8	9			1	" "
910		9	10			13	" "
1011		10	11			1	" "
1516		15	16			13	" "
2021		20	21			1	" "
34		3	4			3	" "

BRANCH	OPTION	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1314	OPTION -3	46.56	2.8	5	3	53.9096844
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA
1415	OPTION -1	27	0.81	7.4074074074e-05	0	0.51529929975
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA
1617	OPTION -2	30.25	0.81	7.4074074074e-05	0	0.51529929975
BRANCH	OPTION -2	FLOW COEFF	AREA			
1718	OPTION -13	0	0.5944			
BRANCH	OPTION -13	DIA	K1	K2	AREA	
1920	OPTION -1	1	800	0.2	0.7854	
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA
3334	OPTION -22	5	5.292	1.8896447468e-06	0	21.995264332
BRANCH	OPTION -22	AREA	FLOW COEF			
3435	OPTION -1	0.13	1			
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA
3031	OPTION -1	13	3.26	6.1349693252e-06	0	8.346890471
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA
3132	OPTION -1	5	5.292	1.8896447468e-06	0	21.995264332
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA
3233	OPTION -1	0.17	0.1875	0.00170666666667	0	0.027611630859
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA
221	OPTION -1	9	0.81	7.4074074074e-05	0	0.51529929975
BRANCH	OPTION -1	LENGTH	DIA	EPSP	ANGLE	AREA
1819	OPTION -1	37	0.81	0	0	0.51529929975
BRANCH	NOUBR	NMUBR				
12	1	221				
78	1	67				
2122	1	2021				
67	1	56				
89	1	78				
910	1	89				
1011	1	910				
1516	1	1415				
2021	1	1920				
34	1	23				
56	1	45				
23	1	12				
45	1	34				
1112	1	1011				
1213	1	1112				
1314	1	1213				
1415	1	1314				
1617	1	1516				
1718	1	1617				
1920	1	1819				
3334	1	3233				
3435	1	3334				

				NMDBR
3031	0			
3132	1	3031		
3233	1	3132		
221	1	2122		
1819	1	1718		
BRANCH		NODBR		
12	1	23		
78	1	89		
2122	1	221		
67	1	78		
89	1	910		
910	1	1011		
1011	1	1112		
1516	1	1617		
2021	1	2122		
34	1	45		
56	1	67		
23	1	34		
45	1	56		
1112	1	1213		
1213	1	1314		
1314	1	1415		
1415	1	1516		
1617	1	1718		
1718	1	1819		
1920	1	2021		
3334	1	3435		
3435	0			
3031	1	3132		
3132	1	3233		
3233	1	3334		
221	1	12		
1819	1	1920		
BRANCH				
12				
UPSTRM BR.		ANGLE		
221		0.00000		
DNSTRM BR.		ANGLE		
23		0.00000		
BRANCH				
78				
UPSTRM BR.		ANGLE		
67		0.00000		
DNSTRM BR.		ANGLE		
89		0.00000		
BRANCH				
2122				

UPSTRM BR. ANGLE
 2021 0.00000
 DNSTRM BR. ANGLE
 221 0.00000
 BRANCH
 67
 UPSTRM BR. ANGLE
 56 0.00000
 DNSTRM BR. ANGLE
 78 0.00000
 BRANCH
 89
 UPSTRM BR. ANGLE
 78 0.00000
 DNSTRM BR. ANGLE
 910 0.00000
 BRANCH
 910
 UPSTRM BR. ANGLE
 89 0.00000
 DNSTRM BR. ANGLE
 1011 0.00000
 BRANCH
 1011
 UPSTRM BR. ANGLE
 910 0.00000
 DNSTRM BR. ANGLE
 1112 0.00000
 BRANCH
 1516
 UPSTRM BR. ANGLE
 1415 0.00000
 DNSTRM BR. ANGLE
 1617 0.00000
 BRANCH
 2021
 UPSTRM BR. ANGLE
 1920 0.00000
 DNSTRM BR. ANGLE
 2122 0.00000
 BRANCH
 34
 UPSTRM BR. ANGLE
 23 0.00000
 DNSTRM BR. ANGLE
 45 0.00000
 BRANCH

56 UPSTRM BR. ANGLE
45 0.00000
DNSTRM BR. ANGLE
67 0.00000
BRANCH
23
UPSTRM BR. ANGLE
12 0.00000
DNSTRM BR. ANGLE
34 0.00000
BRANCH
45
UPSTRM BR. ANGLE
34 0.00000
DNSTRM BR. ANGLE
56 0.00000
BRANCH
1112
UPSTRM BR. ANGLE
1011 0.00000
DNSTRM BR. ANGLE
1213 0.00000
BRANCH
1213
UPSTRM BR. ANGLE
1112 0.00000
DNSTRM BR. ANGLE
1314 0.00000
BRANCH
1314
UPSTRM BR. ANGLE
1213 0.00000
DNSTRM BR. ANGLE
1415 0.00000
BRANCH
1415
UPSTRM BR. ANGLE
1314 0.00000
DNSTRM BR. ANGLE
1516 0.00000
BRANCH
1617
UPSTRM BR. ANGLE
1516 0.00000
DNSTRM BR. ANGLE
1718 0.00000

BRANCH
 1718
 UPSTRM BR. ANGLE
 1617 0.00000
 DNSTRM BR. ANGLE
 1819 0.00000
 BRANCH
 1920
 UPSTRM BR. ANGLE
 1819 0.00000
 DNSTRM BR. ANGLE
 2021 0.00000
 BRANCH
 3334
 UPSTRM BR. ANGLE
 3233 0.00000
 DNSTRM BR. ANGLE
 3435 0.00000
 BRANCH
 3435
 UPSTRM BR. ANGLE
 3334 0.00000
 DNSTRM BR. ANGLE
 BRANCH
 3031
 UPSTRM BR. ANGLE
 DNSTRM BR. ANGLE
 3132 0.00000
 BRANCH
 3132
 UPSTRM BR. ANGLE
 3031 0.00000
 DNSTRM BR. ANGLE
 3233 0.00000
 BRANCH
 3233
 UPSTRM BR. ANGLE
 3132 0.00000
 DNSTRM BR. ANGLE
 3334 0.00000
 BRANCH
 221
 UPSTRM BR. ANGLE
 2122 0.00000
 DNSTRM BR. ANGLE
 12 0.00000
 BRANCH

```

1819
UPSTRM BR.      ANGLE
1718      0.00000
DNSTRM BR.      ANGLE
1920      0.00000
NUMBER OF BRANCHES WITH INERTIA
0
NUMBER OF HEAT EXCHANGERS
1
IBRHOT  IBRCOLD  ITYPHX  ARHOT  ARCOL  UA  HEXEFF
1314  3233  1  0  0  0  0.9
CYCLIC BNDARY NODE  UPSTREAM NODE
1      22

```

Example 20 User Subroutines

```

C
C ***** GFSSP USER SUBROUTINES *****
C
C *****
C *****
C *****
:
:
:
:
*****
SUBROUTINE SORCEF(I,TERM0,TERM1,TERM2,TERM3,TERM4,TERM5,TERM6,
& TERM7,TERM8,TERM9,TERM10,TERM100)
C PURPOSE: ADD MOMENTUM SOURCES (LBF)
C I - GFSSP INDEX NUMBER FOR BRANCH
C TERM0 - UNSTEADY TERM IN MOMENTUM CONSERVATION EQUATION
C TERM1 - LONGITUDINAL INERTIA
C TERM2 - PRESSURE GRADIENT
C TERM3 - GRAVITY FORCE
C TERM4 - FRICTION FORCE
C TERM5 - CENTRIFUGAL FORCE
C TERM6 - EXTERNAL MOMENTUM SOURCE DUE TO PUMP
C TERM7 - MOMENTUM SOURCE DUE TO TRANSVERSE FLOW (MULTI-DIMENSIONAL MODEL)
C TERM8 - MOMENTUM SOURCE DUE TO SHEAR (MULTI-DIMENSIONAL MODEL)
C TERM9 - VARIABLE GEOMETRY UNSTEADY TERM
C TERM10 - NORMAL STRESS
C TERM100 - USER SUPPLIED MOMENTUM SOURCE
C *****
INCLUDE 'COMBLK.FOR'
C *****
C ADD CODE HERE
C MODELING OF THERMO-ELECTRIC PUMP
C DIMENSION VOLT(50),FLWTE(50),DPTTE(50,50)
C LOGICAL UNREAD
C DATA VOLTIN/170/
C READ PUMP CHARACTERISTIC DATA FROM FILE
C IF (ITER.EQ.1.AND. (.NOT. UNREAD)) THEN
C OPEN (NUSRJ,FILE='Ex20_pump.dat',STATUS='UNKNOWN')
C READ(NUSR1,*) NFWL,NVOLT
C READ(NUSR1,*) (VOLT(JJ),JJ=1,NVOLT)
C DO II = 1,NFWL
C READ(NUSRJ,*) FLWTE(II), (DPTTE(II,JJ),JJ=1,NVOLT)
C ENDDO
C UNREAD = .TRUE.
C ENDIF ! IF (ITER.EQ.0)..

```

```

C      IF (IBRANCH(I).EQ.1718) THEN
C      BRACKET THE FLOWRATE
      IR=0
      DO II =2,NFLW
      IF (FLOWR(I).GE.FLWTE(II-1).AND.FLOWR(I).LE.FLWTE(II)) THEN
      IR=II
      GO TO 100
      ENDIF
      ENDDO
100    IF (IR.EQ.0) THEN
      IF (FLOWR(I).GT.FLWTE(NFLW)) IR=NFLW
      IF (FLOWR(I).LT.FLWTE(1)) IR=2
      ENDIF
C      BRACKET THE VOLT
      JR=0
      DO JJ = 2,NVOLT
      IF (VOLTIN.GE.VOLT(JJ-1).AND.VOLTIN.LE.VOLT(JJ)) THEN
      JR=JJ
      GO TO 200
      ENDIF
      ENDDO
200    IF (JR.EQ.0) THEN
      IF (VOLTIN.GT.VOLT(NVOLT)) JR=NVOLT
      IF (VOLTIN.LT.VOLT(1)) JR=2
      ENDIF
C      CALCULATE DELPTE
      FACTFLW=(FLOWR(I)-FLWTE(IR-1))/(FLWTE(IR)-FLWTE(IR-1))
      FACTV=(VOLTIN-VOLT(JR-1))/(VOLT(JR)-VOLT(JR-1))
      DELPTE=(1.-FACTFLW)*(1.-FACTV)*DPTE(IR-1,JR-1)
      & +FACTFLW*(1.-FACTV)*DPTE(IR,JR-1)
      & +FACTFLW*FACTV*DPTE(IR,JR)
      & + (1.-FACTFLW)*FACTV*DPTE(IR-1,JR)
      TERM100=144*DELPTE*AREA(I)
      ENDIF ! IF (IBRANCH(I).EQ....)

      RETURN
      END
C*****
C      SUBROUTINE SOURCEQ(IPN,TERMD)
C      PURPOSE: ADD HEAT SOURCES
C      IPN - GFSSP INDEX NUMBER FOR NODE
C      TERMD - COMPONENT OF LINEARIZED SOURCE TERM APPEARING IN THE
C              DENOMINATOR OF THE ENTHALPY OR ENTROPY EQUATION

```

```

C*****
C      INCLUDE 'COMBLK.FOR'
C*****
C*****
C      ADD CODE HERE
C      DATA TCINLET/1512.6/
C      IF (NODE(IPN).EQ.19) THEN
C          SORCEH(IPN)=1.E20*TCINLET
C          TERMD=1.E20
C      ENDIF
C      RETURN
C      END
C*****

```

NOTE: All other user subroutines are not used in Example 20

 G F S S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

RUN DATE:03/27/2012 08:54

TITLE :Lithium Loop Model
 ANALYST :Alok Majumdar
 FILEIN :D:\GFSSP604Intel\Examples\Ex20\Ex20.dat
 FILEOUT :Ex20.out

OPTION VARIABLES

ADDFLOW	F	BUOYANCY	F	CONDX	F	CONJUG	F	CYCLIC	T	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	F	HCOEF	F	HEX	T	HRATE	T	IFRMIX	T	INERTIA	T	INSUC	F
INVAL	F	MIXTURE	F	MOVEND	F	MSORCE	T	NORMAL	T	NRSOLVT	T	OPVALVE	T	PLOTADD	F
PRESREG	F	PRESS	T	PRINTI	F	PRNTADD	F	PRNTIN	F	RADIATION	F	REACTING	F	ROTATION	F
SAVER	0	SECONDL	F	SHEAR	T	SIMULA	T	SIUNITS	T	STEADY	F	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	F	TRANSV	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F														

NNODES = 28
 NNINT = 25
 NBR = 27
 NF = 2
 NVAR = 52
 Nhref = 2

FLUIDS: FLD1 N2

BOUNDARY NODES

NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)	CONCENTRATIONS	
					FLD1	N2
1	0.7000E+01	0.9320E+03	0.4716E+02	0.0000E+00	0.1000E+01	0.0000E+00
30	0.2000E+03	0.4770E+03	0.5541E+00	0.0000E+00	0.0000E+00	0.1000E+01
35	0.1470E+02	0.6000E+02	0.7386E-01	0.0000E+00	0.0000E+00	0.1000E+01

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)
2	0.0000E+00	0.0000E+00	0.0000E+00
6	0.0000E+00	0.0000E+00	0.0000E+00
7	0.0000E+00	0.0000E+00	0.0000E+00
8	0.0000E+00	0.0000E+00	0.0000E+00
9	0.0000E+00	0.0000E+00	0.0000E+00
10	0.0000E+00	0.0000E+00	0.0000E+00
11	0.0000E+00	0.0000E+00	0.0000E+00
12	0.0000E+00	0.0000E+00	0.0000E+00
13	0.0000E+00	0.0000E+00	0.0000E+00
14	0.0000E+00	0.0000E+00	0.0000E+00
15	0.0000E+00	0.0000E+00	0.0000E+00
16	0.0000E+00	0.0000E+00	0.0000E+00
17	0.0000E+00	0.0000E+00	0.0000E+00
18	0.0000E+00	0.0000E+00	0.0000E+00
19	0.0000E+00	0.0000E+00	0.0000E+00
20	0.0000E+00	0.0000E+00	0.0000E+00
21	0.0000E+00	0.0000E+00	0.0000E+00
22	0.0000E+00	0.0000E+00	0.0000E+00
3	0.0000E+00	0.0000E+00	0.0000E+00
4	0.0000E+00	0.0000E+00	0.0000E+00
5	0.0000E+00	0.0000E+00	0.5000E+01
31	0.0000E+00	0.0000E+00	0.0000E+00
32	0.0000E+00	0.0000E+00	0.0000E+00
33	0.0000E+00	0.0000E+00	0.0000E+00
34	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH

UPNODE	DNNODE	OPTION
12	1	2
12	2	8
78	7	8
78	8	7
2122	21	22
2122	22	21
67	6	7
67	7	6
89	8	9
89	9	8
910	9	10
910	10	9
1011	10	11
1011	11	10


```

1112 BRANCH OPTION -1: 0.870E+00 0.800E+03 0.200E+00 0.594E+00
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1213 0.200E+01 0.810E+00 0.741E-04 0.000E+00 0.515E+00
BR OPT -> 3-3 LENGTH INNER RAD OUTER RAD TYPE AREA
1314 0.466E+02 0.280E+01 0.500E+01 0.300E+01 0.539E+02
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1415 0.270E+02 0.810E+00 0.741E-04 0.000E+00 0.515E+00
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1617 0.302E+02 0.810E+00 0.741E-04 0.000E+00 0.515E+00
BRANCH OPTION -2: FLOW COEF AREA
1718 0.000E+00 0.594E+00
BRANCH OPTION -13: DIA K1 K2 AREA
1920 0.100E+01 0.800E+03 0.200E+00 0.785E+00
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
3334 0.500E+01 0.529E+01 0.189E-05 0.000E+00 0.220E+02
BRANCH OPTION -22 FLOW COEF AREA
3435 0.100E+01 0.130E+00
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
3031 0.130E+02 0.326E+01 0.613E-05 0.000E+00 0.835E+01
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
3132 0.500E+01 0.529E+01 0.189E-05 0.000E+00 0.220E+02
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
3233 0.170E+00 0.188E+00 0.171E-02 0.000E+00 0.276E-01
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
221 0.900E+01 0.810E+00 0.741E-04 0.000E+00 0.515E+00
BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
1819 0.370E+02 0.810E+00 0.000E+00 0.000E+00 0.515E+00

```

INITIAL GUESS FOR INTERNAL NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	CONCENTRATIONS
2	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	FLD1 N2 0.1000E+01 0.0000E+00
6	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
7	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
8	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
9	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
10	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
11	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
12	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
13	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
14	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
15	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
16	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
17	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00
18	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01 0.0000E+00

19	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01	0.0000E+00
20	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01	0.0000E+00
21	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01	0.0000E+00
22	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01	0.0000E+00
3	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01	0.0000E+00
4	0.7020E+01	0.9320E+03	0.2293E-03	0.4716E+02	0.1000E+01	0.0000E+00
5	0.7020E+01	0.9300E+03	0.2296E-03	0.4717E+02	0.1000E+01	0.0000E+00
31	0.7020E+01	0.9320E+03	0.1000E+01	0.1317E-01	0.0000E+00	0.1000E+01
32	0.7020E+01	0.9320E+03	0.1000E+01	0.1317E-01	0.0000E+00	0.1000E+01
33	0.7020E+01	0.9320E+03	0.1000E+01	0.1317E-01	0.0000E+00	0.1000E+01
34	0.7020E+01	0.9320E+03	0.1000E+01	0.1317E-01	0.0000E+00	0.1000E+01

TRIAL SOLUTION

BRANCH	DELP (PSI)	FLOWRATE (LBM/SEC)
12	0.0000	0.0100
78	0.0000	0.0100
2122	0.0000	0.0100
67	0.0000	0.0100
89	0.0000	0.0100
910	0.0000	0.0100
1011	0.0000	0.0100
1516	0.0000	0.0100
2021	0.0000	0.0100
34	0.0000	0.0100
56	0.0000	0.0100
23	0.0000	0.0100
45	0.0000	0.0100
1112	0.0000	0.0100
1213	0.0000	0.0100
1314	0.0000	0.0100
1415	0.0000	0.0100
1617	0.0000	0.0100
1718	0.0000	0.0100
1920	0.0000	0.0100
3334	0.0000	0.0100
3435	0.0000	0.0100
3031	0.0000	0.0100
3132	0.0000	0.0100
3233	0.0000	0.0100
221	0.0000	0.0100
1819	0.0000	0.0100

SOLUTION INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	CONC
------------------------	---------	--------	---	----------------	----------	------

NODE	H		ENTROPY		EMU		COND		CP		GAMA	
	BTU/LB		BTU/LB-R		LBM/FT-SEC		BTU/FT-S-R		BTU/LB-R			
2	0.5707E+01	0.9320E+03	0.1864E-03	0.4716E+02	0.0000E+00	0.4716E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
6	0.5701E+01	0.9398E+03	0.1854E-03	0.4709E+02	0.0000E+00	0.4709E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
7	0.5701E+01	0.9398E+03	0.1854E-03	0.4709E+02	0.0000E+00	0.4709E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
8	0.5045E+01	0.9398E+03	0.1641E-03	0.4709E+02	0.0000E+00	0.4709E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
9	0.4994E+01	0.9398E+03	0.1624E-03	0.4709E+02	0.0000E+00	0.4709E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
10	0.4521E+01	0.9398E+03	0.1470E-03	0.4709E+02	0.0000E+00	0.4709E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
11	0.4057E+01	0.9398E+03	0.1320E-03	0.4709E+02	0.0000E+00	0.4709E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
12	0.3584E+01	0.9398E+03	0.1166E-03	0.4709E+02	0.0000E+00	0.4709E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
13	0.3533E+01	0.9398E+03	0.1149E-03	0.4709E+02	0.0000E+00	0.4709E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
14	0.3533E+01	0.8829E+03	0.1186E-03	0.4756E+02	0.0000E+00	0.4756E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
15	0.2838E+01	0.8829E+03	0.9527E-04	0.4756E+02	0.0000E+00	0.4756E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
16	0.2369E+01	0.8829E+03	0.7954E-04	0.4756E+02	0.0000E+00	0.4756E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
17	0.1591E+01	0.8829E+03	0.5341E-04	0.4756E+02	0.0000E+00	0.4756E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
18	0.8918E+01	0.8829E+03	0.2994E-03	0.4756E+02	0.0000E+00	0.4756E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
19	0.8025E+01	0.9320E+03	0.2621E-03	0.4716E+02	0.0000E+00	0.4716E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
20	0.7773E+01	0.9320E+03	0.2539E-03	0.4716E+02	0.0000E+00	0.4716E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
21	0.7541E+01	0.9320E+03	0.2463E-03	0.4716E+02	0.0000E+00	0.4716E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
22	0.7232E+01	0.9320E+03	0.2362E-03	0.4716E+02	0.0000E+00	0.4716E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
3	0.5707E+01	0.9320E+03	0.1864E-03	0.4716E+02	0.0000E+00	0.4716E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
4	0.5702E+01	0.9320E+03	0.1862E-03	0.4716E+02	0.0000E+00	0.4716E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
5	0.5702E+01	0.9398E+03	0.1855E-03	0.4709E+02	0.0000E+00	0.4709E+02	0.0000E+00	0.1000E+01	0.0000	0.0000E+00	0.1000E+01	0.0000
31	0.2000E+03	0.4770E+03	0.1006E+01	0.5542E+00	0.0000E+00	0.5542E+00	0.0000E+00	0.0000E+00	1.0000	0.0000E+00	0.0000E+00	1.0000
32	0.2000E+03	0.4770E+03	0.1006E+01	0.5542E+00	0.0000E+00	0.5542E+00	0.0000E+00	0.0000E+00	1.0000	0.0000E+00	0.0000E+00	1.0000
33	0.1868E+03	0.8443E+03	0.1006E+01	0.3720E+00	0.0000E+00	0.3720E+00	0.0000E+00	0.0000E+00	1.0000	0.0000E+00	0.0000E+00	1.0000
34	0.1868E+03	0.8443E+03	0.1006E+01	0.3720E+00	0.0000E+00	0.3720E+00	0.0000E+00	0.0000E+00	1.0000	0.0000E+00	0.0000E+00	1.0000

BRANCH	KFACTOR (LBF-F ² /(LBM-FT) ²)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
22	0.0000E+00	0.0000E+00	0.1197E-03	0.2588E+00	0.2088E+00	0.1000E+01	0.113E+02	0.113E+02
3	0.0000E+00	0.0000E+00	0.1197E-03	0.2588E+00	0.2088E+00	0.1000E+01	0.572E+01	0.572E+01
4	0.0000E+00	0.0000E+00	0.1197E-03	0.2588E+00	0.2088E+00	0.1000E+01	0.270E+01	0.270E+01
5	0.0000E+00	0.0000E+00	0.1184E-03	0.2609E+00	0.2089E+00	0.1000E+01	0.211E-04	0.211E-04
31	0.0000E+00	0.1009E+01	0.1784E-04	0.6307E-05	0.2546E+00	0.1396E+01	0.450E+00	0.450E+00
32	0.0000E+00	0.1009E+01	0.1784E-04	0.6307E-05	0.2546E+00	0.1396E+01	0.413E+01	0.413E+01
33	0.0000E+00	0.1099E+01	0.2226E-04	0.8027E-05	0.2642E+00	0.1371E+01	0.405E+01	0.405E+01
34	0.0000E+00	0.1099E+01	0.2226E-04	0.8027E-05	0.2642E+00	0.1371E+01	0.202E+01	0.202E+01
							0.413E-01	0.413E-01
							0.379E-05	0.379E-05
							0.372E-05	0.372E-05
							0.388E-05	0.388E-05
							0.405E+01	0.405E+01
							0.405E+01	0.405E+01
							0.187E-05	0.187E-05
							0.382E-07	0.382E-07
							0.621E-08	0.621E-08
							0.914E-04	0.914E-04
							0.876E-05	0.876E-05
							0.413E+01	0.413E+01
							0.379E-05	0.379E-05
							0.450E+00	0.450E+00
							0.337E-03	0.337E-03
							0.600E+01	0.600E+01
							0.673E+01	0.673E+01
							0.000E+00	0.000E+00
							0.220E+01	0.220E+01
							0.411E-02	0.411E-02
							0.582E+04	0.582E+04
							0.466E-01	0.466E-01
							0.176E-02	0.176E-02
							0.119E+04	0.119E+04
							0.202E+01	0.202E+01
							0.772E+01	0.772E+01
							0.772E+01	0.772E+01
							0.739E-05	0.739E-05

BRANCHES

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-05 IN 36 ITERATIONS

ITERADJC = 3 DIFTEM = 0.000E+00
TAU = 100000000.000000 ISTEP = 1 DTAU = 100000000.000000

TIME OF ANALYSIS WAS 6.250000000000000E-002 SECS

APPENDIX AA—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 21

Expanded LOX-Simplex Model: 25,000 RPM, w/ All Branches & Nodes (& Axial Thrust)

<u>Contents</u>	<u>Page</u>
Example 21 Input File	278
Example 21 Output File	284

```

GFSSP VERSION
604
GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST
Paul Schallhorn (updated to GFSSP v6 by Andre LeClair)
INPUT DATA FILE NAME
D:\GFSSP604Compag\Examples\EX21\Ex21.dat
OUTPUT FILE NAME
Ex21.out
TITLE
Expanded IOx-Simplex Model: 25,000 RPM, w/ All Branches & Nodes (& Axial Thrust)
USEDUP
F
DENCON          GRAVITY          ENERGY          MIXTURE          THRUST          STEADY          TRANSV          SAVER
F               F               T               F               T               T               F               F
HEX             HCOEF             REACTING         INERTIA          CONDX           ADPPROP         PRINTI         ROTATION
F               F               F               F               F               F               F               T
BOUYANCY       HRATE            INVAL           MSORCE          MOVBNB         TPA             VARGEO         TVM
F               F               F               F               F               F               F               F
SHEAR          PRNTIN          PRNTADD         OPVALVE         TRANSQ         CONJUG          RADIAT         WINPLOT
F               T               T               F               F               F               F               F
PRESS          INSUC           VARROT          CYCLIC          CHKVALS        WINFILE         DALTON         NOSTATS
F               F               F               F               F               F               F               F
NORMAL         SIMUL           SECONDL        NRSOLVT         IBDF           NOPLT           PRESREG        FLOWREG
F               T               F               T               F               T               0               0
TRANS_MOM     USERVERS        PSMG           ISOLVE          PLOTADD        SIUNITS         TECPLOT        MDGEN
F               F               F               1               F               F               F               F
NUM_USER_VARS IFR_MIX        PRINTD         SATTABL         MSORIN         PRELVLV        LAMINAR        HSTAG
1               1               F               F               F               F               T               T
NNODES        NINT            NBR            NF              NITER          RELAXNR         RELAXHC        RELAXTS
35            27             36             1              500            0.5             1              1
RELAXK        RELAXD         RELAXH         CC              0.0001         500            0.5             1
0.5           0.25          0.5           0.5            0.0001         500            0.5             1
NFLUID(I), I = 1, NF
6
NODE          INDEX          DESCRIPTION
100           2             " Impeller Discharge"
101           1             " Node 101"
102           2             " Node 102"
103           1             " Node 103"
104           1             " Node 104"
105           2             " Impeller Inlet"
106           1             " Node 106"
107           2             " Node 107"
108           1             " Node 108"
109           1             " Node 109"

```


208	BRANCH	OPTION -2	1.8125	0.01	0.03	1	0.11388	
209	BRANCH	OPTION -2	0	AREA				
210	BRANCH	OPTION -9	0.057	OUTER RAD	INNER RAD	RPM	AREA	
211	BRANCH	OPTION -2	6.0625	1.4375	1.0625	25000	2.9452	
212	BRANCH	OPTION -11	0.057	AREA				
214	BRANCH	OPTION -11	1.2188	CLEARANCE	PITCH	No. OF TEETH	MULTIPLIER	Area
215	BRANCH	OPTION -3	1.25	CLEARANCE	PITCH	5	0.85	0.038288
216	BRANCH	OPTION -2	1.8125	HEIGHT	WIDTH	TYPE	AREA	0.03927
270	BRANCH	OPTION -22	1	AREA	FLOW COEF			
280	BRANCH	OPTION -21	0.38656	DIAMETER	ABS ROUGHNESS	NUMBER TUBES		
281	BRANCH	OPTION -21	1.25	DIAMETER	ABS ROUGHNESS	22		
282	BRANCH	OPTION -4	3.91	DIAMETER	ABS ROUGHNESS	22		
221	BRANCH	OPTION -4	1.4	DIA	ESPD	KI	KE	ANGLE
222	BRANCH	OPTION -1	1.4	DIA	ESPD	0.5	0	0.049087
223	BRANCH	OPTION -1	3.5625	DIA	ESPD	0.5	0	0.049087
224	BRANCH	OPTION -4	3.5625	DIA	ESPD	0	0	0.076698974609
2301	BRANCH	OPTION -4	120	DIA	ESPD	KI	KE	ANGLE
2302	BRANCH	OPTION -21	120	DIA	ESPD	0	1	0.11045
2131	BRANCH	OPTION -21	0.25	DIAMETER	ABS ROUGHNESS	NUMBER TUBES		
2132	BRANCH	OPTION -4	7.825	DIAMETER	ABS ROUGHNESS	8		
231	BRANCH	OPTION -4	1.5	DIA	ESPD	KI	KE	ANGLE
232	BRANCH	OPTION -1	1.5	DIA	ESPD	0.5	0	0.049087
233	BRANCH	OPTION -1	3.625	DIA	ESPD	0	0	0.04908734375
234	BRANCH	OPTION -1	3.625	DIA	ESPD	0	0	0.04908734375

BRANCH	OPTION	LENGTH	DIA	EPSD	ANGLE	AREA
235	-1	0.3	0.45962	0		0.16591564945
BRANCH	OPTION	LENGTH	DIA	EPSD	ANGLE	AREA
236	-1	0.3	0.45962	0		0.16591564945
BRANCH	OPTION	LENGTH	DIA	EPSD	ANGLE	AREA
2381	-1	24.5	0.6	0		0.2827431
BRANCH	OPTION	LENGTH	DIA	EPSD	ANGLE	AREA
2382	-1	24.5	0.6	0		0.2827431
BRANCH	OPTION	LENGTH	DIA	EPSD	ANGLE	AREA
2401	-21	0.375	0.375	0		0.2827431

NUMBER OF ROTATING BRANCHES 8

BRANCH	UPST RAD	DNST RAD	RPM	K ROT
202	2.25	1.688	25000	0.3038
205	1.688	1.5	25000	0.1235
207	2.25	1.813	25000	0.184
209	1.813	1.063	25000	0.1122

 G F S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/14/2012 08:31

TITLE :Expanded Lox-Simplex Model: 25,000 RPM, w/ All Branches & Nodes (& Axial Thrust
 ANALYST :Paul Schallhorn (updated to GFSSP v6 by Andre LeClair)
 FILEIN :D:\GFSSP604Compacq\Examples\EX21\Ex21.dat
 FILEOUT :Ex21.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	CONDX	F	CONJUG	F	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	F	HCOEF	F	HEX	F	HRATE	F	IFRMIX	1	INERTIA	F	INSUC	F
INVAL	F	MIXTURE	F	MOVEND	F	MSORCE	F	NORMAL	F	NRSOLVT	T	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRINTI	F	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	T
SAVER	F	SECONDL	F	SHEAR	F	SIMULA	T	SIUNITS	F	STEADY	T	THRUST	T	TPA	F
TRANS_MOM	F	TRANSQ	F	TRANSV	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F														

NNODES = 35
 NINT = 27
 NBR = 36
 NF = 1
 NVAR = 63
 Nhref = 2

FLUIDS: 02

BOUNDARY NODES	P	T	RHO	AREA
NODE	(PSI)	(F)	(LBM/FT^3)	(IN^2)
100	0.1100E+04	-0.2866E+03	0.7047E+02	0.0000E+00
102	0.1025E+04	-0.2866E+03	0.7040E+02	-0.3479E+01
105	0.3462E+03	-0.2866E+03	0.6968E+02	-0.9388E+00
107	0.1078E+04	-0.2866E+03	0.7045E+02	0.2792E+01
116	0.6260E+02	-0.2656E+03	0.1058E+01	-0.2848E+02
180	0.1470E+02	-0.2860E+03	0.2596E+00	0.4566E+02
130	0.1470E+02	-0.2866E+03	0.2606E+00	0.0000E+00
140	0.9370E+02	-0.2866E+03	0.6940E+02	-0.8442E+01

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA	MASS	HEAT
	(IN^2)	(LBM/S)	(BTU/LBM)
101	-0.3479E+01	0.0000E+00	0.0000E+00
103	0.0000E+00	0.0000E+00	0.0000E+00
104	-0.9388E+00	0.0000E+00	0.0000E+00
106	0.2792E+01	0.0000E+00	0.0000E+00
108	0.3387E+01	0.0000E+00	0.0000E+00
109	0.3387E+01	0.0000E+00	0.5300E+01
110	0.0000E+00	0.0000E+00	0.9320E+00
111	0.0000E+00	0.0000E+00	0.0000E+00
112	-0.8837E+00	0.0000E+00	0.9320E+00
114	0.0000E+00	0.0000E+00	0.0000E+00
115	-0.1228E+02	0.0000E+00	0.0000E+00
170	0.0000E+00	0.0000E+00	0.0000E+00
1181	0.0000E+00	0.0000E+00	0.0000E+00
118	0.0000E+00	0.0000E+00	0.0000E+00
121	0.0000E+00	0.0000E+00	0.0000E+00
122	0.0000E+00	0.0000E+00	0.0000E+00
123	0.0000E+00	0.0000E+00	0.0000E+00
124	0.0000E+00	0.0000E+00	0.0000E+00
1131	0.0000E+00	0.0000E+00	0.0000E+00
113	0.0000E+00	0.0000E+00	0.0000E+00
131	0.0000E+00	0.0000E+00	0.0000E+00
132	0.0000E+00	0.0000E+00	0.0000E+00
133	0.0000E+00	0.0000E+00	0.0000E+00
134	0.0000E+00	0.0000E+00	0.0000E+00
135	0.0000E+00	0.0000E+00	0.0000E+00
136	0.0000E+00	0.0000E+00	0.0000E+00
138	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH	UPNODE	DNNODE	OPTION
201	100	101	9
202	101	102	3

207	0.438E+00	0.625E-01	0.128E+02	0.100E+01	0.798E+00	
BRANCH OPTION -11:	IN RAD	PIPE DIA	ORIFICE DIA	ORIFICE DIA AREA		
208	0.181E+01	0.100E-01	0.300E-01	0.400E+01	0.114E+00	
BRANCH OPTION -2:	FLOW COEF	AREA				
209	0.000E+00	0.282E+01				
BRANCH OPTION -2:	FLOW COEF	AREA				
210	0.570E-01	0.144E+01				
BRANCH OPTION -9:	LENGTH,	OUTER RAD,	INNER RAD,	RPM,	AREA	
211	0.606E+01	0.144E+01	0.106E+01	0.250E+05	0.295E+01	
BRANCH OPTION -2:	FLOW COEF	AREA				
212	0.570E-01	0.144E+01				
BRANCH OPTION -11:	IN RAD	PIPE DIA	ORIFICE DIA	ORIFICE DIA AREA		
214	0.122E+01	0.500E-02	0.300E-01	0.500E+01	0.850E+00	0.383E-01
BRANCH OPTION -11:	IN RAD	PIPE DIA	ORIFICE DIA	ORIFICE DIA AREA		
215	0.125E+01	0.500E-02	0.300E-01	0.400E+01	0.100E+01	0.393E-01
BR OPT -> 3-1	LENGTH	HEIGHT	WIDTH	TYPE	AREA	
216	0.181E+01	0.141E+00	0.135E+02	0.100E+01	0.191E+01	
BRANCH OPTION -2:	FLOW COEF	AREA				
270	0.100E+01	0.387E+00				
BRANCH OPTION -22	FLOW COEF	AREA				
280	0.100E+01	0.387E+00				
BRANCH OPTION -21:	(PARALLEL TUBES)LENGTH,					
2801	0.125E+01	0.391E+01				
BRANCH OPTION -21:	(PARALLEL TUBES)LENGTH,	DIA	EPSD,	NO. OF TUBES	AREA	
2802	0.391E+01	0.625E-01	0.000E+00	0.220E+02	0.675E-01	
BRANCH OPTION -4:	LENGTH,	AREA				
221	0.140E+01	0.250E+00	0.000E+00	0.000E+00	0.000E+00	0.491E-01
BRANCH OPTION -4:	LENGTH,	DIA	EPSD	ANGLE,	AREA	
222	0.140E+01	0.250E+00	0.000E+00	0.000E+00	0.000E+00	0.491E-01
BRANCH OPTION -1:	LENGTH	DIA	EPSD	ANGLE	AREA	
223	0.356E+01	0.312E+00	0.000E+00	0.000E+00	0.767E-01	
BRANCH OPTION -1:	LENGTH	DIA	EPSD	ANGLE	AREA	
224	0.356E+01	0.312E+00	0.000E+00	0.000E+00	0.767E-01	
BRANCH OPTION -4:	LENGTH,	DIA	EPSD	ANGLE,	AREA	
2301	0.120E+03	0.375E+00	0.000E+00	0.000E+00	0.100E+01	0.110E+00
BRANCH OPTION -4:	LENGTH, DIA	EPSD	ANGLE,	AREA		
2302	0.120E+03	0.375E+00	0.000E+00	0.000E+00	0.100E+01	0.110E+00
BRANCH OPTION -21:	(PARALLEL TUBES)LENGTH,	DIA	EPSD,	NO. OF TUBES	AREA	
2131	0.250E+00	0.625E-01	0.000E+00	0.800E+01	0.245E-01	
BRANCH OPTION -21:	(PARALLEL TUBES)LENGTH,	DIA	EPSD,	NO. OF TUBES	AREA	
2132	0.783E+01	0.625E-01	0.000E+00	0.800E+01	0.245E-01	
BRANCH OPTION -4:	LENGTH,	DIA	EPSD	ANGLE,	AREA	
231	0.150E+01	0.250E+00	0.000E+00	0.000E+00	0.000E+00	0.491E-01
BRANCH OPTION -4:	LENGTH,	DIA	EPSD	ANGLE,	AREA	
232	0.150E+01	0.250E+00	0.000E+00	0.000E+00	0.000E+00	0.491E-01
BRANCH OPTION -1:	LENGTH	DIA	EPSD	ANGLE	AREA	
233	0.362E+01	0.250E+00	0.000E+00	0.000E+00	0.491E-01	

BRANCH	OPTION -1:	LENGTH	DIA	EPSD	ANGLE	AREA
234	0.362E+01	0.250E+00	0.000E+00	0.000E+00	0.491E-01	0.000E+00
BRANCH	OPTION -1:	LENGTH	DIA	EPSD	ANGLE	AREA
235	0.300E+00	0.460E+00	0.000E+00	0.000E+00	0.166E+00	0.000E+00
BRANCH	OPTION -1:	LENGTH	DIA	EPSD	ANGLE	AREA
236	0.300E+00	0.460E+00	0.000E+00	0.000E+00	0.166E+00	0.000E+00
BRANCH	OPTION -1:	LENGTH	DIA	EPSD	ANGLE	AREA
2381	0.245E+02	0.600E+00	0.000E+00	0.000E+00	0.283E+00	0.000E+00
BRANCH	OPTION -1:	LENGTH	DIA	EPSD	ANGLE	AREA
2382	0.245E+02	0.600E+00	0.000E+00	0.000E+00	0.283E+00	0.000E+00
BRANCH	OPTION -21: (PARALLEL TUBES)	LENGTH,	DIA	EPSD,	NO. OF TUBES	AREA
2401	0.375E+00	0.375E+00	0.000E+00	0.000E+00	0.800E+01	0.884E+00

SOLUTION INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
101	0.1100E+04	-0.2866E+03	0.2690E+00	0.7047E+02	0.0000E+00	0.0000E+00
103	0.1025E+04	-0.2866E+03	0.2508E+00	0.7040E+02	0.0000E+00	0.0000E+00
104	0.3566E+03	-0.2841E+03	0.8749E-01	0.6926E+02	0.0000E+00	0.0000E+00
106	0.1100E+04	-0.2866E+03	0.2690E+00	0.7047E+02	0.0000E+00	0.0000E+00
108	0.8603E+03	-0.2858E+03	0.2105E+00	0.7009E+02	0.0000E+00	0.0000E+00
109	0.8507E+03	-0.2729E+03	0.2002E+00	0.6785E+02	0.0000E+00	0.0000E+00
110	0.7571E+03	-0.2703E+03	0.1772E+00	0.6727E+02	0.0000E+00	0.0000E+00
111	0.7569E+03	-0.2703E+03	0.1772E+00	0.6727E+02	0.0000E+00	0.0000E+00
112	0.6625E+03	-0.2677E+03	0.1544E+00	0.6668E+02	0.0000E+00	0.0000E+00
114	0.7873E+02	-0.2660E+03	0.1851E-01	0.6549E+02	0.0000E+00	0.0000E+00
115	0.6260E+02	-0.2675E+03	0.2198E-01	0.4421E+02	0.0000E+00	0.8084E-02
170	0.5196E+02	-0.2680E+03	0.9231E+00	0.8760E+00	0.0000E+00	0.1000E+01
1181	0.7370E+02	-0.2659E+03	0.1733E-01	0.6548E+02	0.0000E+00	0.0000E+00
118	0.5796E+02	-0.2694E+03	0.2946E-01	0.3084E+02	0.0000E+00	0.1752E-01
121	0.4887E+02	-0.2734E+03	0.4559E-01	0.1716E+02	0.0000E+00	0.3728E-01
122	0.4887E+02	-0.2734E+03	0.4559E-01	0.1716E+02	0.0000E+00	0.3728E-01
123	0.4717E+02	-0.2742E+03	0.4888E-01	0.1552E+02	0.0000E+00	0.4121E-01
124	0.4717E+02	-0.2742E+03	0.4888E-01	0.1552E+02	0.0000E+00	0.4121E-01
1131	0.6454E+03	-0.2676E+03	0.1504E+00	0.6664E+02	0.0000E+00	0.0000E+00
113	0.1108E+03	-0.2660E+03	0.2604E-01	0.6556E+02	0.0000E+00	0.0000E+00
131	0.9799E+02	-0.2660E+03	0.2303E-01	0.6553E+02	0.0000E+00	0.0000E+00
132	0.9799E+02	-0.2660E+03	0.2303E-01	0.6553E+02	0.0000E+00	0.0000E+00
133	0.9411E+02	-0.2660E+03	0.2212E-01	0.6552E+02	0.0000E+00	0.0000E+00
134	0.9411E+02	-0.2660E+03	0.2212E-01	0.6552E+02	0.0000E+00	0.0000E+00
135	0.9409E+02	-0.2660E+03	0.2211E-01	0.6552E+02	0.0000E+00	0.0000E+00
136	0.9409E+02	-0.2660E+03	0.2211E-01	0.6552E+02	0.0000E+00	0.0000E+00
138	0.9370E+02	-0.2660E+03	0.2202E-01	0.6552E+02	0.0000E+00	0.0000E+00

NODE H ENTROPY EMU COND CP GAMA

216	0.469E+00	0.491E-03	0.388E+00	0.664E+00	0.479E+05	0.861E-03	0.416E-08	0.622E-03
270	0.204E+04	0.106E+02	0.867E+00	0.305E+03	0.318E+07	0.448E+00	0.831E-02	0.126E+04
280	0.246E+04	0.373E+02	0.867E+00	0.369E+03	0.323E+07	0.549E+00	0.123E-01	0.183E+04
2801	0.343E+03	0.503E+01	0.145E+01	0.474E+02	0.872E+06	0.609E-01	0.107E-03	0.161E+02
2802	0.107E+04	0.157E+02	0.145E+01	0.474E+02	0.873E+06	0.609E-01	0.334E-03	0.503E+02
221	0.248E+04	0.909E+01	0.727E+00	0.692E+02	0.614E+06	0.907E-01	0.208E-03	0.308E+02
222	0.248E+04	0.909E+01	0.727E+00	0.692E+02	0.614E+06	0.907E-01	0.208E-03	0.308E+02
223	0.465E+03	0.171E+01	0.727E+00	0.795E+02	0.589E+06	0.107E+00	0.718E-04	0.104E+02
224	0.465E+03	0.171E+01	0.727E+00	0.795E+02	0.589E+06	0.107E+00	0.718E-04	0.104E+02
2301	0.885E+04	0.325E+02	0.727E+00	0.611E+02	0.508E+06	0.823E-01	0.152E-02	0.219E+03
2302	0.885E+04	0.325E+02	0.727E+00	0.611E+02	0.508E+06	0.823E-01	0.152E-02	0.219E+03
2131	0.387E+03	0.171E+02	0.252E+01	0.222E+03	0.230E+07	0.292E+00	0.622E-03	0.929E+02
2132	0.121E+05	0.535E+03	0.252E+01	0.222E+03	0.231E+07	0.292E+00	0.195E-01	0.291E+04
231	0.117E+04	0.129E+02	0.126E+01	0.564E+02	0.882E+06	0.726E-01	0.236E-03	0.356E+02
232	0.117E+04	0.129E+02	0.126E+01	0.564E+02	0.882E+06	0.726E-01	0.236E-03	0.356E+02
233	0.352E+03	0.388E+01	0.126E+01	0.564E+02	0.884E+06	0.726E-01	0.713E-04	0.107E+02
234	0.352E+03	0.388E+01	0.126E+01	0.564E+02	0.884E+06	0.726E-01	0.713E-04	0.107E+02
235	0.155E+01	0.170E-01	0.126E+01	0.167E+02	0.481E+06	0.215E-01	0.313E-06	0.472E-01
236	0.155E+01	0.170E-01	0.126E+01	0.167E+02	0.481E+06	0.215E-01	0.313E-06	0.472E-01
2381	0.350E+02	0.385E+00	0.126E+01	0.979E+01	0.368E+06	0.126E-01	0.709E-05	0.107E+01
2382	0.350E+02	0.385E+00	0.126E+01	0.979E+01	0.368E+06	0.126E-01	0.709E-05	0.107E+01
2401	0.105E+00	0.462E-02	0.252E+01	0.627E+01	0.417E+06	0.807E-02	0.170E-06	0.256E-01

AXIAL THRUST = 566.95967 LBF

TIME OF ANALYSIS WAS 9.375000000000000E-002 SECS

APPENDIX BB—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 22ss

Simulation of a Fluid Network with Fixed Flowrate Option

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```

GFSSP VERSION
604
GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST

INPUT DATA FILE NAME
F:\GFSSP\Revised User Manual\EX22\EX22ss.dat
OUTPUT FILE NAME
EX22ss.out
TITLE
Example 22 -- Simulation of a Fluid Network with Fixed Flowrate Option
USERSETUP
F
DENCON          GRAVITY          ENERGY          MIXTURE          THRUST          STEADY          TRANSV          SAVER
F               F               T               F               F               T               F               F
HEX             HCOEF             REACTING         INERTIA          CONDX           ADPPROP         PRINTI          ROTATION
F               F               F               F               F               F               F               F
BUOYANCY       HRATE             INVAL           MSORCE          MOVBN          TPA             VARGEO          TVM
F               T               F               F               F               F               F               F
SHEAR          PRNTIN           PRNTADD         OPVALVE         TRANSQ         CONJUG          RADIAT          WINPLOT
F               T               T               F               F               F               F               F
PRESS          INSUC            VARROT          CYCLIC          CHKVALS        WINFILE         DALTON          NOSTATS
F               F               F               F               F               F               F               F
NORMAL         SIMUL            SECONDL        NRSOLVT         IBDF           NOPLT           PRESREG         FLOWREG
F               T               F               T               F               T               T               0
TRANS_MOM      USERVARS         PSMG           ISOLVE         PLOTADD        SIUNITS         TECPLOT         MDGEN
F               F               F               1               F               F               F               F
NUM_USER_VARS  IFR_MIX         PRINTD         SATTABL        MSORIN         PRELVLV        LAMINAR        HSTAG
1               1               F               F               F               F               T               T
NNODES         NINT             NBR            NF
5               2               4               1
RELAX          RELAXD           RELAXH         RELAX           RELAXNR        RELAXHC
1               0.5             1               0.0001         500           1
NFLUID(I), I = 1, NF
11
NODE           INDEX           DESCRIPTION
1               2               " Node 1"
2               1               " Node 2"
3               1               " Node 3"
4               2               " Node 4"
5               2               " Node 5"
NODE PRES (PSI)  TEMP (DEGF)  MASS SOURC  HEAT SOURC  THRST AREA  CONCENTRATION
1      14.7        60           0            0            0            0
2      14.7        60           0            0            0            0
3      14.7        60           0            0            0            0
4      14.7        60           0            0            0            0

```

5	14.7	NUMBR	60	NAMEBR	52	0	0	0
INODE								
2		3		12 23				
3		2		23 34				
BRANCH	UPNODE	DNNODE		OPTION	DESCRIPTION			
12	1	2		24	"FixedFlow 12"			
23	2	3		13	"Valve 23"			
34	3	4		1	"Pipe 34"			
52	5	2		24	"FixedFlow 52"			
BRANCH		OPTION -24		FLOW_RATE	AREA	HISTORY		
12				100	200	0		
BRANCH		OPTION -13		DIA	K1	K2	AREA	
23				6	300	0.1	28.274	
BRANCH		OPTION -1		LENGTH	DIA	EPSD	ANGLE	AREA
34				18000	6		1.66666666667e-05	0
BRANCH		OPTION -24		FLOW_RATE	AREA	HISTORY		28.27431
52				-10	200	0		

 G F S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/17/2012 13:22

TITLE :Example 22 -- Simulation of a Fluid Network with Fixed Flowrate Option
 ANALYST :
 FILEIN :F:\GFSSP\Revised User Manual\EX22\EX22ss.dat
 FILEOUT :EX22ss.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	COND	F	CONJUG	F	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	HCOEF	F	HEX	F	HRATE	T	IFRMIX	1	INERTIA	F	INSUC	F
INVAL	F	MIXTURE	MOVEND	F	MSORCE	F	NORMAL	F	NRSOLVT	T	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	PRINTI	F	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	SHEAR	F	SIMULA	T	SIUNITS	F	STEADY	T	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	TRANSV	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F													

NNODES = 5
 NINT = 2
 NBR = 4
 NF = 1
 NVAR = 6
 Nhref = 2

FLUIDS: H2O

BOUNDARY NODES

NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)
1	0.1470E+02	0.6000E+02	0.6237E+02	0.0000E+00
4	0.1470E+02	0.6000E+02	0.6237E+02	0.0000E+00
5	0.1470E+02	0.6000E+02	0.6237E+02	0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)	UPNODE	DNNODE	OPTION	DIA	K1	K2	AREA	EPSP	ANGLE	AFREA
2	0.0000E+00	0.0000E+00	0.0000E+00	1	2	24	0.600E+01	0.300E+03	0.100E+00	0.283E+02	0.167E-04	0.000E+00	0.283E+02
3	0.0000E+00	0.0000E+00	0.0000E+00	2	3	13	0.180E+05	0.600E+01	0.600E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00

BRANCH OPTION -13: DIA K1 K2 AREA

BRANCH OPTION -1: LENGTH DIA

SOLUTION

INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.3067E+02	0.5995E+02	0.1589E-02	0.6237E+02	0.0000E+00	0.0000E+00
3	0.3063E+02	0.5995E+02	0.1587E-02	0.6237E+02	0.0000E+00	0.0000E+00

NODE	H (BTU/LB)	ENTROPY (BTU/LB-R)	EMU (LBM/FT-SEC)	COND (BTU/FT-S-R)	CP (BTU/LB-R)	GAMA
2	0.2813E+02	0.5555E-01	0.7548E-03	0.9511E-04	0.1002E+01	0.1003E+01
3	0.2813E+02	0.5555E-01	0.7548E-03	0.9511E-04	0.1002E+01	0.1003E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. (BTU/(R-SEC))	LOST WORK (LBF-FT/SEC)
12	0.000E+00	-0.160E+02	0.100E+03	0.115E+01	0.127E+06	0.962E-03	0.000E+00	0.000E+00
23	0.760E-03	0.428E-01	0.900E+02	0.735E+01	0.304E+06	0.613E-02	0.220E-04	0.889E+01
34	0.283E+00	0.159E+02	0.900E+02	0.735E+01	0.304E+06	0.613E-02	0.819E-02	0.331E+04
52	0.000E+00	-0.160E+02	-0.100E+02	-0.116E+00	0.127E+05	0.963E-04	0.000E+00	0.000E+00

TIME OF ANALYSIS WAS 0.0000000000000000E+000 SECS

APPENDIX CC—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 22tr

Simulation of a Fluid Network with Fixed Flowrate Option

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Example 22tr Output File	301

GFSSP VERSION
604

GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST

INPUT DATA FILE NAME
F:\GFSSP\Revised User Manual\EX22\EX22tr.dat
OUTPUT FILE NAME
EX22tr.out

TITLE
Example 22 -- Simulation of a Fluid Network with Fixed Flowrate Option
USERUP

F	DENCON	GRAVITY	ENERGY	MIXTURE	THRUST	STEADY	TRANSV	SAVER
F	HEX	HCOEF	REACTING	INERTIA	CONDX	ADDDPROP	PRINTI	ROTATION
F	BUOYANCY	HRATE	INVAL	MSORCE	MOVBND	TPA	VARGEO	TVM
F	SHEAR	PRNTIN	PRNTADD	OPVALVE	TRANSQ	CONJUG	RADIAT	WINPLOT
F	PRESS	INSUC	VARROT	CYCLIC	CHKVALS	WINFILE	DALTON	NOSTATS
F	NORMAL	STIMUL	SECONDL	NRSOLVT	IBDF	NOPLT	PRESREG	FLOWREG
F	TRANS_MOM	USERSVARS	PSMG	ISOLVE	PLOTADD	SIUNITS	TECPLOT	MDGEN
F	NUM_USER_VARS	IFR_MIX	PRINTD	SATTABL	MSORIN	PRELVLV	LAMINAR	HSTAG
1	1	1	F	F	F	F	T	T
NNODES	NINT	NBR	NF	NF	NITER	RELAXNR	RELAXHC	RELAXTS
5	2	4	1	CC	2000	1	1	1
RELAXK	RELAXD	RELAXH	1	1e-05	NPWSTEP	WPLSTEP	WFLBUFF	1.1
1	0.5	TIMEL	NPSTEP	20	1	1	50	
DTAU	TIMEF	0	20					
1	1	NFLUID(I), I = 1, NF						
11	11							
INDEX	DESCRIPTION	HEAT SOURC	THRST AREA	NODE-VOLUME	CONCENTRATION			
2	" Node 1"	0	0	0	0			
1	" Node 2"	0	0	0	0			
3	" Node 3"	0	0	0	0			
1	" Node 3"	0	0	0	0			
2	" Node 4"	0	0	0	0			
2	" Node 4"	0	0	0	0			
2	" Node 5"	0	0	0	0			
2	" Node 5"	0	0	0	0			
2	60	0	0	0	0			
14.7	60	0	0	0	0			
3	14.7	0	0	0	0			

```

Hist1.dat
Hist4.dat
Hist5.dat
INODE      NUMBR      NAMEBR      DESCRIPTION
  2         3         12 23 52
  3         2         23 34
BRANCH  UPNODE  DNNODE  OPTION  DESCRIPTION
  12     1       2       24      "FixedFlow 12"
  23     2       3       13      "Valve 23"
  34     3       4       1       "Pipe 34"
  52     5       2       24      "FixedFlow 52"
BRANCH  UPNODE  DNNODE  OPTION  FLOW_RATE  AREA  HISTORY
  12     1       2       0       0           200      1
mdot12.dat
BRANCH  UPNODE  DNNODE  OPTION  DIA  K1  K2  AREA
  23     1       2       6       300  0.1 28.274
BRANCH  UPNODE  DNNODE  OPTION  LENGTH  DIA  EPSD  ANGLE  AREA
  34     1       2       18000  6     1.6666666667e-05 28.27431
BRANCH  UPNODE  DNNODE  OPTION  FLOW_RATE  AREA  HISTORY
  52     1       2       0       200  1
mdot52.dat
INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW
  12 0
  23 0
  34 0
  52 0

```

EXAMPLE 22tr HISTORY FILES

```
Hist1.dat
2
0.0 14.7 60.0 1.0
20.0 14.7 60.0 1.0

Hist4.dat
2
0.0 14.7 60.0 1.0
20.0 14.7 60.0 1.0

Hist5.dat
2
0.0 14.7 60.0 1.0
20.0 14.7 60.0 1.0

Mdot12.dat
3
0.0 100.0 200.0
10.0 50.0 200.0
20.0 50.0 200.0

Mdot52.dat
4
0.0 -10.0 200.0
10.0 -10.0 200.0
10.1 10.0 200.0
20.0 10.0 200.0
```

 G F S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/17/2012 13:14

TITLE :Example 22 -- Simulation of a Fluid Network with Fixed Flowrate Option
 ANALYST :
 FILEIN :F:\GFSSP\Revised User Manual\EX22\EX22tr.dat
 FILEOUT :EX22tr.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	COND	F	CONJUG	F	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	F	HCOEF	F	HEX	F	HRATE	T	IFRMIX	1	INERTIA	F	INSUC	F
INVAL	F	MIXTURE	F	MOVEND	F	MSORCE	F	NORMAL	F	NRSOLVT	T	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRINTI	F	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	F	SHEAR	F	SIMULA	T	SIUNITS	F	STEADY	F	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	F	TRANSV	T	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F														

NNODES = 5
 NINT = 2
 NBR = 4
 NF = 1
 NVAR = 8
 Nhref = 2

FLUIDS: H2O

BOUNDARY NODES
 NODE P (PSI) T (F) RHO (LBM/FT^3) AREA (IN^2)

1 0.1470E+02 0.6000E+02 0.6237E+02 0.0000E+00
 4 0.1470E+02 0.6000E+02 0.6237E+02 0.0000E+00
 5 0.1470E+02 0.6000E+02 0.6237E+02 0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE AREA MASS HEAT
 (IN^2) (LBM/S) (BTU/S)
 2 0.0000E+00 0.0000E+00 0.0000E+00
 3 0.0000E+00 0.0000E+00 0.0000E+00

BRANCH UPNODE DNNODE OPTION

12 1 2 24
 23 2 3 13
 34 3 4 1
 52 5 2 24

BRANCH OPTION -13: DIA K1 K2 AREA

23 0.600E+01 0.300E+03 0.100E+00 0.283E+02

BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA

34 0.180E+05 0.600E+01 0.167E-04 0.000E+00 0.283E+02

ISTEP = 1 TAU = 0.10000E+01

BOUNDARY NODES

NODE P (PSI) TF (F) Z (COMP) RHO (LBM/FT^3) QUALITY
 1 0.1470E+02 0.6000E+02 0.0000E+00 0.6237E+02 0.0000E+00
 4 0.1470E+02 0.6000E+02 0.0000E+00 0.6237E+02 0.0000E+00
 5 0.1470E+02 0.6000E+02 0.0000E+00 0.6237E+02 0.0000E+00

SOLUTION

INTERNAL NODES

NODE P (PSI) TF (F) Z RHO (LBM/FT^3) EM (LBM) QUALITY
 2 0.2888E+02 0.5996E+02 0.1496E-02 0.6237E+02 0.5218E-15 0.0000E+00
 3 0.2885E+02 0.6000E+02 0.1494E-02 0.6237E+02 0.1837E+05 0.0000E+00

NODE H ENTROPY EMU COND CP GAMA

BTU/LB BTU/LB-R LBM/FT-SEC BTU/FT-S-R BTU/LB-R
 2 0.2813E+02 0.5555E-01 0.7547E-03 0.9511E-04 0.1002E+01 0.1003E+01
 3 0.2817E+02 0.5555E-01 0.7542E-03 0.9511E-04 0.1002E+01 0.1003E+01

BRANCHES	BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA P (PSI)	Z	RHO (LBM/FT^3)	QUALITY	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
	12	0.000E+00	-0.142E+02				0.100E+05	0.635E-05	0.000E+00	0.000E+00
	23	0.761E-03	0.382E-01				0.287E+06	0.579E-02	0.185E-04	0.749E+01
	34	0.286E+00	0.141E+02				0.285E+06	0.574E-02	0.681E-02	0.275E+04
	52	0.000E+00	-0.142E+02				0.106E+04	0.668E-06	0.000E+00	0.000E+00

SOLUTION INTERNAL NODES

INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	QUALITY
2	0.2233E+02	0.5998E+02	0.1158E-02	0.6237E+02	-0.5422E-16
3	0.2233E+02	0.6000E+02	0.1157E-02	0.6237E+02	0.1837E+05

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-S-R	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.2813E+02	0.5555E-01	0.7545E-03	0.9511E-04	0.1002E+01	0.1003E+01
3	0.2815E+02	0.5555E-01	0.7543E-03	0.9511E-04	0.1002E+01	0.1003E+01

BRANCHES	BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA P (PSI)	Z	RHO (LBM/FT^3)	QUALITY	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
	12	0.000E+00	-0.765E+01				0.529E+04	0.334E-05	0.000E+00	0.000E+00
	23	0.764E-03	0.191E-01				0.202E+06	0.408E-02	0.654E-05	0.264E+01
	34	0.305E+00	0.763E+01				0.203E+06	0.409E-02	0.261E-02	0.106E+04
	52	0.000E+00	-0.765E+01				0.106E+04	0.668E-06	0.000E+00	0.000E+00

TIME OF ANALYSIS WAS 0.56250000000000 SECS

APPENDIX DD—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 23A

Oxygen Recirculation Line with Deliberate Heat Leak

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GFSSP VERSION

604

GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST

INPUT DATA FILE NAME
F:\GFSSP\Revised User Manual\EX23\EX23A.dat

OUTPUT FILE NAME

EX23A.out

TITLE

Oxygen Recirculation Line with Deliberate Heat Leak

USERVARS

F	DENCON	GRAVITY	ENERGY	MIXTURE	THRUST	STEADY	TRANSV	SAVER
F		T	T	F	F	T	F	F
F	HEX	HCOEF	REACTING	INERTIA	CONDX	ADDDPROP	PRINTI	ROTATION
F		F	F	F	F	F	F	F
F	BUOYANCY	HRATE	INVAL	MSORCE	MOVBND	TPA	VARGEO	TVM
F		T	F	F	F	F	F	F
F	SHEAR	PRNTIN	PRNTADD	OPVALVE	TRANSQ	CONJUG	RADIAT	WINPLOT
F		T	T	F	F	T	F	F
F	PRESS	INSUC	VARROT	CYCLIC	CHKVALS	WINFILE	DALTON	NOSTATS
F		F	F	F	F	F	F	F
F	NORMAL	SIMUL	SECONDL	NRSOLVT	IBDF	NOPLT	PRESREG	FLOWREG
F		T	F	T	T	T	0	0
F	TRANS_MOM	USERVARS	PSMG	ISOLVE	PLOTADD	SIUNITS	TECPLOT	MDGEN
F		F	F	1	F	F	F	F
F	NUM_USER_VARS	IFR_MIX	PRINTD	SATTABL	MSORIN	PRELVLV	LAMINAR	HSTAG
1		1	F	F	F	F	T	T
1	NNODES	NINT	NBR	NF	MSORIN	PRELVLV	LAMINAR	HSTAG
8		6	7	1	F	F	T	T
RELAXK	RELAXD	RELAXH	RELAXH	CC	NITER	RELAXNR	RELAXHC	RELAXTS
1	0.5	1	1	0.0001	500	1	1	1
NFLUID(I), I = 1, NF								
6								

NODE	INDEX	DESCRIPTION
1	2	" Node 1"
2	1	" Node 2"
3	1	" Node 3"
4	1	" Node 4"
5	1	" Node 5"
6	1	" Node 6"
7	1	" Node 7"
8	2	" Node 8"

NODE	PRES (PSI)	TEMP (DEGF)	MASS SOURC	HEAT SOURC	THRST AREA	CONCENTRATION
1	55.78	-272.5	0	0	0	0


```

NAME$A
1011
NODEAM  TAMB  DESCRIPTION
11      70.00000  "Node 11"
ICNSS   ICNSI  ICNSJ  ARCSIJ  DISTSIJ  DESCRIPTION
910     9       10     79.00000  0.22500  "Conductor 910"
ICONSF  ICS   ICF  MODEL  ARSF   HCSE   RADSF  EMSFS   EMSFF  DESCRIPTION
49      9       4       1       7.05000e+01  0.00000e+00  F  0.00000e+00  0.00000e+00  "Convection 49"
ICNSA   ICSAS  ICNSA  ARSA   HCSA   RADSA  EMSAS   EMSAA  DESCRIPTION
1011    10     11     8.75000e+01  5.56000e-04  F  0.00000e+00  0.00000e+00  "Convection 1011"

```

 G F S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/20/2012 10:13

TITLE :Oxygen Recirculation Line with Deliberate Heat Leak
 ANALYST :
 FILEIN :F:\GFSSP\Revised User Manual\EX23\EX23A.dat
 FILEOUT :EX23A.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	F	COND	F	CONJUG	T	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	T	HCOEF	F	HEX	F	HRATE	T	IFRMIX	1	INERTIA	F	INSUC	F
INVAL	F	MIXTURE	F	MOVEND	F	MSORCE	F	NORMAL	F	NRSOLVT	T	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	F	PRINTI	F	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	F	SHEAR	F	SIMULA	T	SIUNITS	F	STEADY	T	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	F	TRANSV	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F														

NNODES = 8
 NINT = 6
 NBR = 7
 NF = 1
 NVAR = 13
 Nhref = 2

FLUIDS: O2

BOUNDARY NODES	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)
1	0.5578E+02	-0.2725E+03	0.6674E+02	0.0000E+00
8	0.5300E+02	-0.2725E+03	0.6674E+02	0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)
2	0.0000E+00	0.0000E+00	0.0000E+00
3	0.0000E+00	0.0000E+00	0.0000E+00
4	0.0000E+00	0.0000E+00	0.0000E+00
5	0.0000E+00	0.0000E+00	0.0000E+00
6	0.0000E+00	0.0000E+00	0.0000E+00
7	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH

UPNODE	DNNODE	OPTION
12	1	2
23	2	1
34	3	1
45	4	1
56	5	1
67	6	1
78	7	1

BRANCH OPTION -2: FLOW COEF AREA

LENGTH	DIA	AREA	EPSP	ANGLE	AREA
0.424E+00	0.639E+00				
0.120E+02	0.187E+01	0.180E+03	0.000E+00	0.180E+03	0.275E+01
0.120E+02	0.187E+01	0.180E+03	0.000E+00	0.180E+03	0.275E+01
0.120E+02	0.187E+01	0.180E+03	0.000E+00	0.180E+03	0.275E+01
0.120E+02	0.187E+01	0.180E+03	0.000E+00	0.180E+03	0.275E+01
0.120E+02	0.187E+01	0.180E+03	0.000E+00	0.180E+03	0.275E+01
0.120E+02	0.187E+01	0.180E+03	0.000E+00	0.180E+03	0.275E+01
0.120E+02	0.187E+01	0.180E+03	0.000E+00	0.180E+03	0.275E+01

CONJUGATE HEAT TRANSFER

NSOLIDX = 2
 NAMB = 1
 NSSC = 1
 NSFC = 1
 NSAC = 1

```

NSSR = 0
NODESL MATRLL SMASS TS NUMSS NUMSF NUMSA
  9 17 2.6300 70.0000 1 1 0
NAMESS
  910
NAMESEF
  49
NODESL MATRLL SMASS TS NUMSS NUMSF NUMSA
 10 17 2.6300 70.0000 1 0 1
NAMESS
  910
NAMESEA
 1011
NODEAM TAMB
 11 70.0000
ICONSS ICNSI ICNSJ ARCSIJ DISTSIJ
  910 9 10 79.0000 0.2250
ICONSF ICS ICF ARSF EMSFS EMSFF
  49 9 4 70.5000 0.0000 0.0000
ICONSA ICSAS ICSAA ARSA HCSA EMSAA
 1011 10 11 0.8750E+02 0.5560E-03 0.0000E+00 0.0000E+00

```

SOLUTION

```

INTERNAL NODES
NODE P (PSI) TF (F) Z RHO EM (LBM) QUALITY
(LBM/FT^3)
  2 0.5577E+02 -0.2725E+03 0.1332E-01 0.6667E+02 0.0000E+00 0.0000E+00
  3 0.5530E+02 -0.2725E+03 0.1321E-01 0.6667E+02 0.0000E+00 0.0000E+00
  4 0.5484E+02 -0.2710E+03 0.1305E-01 0.6639E+02 0.0000E+00 0.0000E+00
  5 0.5438E+02 -0.2710E+03 0.1294E-01 0.6639E+02 0.0000E+00 0.0000E+00
  6 0.5392E+02 -0.2711E+03 0.1320E-01 0.6546E+02 0.0000E+00 0.4101E-03
  7 0.5346E+02 -0.2713E+03 0.1402E-01 0.6331E+02 0.0000E+00 0.1425E-02

```

GAMA

```

NODE H ENTROPY EMU COND CP
BTU/LB BTU/LB-R LBM/FT-SEC BTU/FT-S-R BTU/LB-R
  2 0.7134E+02 0.1525E+01 0.9487E-04 0.1882E-04 0.4194E+00 0.1944E+01
  3 0.7134E+02 0.1525E+01 0.9486E-04 0.1882E-04 0.4194E+00 0.1944E+01
  4 0.7196E+02 0.1525E+01 0.9294E-04 0.1871E-04 0.4199E+00 0.1959E+01
  5 0.7196E+02 0.1525E+01 0.9293E-04 0.1871E-04 0.4199E+00 0.1959E+01
  6 0.7196E+02 0.1525E+01 0.9246E-04 0.1871E-04 0.4198E+00 0.1959E+01
  7 0.7196E+02 0.1525E+01 0.9131E-04 0.1870E-04 0.4196E+00 0.1956E+01

```

BRANCHES

```

BRANCH KFACTOR DELP FLOW RATE VELOCITY REYN. NO. MACH NO. ENTROPY GEN. LOST WORK
(LBF-S^2/(LBM-FT)^2) (PSI) (LBM/SEC) (FT/SEC) (BTU/(R-SEC)) LBF-FT/SEC
 12 0.658E+02 0.185E-01 0.172E+00 0.727E+00 0.308E+05 0.346E-07 0.504E-02

```


23	0.115E+00	0.462E+00	0.172E+00	0.169E+00	0.148E+05	0.225E-03	0.604E-10	0.880E-05
34	0.115E+00	0.461E+00	0.172E+00	0.169E+00	0.148E+05	0.225E-03	0.604E-10	0.880E-05
45	0.115E+00	0.459E+00	0.172E+00	0.170E+00	0.151E+05	0.225E-03	0.602E-10	0.883E-05
56	0.115E+00	0.459E+00	0.172E+00	0.170E+00	0.151E+05	0.225E-03	0.602E-10	0.883E-05
67	0.116E+00	0.459E+00	0.172E+00	0.170E+00	0.152E+05	0.225E-03	0.618E-10	0.907E-05
78	0.120E+00	0.461E+00	0.172E+00	0.171E+00	0.154E+05	0.225E-03	0.660E-10	0.966E-05

SOLID NODES

NODESL	CPSLD	TS
	BTU/LB F	F
9	0.000E+00	-0.248E+03
10	0.000E+00	-0.245E+03

SOLID TO SOLID CONDUCTOR

ICONS	CONDKIJ	QDOTSS
	BTU/S FT F	BTU/S
910	0.135E-02	-0.106E+00

SOLID TO FLUID CONDUCTOR

ICONSF	QDOTSF	HCSF	HCSFR
	BTU/S	BTU/S FT**2 F	BTU/S FT**2 F
49	0.106E+00	0.925E-02	0.000E+00

SOLID TO AMBIENT CONDUCTOR

ICONS	QDOTSA	HCSA	HCSAR
	BTU/S	BTU/S FT**2 F	BTU/S FT**2 F
1011	-0.106E+00	0.556E-03	0.000E+00

TIME OF ANALYSIS WAS 1.562500000000000E-002 SECS

APPENDIX EE—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 23B

Helium Injector

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GFSSP VERSION
604

GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST

INPUT DATA FILE NAME
F:\GFSSP\Revised User Manual\EX23\EX23B.dat

OUTPUT FILE NAME
EX23B.out

TITLE
Helium Injector
SETUP

F	DENCON	GRAVITY	ENERGY	MIXTURE	THRUST	STEADY	TRANSV	SAVER
F	HEX	HCOEF	REACTING	INERTIA	COND	ADDDPROP	PRINTI	ROTATION
F	HEX	F	F	T	F	F	F	F
F	BUOYANCY	HRATE	INVAL	MSORCE	MOVBND	TPA	VARGEO	TVM
F	HEX	T	F	F	F	F	F	F
F	SHEAR	PRNTIN	PRNTADD	OPVALVE	TRANSQ	CONJUG	RADIAT	WINPLOT
F	HEX	T	T	F	F	F	F	F
F	PRESS	INSUC	VARROT	CYCLIC	CHKVALS	WINFILE	DALTON	NOSTATS
F	HEX	F	F	F	F	F	F	F
F	NORMAL	STIMUL	SECONDL	NRSOLVT	IBDF	NOPLT	PRESREG	FLOWREG
F	HEX	T	F	T	1	T	0	0
F	TRANS_MOM	USERSVARS	PSMG	ISOLVE	PLOTADD	SIUNITS	TECPLOT	MDGEN
F	HEX	F	F	1	F	F	F	F
F	NUM_USER_VARS	IFR_MIX	PRINTD	SATTABL	MSORIN	PRELVLV	LAMINAR	HSTAG
1	1	1	F	F	F	F	T	T
NNODES	NINT	NBR	NBR	NF				
4	2	3	3	1				
RELAXK	RELAXD	RELAXH	RELAXH	CC	NITER	RELAXNR	RELAXHC	RELAXTS
1	0.5	1	1	0.0001	500	1	1	1
NFLUID(I), I = 1, NF								

1	1	100	100	0	0	0	0	0
2	14.7	60	60	0	0	0	0	0
3	14.7	60	60	0	0	0	0	0
4	14.7	60	60	0	0	0	0	0

 G F S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/21/2012 08:43

TITLE : Helium Injector
 ANALYST :
 FILEIN : F:\GFSSP\Revised User Manual\EX23\EX23B.dat
 FILEOUT : EX23B.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	COND	F	CONJUG	F	CYCLIC	F	DALTON	F	DENCON	F	ENERGY	T
FLOWREG	0	GRAVITY	HCOEF	F	HEX	F	HRATE	T	IFRMIX	1	INERTIA	T	INSUC	F
INVAL	F	MIXTURE	MOVEND	F	MSORCE	F	NORMAL	F	NRSOLVT	T	OPVALVE	F	PLOTADD	F
PRESREG	0	PRESS	PRINTI	F	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION	F
SAVER	F	SECONDL	SHEAR	F	SIMULA	T	SIUNITS	F	STEADY	T	THRUST	F	TPA	F
TRANS_MOM	F	TRANSQ	TRANSV	F	TVM	F	TWOD	F	USRVAR	F	VARGEO	F	VARROT	F
RLFVLV	F													

NNODES = 4
 NINT = 2
 NBR = 3
 NF = 1
 NVAR = 5
 Nhref = 2

FLUIDS: HE

BOUNDARY NODES
 NODE P (PSI) T (F) RHO (LBM/FT^3) AREA (IN^2)
 1 0.4250E+03 0.1000E+03 0.2786E+00 0.0000E+00
 4 0.1470E+02 0.6000E+02 0.1054E-01 0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE AREA MASS HEAT
 (IN^2) (LBM/S) (BTU/S)
 2 0.0000E+00 0.0000E+00 0.0000E+00
 3 0.0000E+00 0.0000E+00 0.0000E+00

BRANCH UPNODE DNNODE OPTION
 12 1 2 1
 23 2 3 2
 34 3 4 1

BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
 12 0.120E+02 0.152E+00 0.000E+00 0.000E+00 0.181E-01

BRANCH OPTION -2: FLOW COEF AREA
 23 0.600E+00 0.126E-02

BRANCH OPTION -1: LENGTH DIA EPSD ANGLE AREA
 34 0.280E+02 0.152E+00 0.000E+00 0.000E+00 0.181E-01

SOLUTION

INTERNAL NODES
 NODE P (PSI) TF (F) Z RHO (LBM/FT^3) QUALITY
 2 0.4248E+03 0.1000E+03 0.1017E+01 0.2785E+00 0.0000E+00 0.1000E+01
 3 0.2164E+02 0.1032E+03 0.1001E+01 0.1432E-01 0.0000E+00 0.1000E+01

NODE H ENTROPY EMU COND CP GAMA
 BTU/LB BTU/LB-R LBM/FT-SEC BTU/FT-S-R BTU/LB-R
 2 0.7052E+03 0.7460E+01 0.1415E-04 0.2598E-04 0.1243E+01 0.1669E+01
 3 0.7052E+03 0.7460E+01 0.1415E-04 0.2597E-04 0.1241E+01 0.1667E+01

BRANCHES

BRANCH KFACTOR DELP (PSI) FLOW RATE VELOCITY REYN. NO. MACH NO. ENTROPY GEN. LOST WORK
 (LBF-S^2/(LBM-FT)^2) (LBM/SEC) (FT/SEC) BTU/(R-SEC) LBF-FT/SEC
 12 0.824E+07 0.153E+00 0.163E-02 0.466E+02 0.116E+05 0.137E-01 0.296E-06 0.129E+00
 23 0.204E+10 0.403E+03 0.163E-02 0.673E+03 0.441E+05 0.197E+00 0.733E-04 0.319E+02
 34 0.374E+09 0.694E+01 0.163E-02 0.907E+03 0.116E+05 0.260E-03 0.260E+00 0.114E+03

TIME OF ANALYSIS WAS 0.0000000000000000E+000 SECS

APPENDIX FF—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 23C

Helium Injector

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GFSSP VERSION

604

GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST

INPUT DATA FILE NAME
F:\GFSSP\Revised User Manual\EX23\EX23C.dat

OUTPUT FILE NAME

EX23C.out

TITLE

Lox Recirculation Line with Helium Injection

USERSETUP

F	DENCON	GRAVITY	ENERGY	MIXTURE	THRUST	STEADY	TRANSV	SAVER
F	HEX	HCOEF	REACTING	INERTIA	CONDX	ADDDPROP	PRINTI	ROTATION
F	BUOYANCY	HRATE	INVAL	MSORCE	MOVBND	TPA	VARGEO	TVM
F	SHEAR	PRNTIN	PRNTADD	OPVALVE	TRANSQ	CONJUG	RADIAT	WINPLOT
F	PRESS	INSUC	VARROT	CYCLIC	CHKVALS	WINFILE	DALTON	NOSTATS
F	NORMAL	STIMUL	SECONDL	NRSOLVT	IBDF	NOPLT	PRESREG	FLOWREG
F	TRANS_MOM	USERSVARS	PSMG	ISOLVE	PLOTADD	SIUNITS	TECPLOT	MDGEN
F	NUM_USER_VARS	IFR_MIX	PRINTD	SATTABL	MSORIN	PRELVLV	LAMINAR	HSTAG
1	3	3	F	F	F	F	T	T
NNODES	NINT	NBR	NBR	NF				
11	8	10	10	2				
RELAXX	RELAXD	RELAXH	RELAXH	CC				
1	1	0.5	1	0.0001	NITER	RELAXNR	RELAXHC	RELAXTS
DTAU	TIMEF	TIME1	TIME1	NPSTEP	NPWSTEP	WPLSTEP	WPLBUFF	1
0.1	0			250	10	1	50	1.1
NFLUID(I), I = 1, NF								
1	6							
NODE	INDEX	DESCRIPTION						
1	2	" Node 1"						
2	1	" Node 2"						
3	1	" Node 3"						
101	2	" Node 1"						
102	1	" Node 2"						
103	1	" Node 3"						
104	1	" Node 4"						
5	1	" Node 5"						

BRANCH	OPTION	LENGTH	DIA	EPSD	ANGLE	AREA
45	-1	12	1.87	0		180
BRANCH		LENGTH	DIA	EPSD	ANGLE	AREA
56	-1	12	1.87	0		180
BRANCH		LENGTH	DIA	EPSD	ANGLE	AREA
67	-1	12	1.87	0		180
BRANCH		LENGTH	DIA	EPSD	ANGLE	AREA
78	-1	12	1.87	0		180

INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW

BRANCH	NOUBR	NMUBR
12	0	
23	1	12
34	1	23
112	0	
123	1	112
134	2	123 34
45	1	134
56	1	45
67	1	56
78	1	67
BRANCH	NODBR	NMDBR
12	1	23
23	1	34
34	2	123 134
112	1	123
123	2	134 34
134	1	45
45	1	56
56	1	67
67	1	78
78	0	
BRANCH	UPSTRM BR.	ANGLE
12		
DNSTRM BR.		ANGLE
23	0.00000	
BRANCH		

23 UPSTRM BR. ANGLE
12 0.00000
DNSTRM BR. ANGLE
34 0.00000
BRANCH
34
UPSTRM BR. ANGLE
23 0.00000
DNSTRM BR. ANGLE
123 0.00000
134 0.00000
BRANCH
112
UPSTRM BR. ANGLE
DNSTRM BR. ANGLE
123 0.00000
BRANCH
123
UPSTRM BR. ANGLE
112 0.00000
DNSTRM BR. ANGLE
134 0.00000
34 0.00000
BRANCH
134
UPSTRM BR. ANGLE
123 0.00000
34 0.00000
DNSTRM BR. ANGLE
45 0.00000
BRANCH
45
UPSTRM BR. ANGLE
134 0.00000
DNSTRM BR. ANGLE
56 0.00000
BRANCH
56
UPSTRM BR. ANGLE
45 0.00000
DNSTRM BR. ANGLE
67 0.00000
BRANCH
67
UPSTRM BR. ANGLE
56 0.00000

```

DNSTRM BR.      ANGLE
78      0.00000
BRANCH
78
UPSTRM BR.      ANGLE
67      0.00000
DNSTRM BR.      ANGLE
NUMBER OF BRANCHES WITH INERTIA
1
23
NSOLID  NAMB  NSSC  NSFC  NSAC  NSSR
2      1      1      1      1      0
NODESL  MATRL  SMASS  TS
9      17      2.6300000  70.0000000
NAMESS
910
NAMESEF
49
10      17      2.6300000  70.0000000  0.0000000  1  0  1  0  0  "Node 10"
NAMESS
910
NAMESA
1011
NODEAM  TAMB  DESCRIPTION
11      70.00000  "Node 11"  0
ICONS  ICNSI  ICNSJ  ARCSIJ  DISTSIJ  DESCRIPTION
910      9      10      79.00000  0.22500  "Conductor 910"
ICONSF  ICS  ICF  MODEL  ARSF  HCSF  RADSF  EMSFS  EMSFF  DESCRIPTION
49      9      104  1  7.05000e+01  0.00000e+00  F  0.00000e+00  0.00000e+00  "Convection 49"
ICONSA  ICSAS  ICSAA  ARSA  HCSA  RADSA  EMSAS  EMSAA  DESCRIPTION
1011     10     11     8.75000e+01  5.56000e-04  F  0.00000e+00  0.00000e+00  "Convection 1011"

```

EXAMPLE 23C HISTORY FILES**Hist1.dat**

```
2 0.0 425.0 100.0 1.0 0.0
  100.0 425.0 100.0 1.0 0.0
```

Hist8.dat

```
2 0.0 53.0 -272.5 0.0 1.0
  1000.0 53.0 -272.5 0.0 1.0
```

Hist101.dat

```
2 0.0 55.78 -272.5 0.0 1.0
  1000.0 55.78 -272.5 0.0 1.0
```

G F S S P (Version 604)
Generalized Fluid System Simulation Program
April 2013

Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/17/2013 10:53

TITLE :LOx Recirculation Line with Helium Injection
ANALYST :
FILEIN :C:\GFSSPInstallFiles\InstallGFSSP604\Examples\EX23\EX23C.dat
FILEOUT :EX23C.out

OPTION VARIABLES

ADDPROP	BUOYANCY	CONDX	CONJUG	CYCLIC	DALTON	DENCON	ENERGY
F	F	F	T	F	F	F	T
FLOWREG	GRAVITY	HCOEF	HEX	HRATE	IFRMIX	INERTIA	INSUC
0	T	F	F	T	3	T	F
INVAL	MIXTURE	MOVBND	MSORCE	NORMAL	NRSOLVT	OPVALVE	PLOTADD
F	T	F	F	F	T	F	F
PRESREG	PRESS	PRINTI	PRNTADD	PRNTIN	RADIATION	REACTING	ROTATION
0	F	F	T	T	F	F	F
SAVER	SECONDL	SHEAR	SIMULA	SIUNITS	STEADY	THRUST	TPA
F	F	F	T	F	F	F	F
TRANS_MOM	TRANSQ	TRANSV	TVM	TWOD	USRVAR	VARGEO	VARROT
F	F	T	F	F	F	F	F
RLFVLV							
F							

NNODES = 11
NINT = 8
NBR = 10
NF = 2
NVAR = 26
NHREF = 2

FLUIDS: HE O2

BOUNDARY NODES

NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)		CONCENTRATIONS	
				HE	O2	HE	O2
1	4.2500E+02	1.0000E+02	2.7856E-01	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00
101	5.5780E+01	-2.7250E+02	6.6739E+01	0.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00
8	5.3000E+01	-2.7250E+02	6.6735E+01	0.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)
2	0.0000E+00	0.0000E+00	0.0000E+00
3	0.0000E+00	0.0000E+00	0.0000E+00
102	0.0000E+00	0.0000E+00	0.0000E+00
103	0.0000E+00	0.0000E+00	0.0000E+00
104	0.0000E+00	0.0000E+00	0.0000E+00
5	0.0000E+00	0.0000E+00	0.0000E+00
6	0.0000E+00	0.0000E+00	0.0000E+00
7	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH	UPNODE	DNNODE	OPTION
12	1	2	1
23	2	3	2
34	3	103	1
112	101	102	2
123	102	103	1
134	103	104	1
45	104	5	1
56	5	6	1
67	6	7	1
78	7	8	1

BRANCH	OPTION	-1: LENGTH	DIA	EPSD	ANGLE	AREA
12		0.120E+02	0.152E+00	0.000E+00	0.900E+02	0.181E-01
BRANCH	OPTION	-2: FLOW COEF	AREA			
23		0.600E+00	0.126E-02			
BRANCH	OPTION	-1: LENGTH	DIA	EPSD	ANGLE	AREA
34		0.280E+02	0.152E+00	0.000E+00	0.900E+02	0.181E-01
BRANCH	OPTION	-2: FLOW COEF	AREA			
112		0.424E+00	0.639E+00			
BRANCH	OPTION	-1: LENGTH	DIA	EPSD	ANGLE	AREA
123		0.120E+02	0.187E+01	0.000E+00	0.180E+03	0.275E+01
BRANCH	OPTION	-1: LENGTH	DIA	EPSD	ANGLE	AREA
134		0.120E+02	0.187E+01	0.000E+00	0.180E+03	0.275E+01
BRANCH	OPTION	-1: LENGTH	DIA	EPSD	ANGLE	AREA
45		0.120E+02	0.187E+01	0.000E+00	0.180E+03	0.275E+01
BRANCH	OPTION	-1: LENGTH	DIA	EPSD	ANGLE	AREA
56		0.120E+02	0.187E+01	0.000E+00	0.180E+03	0.275E+01
BRANCH	OPTION	-1: LENGTH	DIA	EPSD	ANGLE	AREA
67		0.120E+02	0.187E+01	0.000E+00	0.180E+03	0.275E+01
BRANCH	OPTION	-1: LENGTH	DIA	EPSD	ANGLE	AREA
78		0.120E+02	0.187E+01	0.000E+00	0.180E+03	0.275E+01

CONJUGATE HEAT TRANSFER

NSOLIDX = 2
 NAMB = 1
 NSSC = 1
 NSFC = 1
 NSAC = 1
 NSSR = 0

NODESL	MATRL	SMASS	TS	NUMSS	NUMSF	NUMSA
9	17	2.6300	70.0000	1	1	0


```

NAMESS
 910
NAMESF
 49
NODESL  MATRL    SMASS      TS          NUMSS  NUMSF  NUMSA
 10     17      2.6300    70.0000     1      0      1
NAMESS
 910
NAMESA
 1011
NODEAM  TAMB
 11      70.0000
ICONSS  ICNSI  ICNSJ    ARCSIJ      DISTSIJ
 910    9     10     79.0000     0.2250
ICONSF  ICS   ICF     ARSF        EMSFS       EMSFF
 49     9    104    70.5000     0.0000     0.0000
ICONSA  ICSAS  ICSAA   ARSA        HCSA        EMSAS       EMSAA
 1011   10    11    0.8750E+02  0.5560E-03  0.0000E+00  0.0000E+00

```

```

ISTEP = 10          TAU = 0.10000E+01
BOUNDARY NODES

```

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT ³)	CONCENTRATIONS	
					HE	O2
1	4.2500E+02	1.0000E+02	1.0171E+00	2.7856E-01	1.0000E+00	0.0000E+00
101	5.5780E+01	-2.7250E+02	1.3318E-02	6.6739E+01	0.0000E+00	1.0000E+00
8	5.3000E+01	-2.7250E+02	1.2655E-02	6.6735E+01	0.0000E+00	1.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT ³)	EM (LBM)		CONC
					HE	O2	
2	4.2391E+02	1.0001E+02	1.0170E+00	2.7786E-01	3.5013E-05	1.0000E+00	
0.0000							
3	6.8985E+01	1.0285E+02	1.0030E+00	4.5617E-02	6.7063E-06	1.0000E+00	
0.0000							
102	5.3753E+01	-2.7167E+02	1.2868E-02	6.6265E+01	6.3165E-01	6.1255E-06	
1.0000							
103	5.3467E+01	-2.7088E+02	5.3310E-02	1.5505E+01	2.9678E-01	3.1281E-03	
0.9969							
104	5.3385E+01	-2.7071E+02	1.1765E-01	6.9921E+00	1.3482E-01	3.4754E-03	
0.9965							
5	5.3333E+01	-2.7051E+02	1.3716E-01	5.9752E+00	1.1489E-01	3.7320E-03	
0.9963							
6	5.3288E+01	-2.7027E+02	1.6110E-01	5.0691E+00	9.7536E-02	3.9443E-03	
0.9961							
7	5.3251E+01	-2.6986E+02	2.0321E-01	3.9985E+00	1.1576E-01	4.2613E-03	
0.9957							

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA

3	0.0000E+00	6.7902E+00	1.4148E-05	2.5974E-05	1.2414E+00	1.6670E+00
102	0.0000E+00	7.6502E-01	9.3309E-05	1.8754E-05	4.1969E-01	1.9529E+00
103	0.0000E+00	7.8678E-01	2.6906E-05	1.8432E-05	4.2047E-01	1.9448E+00
104	0.0000E+00	8.1967E-01	1.5121E-05	1.7283E-05	4.0927E-01	1.9146E+00
5	0.0000E+00	8.2874E-01	1.3769E-05	1.7017E-05	4.0669E-01	1.9069E+00
6	0.0000E+00	8.4018E-01	1.2609E-05	1.6661E-05	4.0313E-01	1.8969E+00
7	0.0000E+00	8.6083E-01	1.1256E-05	1.6002E-05	3.9650E-01	1.8788E+00

MIXTURE NODE	FLUID TFX (F)	HE HX	(AMAGAT MODEL) XVX	RHOX	EMUX	CONDUCTX
ENTROPY						
		BTU/LB		LBM/FT^3	LBM/FT-SEC	BTU/FT-S-R
BTU/LB-R						
1	1.0000E+02	7.0518E+02	0.0000E+00	2.7856E-01	1.4145E-05	2.5975E-05
5.8806E+00						
2	1.0001E+02	7.0518E+02	1.0000E+00	2.7786E-01	1.4145E-05	2.5975E-05
5.8819E+00						
3	1.0285E+02	7.0518E+02	1.0000E+00	4.5617E-02	1.4148E-05	2.5974E-05
6.7902E+00						
102	-2.5198E+02	2.6443E+02	1.0000E+00	9.6072E-02	7.2156E-06	1.3330E-05
5.6768E+00						
103	-2.2473E+02	2.9828E+02	1.0000E+00	8.4514E-02	7.8057E-06	1.4456E-05
5.8326E+00						
104	-2.1164E+02	3.1455E+02	1.0000E+00	7.9944E-02	8.0830E-06	1.4984E-05
5.9008E+00						
5	-1.9644E+02	3.3343E+02	1.0000E+00	7.5269E-02	8.4005E-06	1.5585E-05
5.9751E+00						
6	-1.7988E+02	3.5400E+02	1.0000E+00	7.0768E-02	8.7416E-06	1.6231E-05
6.0513E+00						
7	-1.5616E+02	3.8345E+02	1.0000E+00	6.5208E-02	9.2226E-06	1.7142E-05
6.1527E+00						

NODE	CM	CX	PX	VOLX	GAMAX	CPX
CVX						
QHES						
MOL CONC		MASS CONC	PSIA	FT^3		BTU/LB-R
BTU/LB-R						
1	1.0000E+00	1.0000E+00	4.2500E+02	0.0000E+00	1.6688E+00	1.2427E+00
0.0000E+00	0.0000E+00					
2	1.0000E+00	1.0000E+00	4.2391E+02	1.2601E-04	1.6688E+00	1.2427E+00
7.4470E-01	0.0000E+00					
3	1.0000E+00	1.0000E+00	6.8985E+01	1.4701E-04	1.6670E+00	1.2414E+00
7.4470E-01	0.0000E+00					
102	4.8965E-05	6.1255E-06	5.3753E+01	4.6695E-07	1.6686E+00	1.2426E+00
7.4470E-01	0.0000E+00					
103	2.4471E-02	3.1281E-03	5.3467E+01	4.7032E-04	1.6682E+00	1.2423E+00
7.4470E-01	0.0000E+00					
104	2.7123E-02	3.4754E-03	5.3385E+01	5.1730E-04	1.6680E+00	1.2422E+00
7.4470E-01	0.0000E+00					
5	2.9075E-02	3.7320E-03	5.3333E+01	5.5453E-04	1.6679E+00	1.2421E+00
7.4470E-01	0.0000E+00					
6	3.0685E-02	3.9443E-03	5.3288E+01	5.8524E-04	1.6677E+00	1.2420E+00
7.4470E-01	0.0000E+00					
7	3.3079E-02	4.2613E-03	5.3251E+01	9.4635E-04	1.6676E+00	1.2419E+00
7.4470E-01	0.0000E+00					

MIXTURE NODE	FLUID TFX(F)	O2	(AMAGAT MODEL)		RHOX	EMUX	CONDUCTX
		HX	XVX				
ENTROPY		BTU/LB			LBM/FT^3	LBM/FT-SEC	BTU/FT-S-R
BTU/LB-R							
101	-2.7250E+02	7.1338E+01	0.0000E+00	6.6739E+01	9.4870E-05	1.8816E-05	7.6311E-01
102	-2.7167E+02	7.1685E+01	0.0000E+00	6.6575E+01	9.3759E-05	1.8754E-05	7.6499E-01
103	-2.7131E+02	7.2806E+01	1.1497E-02	3.6628E+01	5.3408E-05	1.8532E-05	7.7095E-01
104	-2.7134E+02	7.8644E+01	8.0916E-02	9.8536E+00	1.7677E-05	1.7347E-05	8.0195E-01
5	-2.7137E+02	8.0057E+01	9.7783E-02	8.3611E+00	1.5687E-05	1.7060E-05	8.0946E-01
6	-2.7139E+02	8.1955E+01	1.2038E-01	6.9509E+00	1.3806E-05	1.6675E-05	8.1954E-01
7	-2.7140E+02	8.5462E+01	1.6204E-01	5.3029E+00	1.1605E-05	1.5963E-05	8.3818E-01
8	-2.7250E+02	7.1335E+01	0.0000E+00	6.6735E+01	9.4842E-05	1.8814E-05	7.6314E-01

CVX	NODE	CM	CX	PX	VOLX	GAMAX	CPX
		QHES			FT^3	BTU/LB-R	
BTU/LB-R		MOL CONC	MASS CONC	PSIA			
0.0000E+00		BTU/S					
101	1.0000E+00	1.0000E+00	5.5780E+01	0.0000E+00	1.9443E+00	4.1943E-01	0.0000E+00
102	9.9995E-01	9.9999E-01	5.3753E+01	9.5358E-03	1.9530E+00	4.1969E-01	2.1490E-01
103	9.7553E-01	9.9687E-01	5.3467E+01	1.8749E-02	1.9517E+00	4.1789E-01	2.1399E-01
104	9.7288E-01	9.9652E-01	5.3385E+01	1.8555E-02	1.9215E+00	4.0637E-01	2.1068E-01
5	9.7093E-01	9.9627E-01	5.3333E+01	1.8518E-02	1.9140E+00	4.0356E-01	2.0989E-01
6	9.6932E-01	9.9606E-01	5.3288E+01	1.8487E-02	1.9041E+00	3.9980E-01	2.0881E-01
7	9.6692E-01	9.9574E-01	5.3251E+01	2.7663E-02	1.8860E+00	3.9288E-01	2.0682E-01
8	1.0000E+00	1.0000E+00	5.3000E+01	0.0000E+00	1.9446E+00	4.1947E-01	0.0000E+00

BRANCHES						
BRANCH NO.	KFACTOR	DELP	FLOW RATE	VELOCITY	REYN. NO.	MACH
ENTROPY GEN.		LOST WORK				
(LBF-S^2/(LBM-FT)^2)		(PSI)	(LBM/SEC)	(FT/SEC)		
BTU/(R-SEC)		LBF-FT/SEC				
12	6.260E+06	1.089E+00	5.005E-03	1.426E+02	3.557E+04	4.187E-02
23	6.471E-06	2.818E+00	5.005E-03	2.064E+03	1.352E+05	6.061E-01
34	2.040E+09	3.549E+02	5.005E-03	8.707E+02	3.556E+04	2.552E-01
	2.114E-03	9.206E+02				
	8.920E+07	1.552E+01				
	5.602E-04	2.452E+02				

112	6.578E+01	2.029E+00	2.107E+00	7.116E+00	3.761E+05
9.464E-03	6.328E-05	9.214E+00			
123	6.616E-02	2.845E-01	2.038E+00	1.618E+00	1.784E+05
2.142E-03	5.777E-08	8.448E-03			
134	2.346E-01	8.172E-02	1.572E+00	5.511E+00	4.773E+05
7.220E-03	4.001E-07	5.875E-02			
45	4.778E-01	5.240E-02	1.423E+00	1.085E+01	7.691E+05
1.430E-02	1.341E-06	1.971E-01			
56	5.614E-01	4.495E-02	1.266E+00	1.131E+01	7.514E+05
1.492E-02	1.296E-06	1.908E-01			
67	6.662E-01	3.751E-02	1.117E+00	1.172E+01	7.237E+05
1.548E-02	1.243E-06	1.831E-01			
78	8.550E-01	2.503E-01	9.296E-01	1.217E+01	6.747E+05
1.611E-02	1.163E-06	1.718E-01			

SOLID NODES

NODESL	CPSLD BTU/LB F	TS F
9	1.040E-01	5.151E+01
10	1.040E-01	6.848E+01

SOLID TO SOLID CONDUCTOR

ICONSS	CONDKIJ BTU/S FT F	QDOTSS BTU/S
910	1.767E-03	-8.772E-01

SOLID TO FLUID CONDUCTOR

ICONSF	QDOTSF BTU/S	HCSF BTU/S FT**2 F	HCSFR
49	7.998E+00	5.072E-02	0.000E+00

SOLID TO AMBIENT CONDUCTOR

ICONSA	QDOTSA BTU/S	HCSA BTU/S FT**2 F	HCSAR BTU/S FT**2 F
1011	-5.131E-04	5.560E-04	0.000E+00

ISTEP = 500 TAU = 0.50000E+02

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	CONCENTRATIONS	
					HE	O2
1	4.2500E+02	1.0000E+02	1.0171E+00	2.7856E-01	1.0000E+00	0.0000E+00
101	5.5780E+01	-2.7250E+02	1.3318E-02	6.6739E+01	0.0000E+00	1.0000E+00
8	5.3000E+01	-2.7250E+02	1.2655E-02	6.6735E+01	0.0000E+00	1.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	CONC
					HE	O2
2	4.2391E+02	1.0001E+02	1.0170E+00	2.7786E-01	3.5013E-05	1.0000E+00
0.0000						
3	6.9356E+01	1.0284E+02	1.0030E+00	4.5862E-02	6.7424E-06	1.0000E+00
0.0000						

102	5.4254E+01	-2.7250E+02	1.2954E-02	6.6736E+01	6.3642E-01	1.7528E-61
1.0000						
103	5.3935E+01	-2.7142E+02	3.4082E-02	2.4603E+01	4.7286E-01	2.7284E-03
0.9973						
104	5.3770E+01	-2.7117E+02	3.8129E-02	2.1896E+01	4.1760E-01	2.7278E-03
0.9973						
5	5.3615E+01	-2.7124E+02	3.8456E-02	2.1655E+01	4.1300E-01	2.7272E-03
0.9973						
6	5.3461E+01	-2.7131E+02	3.8781E-02	2.1420E+01	4.0852E-01	2.7265E-03
0.9973						
7	5.3309E+01	-2.7137E+02	3.9129E-02	2.1176E+01	6.0582E-01	2.7256E-03
0.9973						

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.0000E+00	5.8819E+00	1.4145E-05	2.5975E-05	1.2427E+00	1.6688E+00
3	0.0000E+00	6.7876E+00	1.4148E-05	2.5974E-05	1.2414E+00	1.6670E+00
102	0.0000E+00	7.6314E-01	9.4849E-05	1.8815E-05	4.1945E-01	1.9445E+00
103	0.0000E+00	7.7861E-01	3.8739E-05	1.8603E-05	4.2200E-01	1.9494E+00
104	0.0000E+00	7.8124E-01	3.4895E-05	1.8508E-05	4.2131E-01	1.9499E+00
5	0.0000E+00	7.8127E-01	3.4588E-05	1.8506E-05	4.2123E-01	1.9490E+00
6	0.0000E+00	7.8129E-01	3.4288E-05	1.8504E-05	4.2114E-01	1.9482E+00
7	0.0000E+00	7.8134E-01	3.3977E-05	1.8502E-05	4.2106E-01	1.9474E+00

MIXTURE NODE	FLUID TFX(F)	HE BTU/LB	(AMAGAT MODEL) HX	XVX	RHOX LBM/FT^3	EMUX LBM/FT-SEC	CONDUCTX BTU/FT-S-R
ENTROPY BTU/LB-R							
1	1.0000E+02	7.0518E+02	0.0000E+00	2.7856E-01	1.4145E-05	2.5975E-05	5.8806E+00
2	1.0001E+02	7.0518E+02	1.0000E+00	2.7786E-01	1.4145E-05	2.5975E-05	5.8819E+00
3	1.0284E+02	7.0518E+02	1.0000E+00	4.5862E-02	1.4148E-05	2.5974E-05	6.7876E+00
102	-2.7249E+02	2.3894E+02	1.0000E+00	1.0755E-01	6.7576E-06	1.2455E-05	5.5430E+00
103	-2.7148E+02	2.4020E+02	1.0000E+00	1.0635E-01	6.7804E-06	1.2498E-05	5.5526E+00
104	-2.7139E+02	2.4031E+02	1.0000E+00	1.0597E-01	6.7824E-06	1.2502E-05	5.5548E+00
5	-2.7131E+02	2.4041E+02	1.0000E+00	1.0563E-01	6.7841E-06	1.2505E-05	5.5567E+00
6	-2.7124E+02	2.4050E+02	1.0000E+00	1.0528E-01	6.7856E-06	1.2509E-05	5.5586E+00
7	-2.7112E+02	2.4064E+02	1.0000E+00	1.0492E-01	6.7881E-06	1.2513E-05	5.5608E+00

NODE CVX	CM QHES MOL CONC BTU/S	CX MASS CONC	PX PSIA	VOLX FT^3	GAMAX	CPX BTU/LB-R
1	1.0000E+00	1.0000E+00	4.2500E+02	0.0000E+00	1.6688E+00	1.2427E+00
0.0000E+00	0.0000E+00					

2	1.0000E+00	1.0000E+00	4.2391E+02	1.2601E-04	1.6688E+00	1.2427E+00
7.4470E-01	0.0000E+00					
3	1.0000E+00	1.0000E+00	6.9356E+01	1.4701E-04	1.6670E+00	1.2414E+00
7.4470E-01	0.0000E+00					
102	1.4012E-60	1.7528E-61	5.4254E+01	1.3362E-62	1.6691E+00	1.2430E+00
7.4470E-01	0.0000E+00					
103	2.1403E-02	2.7284E-03	5.3935E+01	4.1135E-04	1.6691E+00	1.2429E+00
7.4470E-01	0.0000E+00					
104	2.1398E-02	2.7278E-03	5.3770E+01	4.0811E-04	1.6690E+00	1.2429E+00
7.4470E-01	0.0000E+00					
5	2.1393E-02	2.7272E-03	5.3615E+01	4.0802E-04	1.6690E+00	1.2429E+00
7.4470E-01	0.0000E+00					
6	2.1388E-02	2.7265E-03	5.3461E+01	4.0793E-04	1.6690E+00	1.2429E+00
7.4470E-01	0.0000E+00					
7	2.1381E-02	2.7256E-03	5.3309E+01	6.1169E-04	1.6690E+00	1.2429E+00
7.4470E-01	0.0000E+00					

MIXTURE FLUID	O2	(AMAGAT MODEL)				
NODE	TFX(F)	HX	XVX	RHOX	EMUX	CONDUCTX
ENTROPY		BTU/LB		LBM/FT^3	LBM/FT-SEC	BTU/FT-S-R
BTU/LB-R						
101	-2.7250E+02	7.1338E+01	0.0000E+00	6.6739E+01	9.4870E-05	1.8816E-05
7.6311E-01						
102	-2.7250E+02	7.1338E+01	0.0000E+00	6.6736E+01	9.4849E-05	1.8815E-05
7.6314E-01						
103	-2.7142E+02	7.1791E+01	0.0000E+00	6.6527E+01	9.3435E-05	1.8736E-05
7.6555E-01						
104	-2.7117E+02	7.2285E+01	4.6565E-03	5.0042E+01	7.1211E-05	1.8639E-05
7.6818E-01						
5	-2.7124E+02	7.2290E+01	5.0518E-03	4.8985E+01	6.9853E-05	1.8637E-05
7.6821E-01						
6	-2.7131E+02	7.2294E+01	5.4439E-03	4.7974E+01	6.8554E-05	1.8635E-05
7.6823E-01						
7	-2.7138E+02	7.2301E+01	5.8600E-03	4.6942E+01	6.7226E-05	1.8633E-05
7.6827E-01						
8	-2.7250E+02	7.1335E+01	0.0000E+00	6.6735E+01	9.4842E-05	1.8814E-05
7.6314E-01						

NODE	CM	CX	PX	VOLX	GAMAX	CPX
CVX	QHES					
BTU/LB-R	MOL CONC	MASS CONC	PSIA	FT^3		BTU/LB-R
	BTU/S					
101	1.0000E+00	1.0000E+00	5.5780E+01	0.0000E+00	1.9443E+00	4.1943E-01
0.0000E+00	0.0000E+00					
102	1.0000E+00	1.0000E+00	5.4254E+01	9.5363E-03	1.9445E+00	4.1945E-01
2.1571E-01	0.0000E+00					
103	9.7860E-01	9.9727E-01	5.3935E+01	1.8808E-02	1.9555E+00	4.1976E-01
2.1466E-01	0.0000E+00					
104	9.7860E-01	9.9727E-01	5.3770E+01	1.8665E-02	1.9560E+00	4.1907E-01
2.1420E-01	0.0000E+00					
5	9.7861E-01	9.9727E-01	5.3615E+01	1.8665E-02	1.9552E+00	4.1898E-01
2.1424E-01	0.0000E+00					
6	9.7861E-01	9.9727E-01	5.3461E+01	1.8665E-02	1.9543E+00	4.1890E-01
2.1429E-01	0.0000E+00					

7	9.7862E-01	9.9727E-01	5.3309E+01	2.7997E-02	1.9535E+00	4.1881E-01
2.1433E-01	0.0000E+00					
8	1.0000E+00	1.0000E+00	5.3000E+01	0.0000E+00	1.9446E+00	4.1947E-01
0.0000E+00	0.0000E+00					

BRANCHES

BRANCH NO.	KFACTOR ENTROPY GEN. (LBF-S^2/(LBM-FT)^2) BTU/(R-SEC)	DELP LOST WORK (PSI) LBF-FT/SEC	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH
12	6.261E+06	1.088E+00	5.002E-03	1.425E+02	3.555E+04	
4.185E-02	6.461E-06	2.814E+00				
23	2.040E+09	3.546E+02	5.002E-03	2.063E+03	1.351E+05	
6.058E-01	2.111E-03	9.192E+02				
34	8.874E+07	1.542E+01	5.002E-03	8.656E+02	3.554E+04	
2.537E-01	5.534E-04	2.422E+02				
112	6.578E+01	1.526E+00	1.828E+00	6.173E+00	3.264E+05	
8.210E-03	4.135E-05	6.020E+00				
123	6.735E-02	3.187E-01	1.828E+00	1.436E+00	1.575E+05	
1.910E-03	4.234E-08	6.165E-03				
134	1.537E-01	1.650E-01	1.833E+00	3.907E+00	3.867E+05	
5.126E-03	2.628E-07	3.849E-02				
45	1.694E-01	1.551E-01	1.831E+00	4.385E+00	4.287E+05	
5.749E-03	3.239E-07	4.750E-02				
56	1.711E-01	1.535E-01	1.829E+00	4.429E+00	4.320E+05	
5.809E-03	3.296E-07	4.831E-02				
67	1.727E-01	1.519E-01	1.826E+00	4.473E+00	4.352E+05	
5.869E-03	3.353E-07	4.913E-02				
78	1.745E-01	3.093E-01	1.823E+00	4.518E+00	4.384E+05	
5.929E-03	3.409E-07	4.993E-02				

SOLID NODES

NODESL	CPSLD BTU/LB F	TS F
9	1.040E-01	-2.458E+02
10	1.040E-01	-2.310E+02

SOLID TO SOLID CONDUCTOR

ICONSS	CONDKIJ BTU/S FT F	QDOTSS BTU/S
910	1.360E-03	-5.897E-01

SOLID TO FLUID CONDUCTOR

ICONSF	QDOTSF BTU/S	HCSF BTU/S FT**2 F	HCSFR
49	9.182E-01	7.396E-02	0.000E+00

SOLID TO AMBIENT CONDUCTOR

ICONSA	QDOTSA BTU/S	HCSA BTU/S FT**2 F	HCSAR BTU/S FT**2 F
1011	-1.017E-01	5.560E-04	0.000E+00

ISTEP = 1000 TAU = 0.10000E+03
BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	CONCENTRATIONS	
					HE	O2
1	4.2500E+02	1.0000E+02	1.0171E+00	2.7856E-01	1.0000E+00	0.0000E+00
101	5.5780E+01	-2.7250E+02	1.3318E-02	6.6739E+01	0.0000E+00	1.0000E+00
8	5.3000E+01	-2.7250E+02	1.2655E-02	6.6735E+01	0.0000E+00	1.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	CONC
					HE	O2
2	4.2391E+02	1.0001E+02	1.0170E+00	2.7786E-01	3.5013E-05	1.0000E+00
0.0000						
3	6.9405E+01	1.0284E+02	1.0030E+00	4.5895E-02	6.7472E-06	1.0000E+00
0.0000						
102	5.4315E+01	-2.7250E+02	1.2969E-02	6.6736E+01	6.3642E-01	1.2207-115
1.0000						
103	5.3997E+01	-2.7140E+02	3.4529E-02	2.4300E+01	4.6703E-01	2.7850E-03
0.9972						
104	5.3825E+01	-2.7117E+02	3.4456E-02	2.4245E+01	4.6242E-01	2.7850E-03
0.9972						
5	5.3654E+01	-2.7123E+02	3.4659E-02	2.4033E+01	4.5837E-01	2.7849E-03
0.9972						
6	5.3484E+01	-2.7130E+02	3.4966E-02	2.3756E+01	4.5309E-01	2.7849E-03
0.9972						
7	5.3317E+01	-2.7137E+02	3.5272E-02	2.3485E+01	6.7189E-01	2.7848E-03
0.9972						

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.0000E+00	5.8819E+00	1.4145E-05	2.5975E-05	1.2427E+00	1.6688E+00
3	0.0000E+00	6.7872E+00	1.4148E-05	2.5974E-05	1.2414E+00	1.6670E+00
102	0.0000E+00	7.6314E-01	9.4850E-05	1.8815E-05	4.1945E-01	1.9445E+00
103	0.0000E+00	7.7893E-01	3.8336E-05	1.8599E-05	4.2206E-01	1.9495E+00
104	0.0000E+00	7.7943E-01	3.8180E-05	1.8583E-05	4.2213E-01	1.9517E+00
5	0.0000E+00	7.7944E-01	3.7909E-05	1.8582E-05	4.2207E-01	1.9511E+00
6	0.0000E+00	7.7945E-01	3.7556E-05	1.8581E-05	4.2199E-01	1.9502E+00
7	0.0000E+00	7.7946E-01	3.7211E-05	1.8580E-05	4.2191E-01	1.9493E+00

MIXTURE NODE	FLUID TFX (F)	HE HX	(AMAGAT MODEL) XVX	RHOX	EMUX	CONDUCTX
		BTU/LB		LBM/FT^3	LBM/FT-SEC	BTU/FT-S-R
1	1.0000E+02	7.0518E+02	0.0000E+00	2.7856E-01	1.4145E-05	2.5975E-05
5.8806E+00						
2	1.0001E+02	7.0518E+02	1.0000E+00	2.7786E-01	1.4145E-05	2.5975E-05
5.8819E+00						
3	1.0284E+02	7.0518E+02	1.0000E+00	4.5895E-02	1.4148E-05	2.5974E-05
6.7872E+00						
102	-2.7249E+02	2.3894E+02	1.0000E+00	1.0767E-01	6.7577E-06	1.2455E-05
5.5424E+00						

103	-2.7145E+02	2.4024E+02	1.0000E+00	1.0645E-01	6.7812E-06	1.2500E-05
5.5522E+00						
104	-2.7145E+02	2.4024E+02	1.0000E+00	1.0611E-01	6.7811E-06	1.2500E-05
5.5538E+00						
5	-2.7144E+02	2.4025E+02	1.0000E+00	1.0577E-01	6.7812E-06	1.2500E-05
5.5555E+00						
6	-2.7143E+02	2.4026E+02	1.0000E+00	1.0544E-01	6.7813E-06	1.2500E-05
5.5571E+00						
7	-2.7142E+02	2.4027E+02	1.0000E+00	1.0510E-01	6.7815E-06	1.2501E-05
5.5588E+00						

NODE	CM	CX	PX	VOLX	GAMAX	CPX
CVX	QHES					
	MOL CONC	MASS CONC	PSIA	FT^3		BTU/LB-R
BTU/LB-R	BTU/S					
1	1.0000E+00	1.0000E+00	4.2500E+02	0.0000E+00	1.6688E+00	1.2427E+00
0.0000E+00	0.0000E+00					
2	1.0000E+00	1.0000E+00	4.2391E+02	1.2601E-04	1.6688E+00	1.2427E+00
7.4470E-01	0.0000E+00					
3	1.0000E+00	1.0000E+00	6.9405E+01	1.4701E-04	1.6670E+00	1.2414E+00
7.4470E-01	0.0000E+00					
102	9.7586-115	1.2207-115	5.4315E+01	9.3061-117	1.6691E+00	1.2430E+00
7.4470E-01	0.0000E+00					
103	2.1838E-02	2.7850E-03	5.3997E+01	4.1972E-04	1.6691E+00	1.2429E+00
7.4470E-01	0.0000E+00					
104	2.1838E-02	2.7850E-03	5.3825E+01	4.1650E-04	1.6691E+00	1.2429E+00
7.4470E-01	0.0000E+00					
5	2.1837E-02	2.7849E-03	5.3654E+01	4.1649E-04	1.6690E+00	1.2429E+00
7.4470E-01	0.0000E+00					
6	2.1837E-02	2.7849E-03	5.3484E+01	4.1649E-04	1.6690E+00	1.2429E+00
7.4470E-01	0.0000E+00					
7	2.1836E-02	2.7848E-03	5.3317E+01	6.2471E-04	1.6690E+00	1.2429E+00
7.4470E-01	0.0000E+00					

MIXTURE FLUID	O2	(AMAGAT MODEL)				
NODE	TFX(F)	HX	XVX	RHOX	EMUX	CONDUCTX
ENTROPY						
		BTU/LB		LBM/FT^3	LBM/FT-SEC	BTU/FT-S-R
BTU/LB-R						
3	8.9132E+01	2.3714E+02	1.0000E+00	3.7809E-01	1.4196E-05	4.3348E-06
1.4399E+00						
101	-2.7250E+02	7.1338E+01	0.0000E+00	6.6739E+01	9.4870E-05	1.8816E-05
7.6311E-01						
102	-2.7250E+02	7.1338E+01	0.0000E+00	6.6736E+01	9.4850E-05	1.8815E-05
7.6314E-01						
103	-2.7139E+02	7.1800E+01	0.0000E+00	6.6523E+01	9.3407E-05	1.8735E-05
7.6560E-01						
104	-2.7117E+02	7.1894E+01	0.0000E+00	6.6479E+01	9.3117E-05	1.8719E-05
7.6610E-01						
5	-2.7122E+02	7.1894E+01	2.6646E-04	6.5260E+01	9.1543E-05	1.8718E-05
7.6610E-01						
6	-2.7130E+02	7.1894E+01	6.4557E-04	6.3592E+01	8.9391E-05	1.8716E-05
7.6611E-01						
7	-2.7137E+02	7.1895E+01	1.0235E-03	6.2002E+01	8.7340E-05	1.8715E-05
7.6611E-01						

8 -2.7250E+02 7.1335E+01 0.0000E+00 6.6735E+01 9.4842E-05 1.8814E-05
 7.6314E-01

NODE	CM	CX	PX	VOLX	GAMAX	CPX
CVX	QHES					
	MOL CONC	MASS CONC	PSIA	FT^3		BTU/LB-R
BTU/LB-R	BTU/S					
3	2.7776E-17	2.2204E-16	6.9405E+01	4.0835E-21	1.4027E+00	2.2144E-01
1.5787E-01	0.0000E+00					
101	1.0000E+00	1.0000E+00	5.5780E+01	0.0000E+00	1.9443E+00	4.1943E-01
0.0000E+00	0.0000E+00					
102	1.0000E+00	1.0000E+00	5.4315E+01	9.5363E-03	1.9445E+00	4.1945E-01
2.1571E-01	0.0000E+00					
103	9.7816E-01	9.9721E-01	5.3997E+01	1.8800E-02	1.9557E+00	4.1976E-01
2.1463E-01	0.0000E+00					
104	9.7816E-01	9.9722E-01	5.3825E+01	1.8656E-02	1.9580E+00	4.1984E-01
2.1442E-01	0.0000E+00					
5	9.7816E-01	9.9722E-01	5.3654E+01	1.8656E-02	1.9574E+00	4.1978E-01
2.1446E-01	0.0000E+00					
6	9.7816E-01	9.9722E-01	5.3484E+01	1.8656E-02	1.9565E+00	4.1970E-01
2.1451E-01	0.0000E+00					
7	9.7816E-01	9.9722E-01	5.3317E+01	2.7984E-02	1.9556E+00	4.1961E-01
2.1456E-01	0.0000E+00					
8	1.0000E+00	1.0000E+00	5.3000E+01	0.0000E+00	1.9446E+00	4.1947E-01
0.0000E+00	0.0000E+00					

BRANCHES

BRANCH NO.	KFACTOR ENTROPY GEN.	DELTA P LOST WORK	FLOW RATE	VELOCITY	REYN. NO.	MACH
	(LBF-S^2/(LBM-FT)^2)	(PSI)	(LBM/SEC)	(FT/SEC)		
BTU/(R-SEC)	LBF-FT/SEC					
12	6.261E+06	1.088E+00	5.002E-03	1.425E+02	3.555E+04	
4.184E-02	6.460E-06	2.813E+00				
23	2.040E+09	3.545E+02	5.002E-03	2.063E+03	1.351E+05	
6.058E-01	2.110E-03	9.190E+02				
34	8.867E+07	1.541E+01	5.002E-03	8.649E+02	3.554E+04	
2.535E-01	5.525E-04	2.418E+02				
112	6.578E+01	1.465E+00	1.791E+00	6.048E+00	3.198E+05	
8.044E-03	3.889E-05	5.663E+00				
123	6.763E-02	3.176E-01	1.791E+00	1.407E+00	1.543E+05	
1.871E-03	3.999E-08	5.822E-03				
134	1.559E-01	1.721E-01	1.796E+00	3.875E+00	3.828E+05	
5.083E-03	2.538E-07	3.717E-02				
45	1.561E-01	1.711E-01	1.796E+00	3.884E+00	3.844E+05	
5.089E-03	2.545E-07	3.731E-02				
56	1.573E-01	1.695E-01	1.796E+00	3.918E+00	3.871E+05	
5.135E-03	2.586E-07	3.791E-02				
67	1.589E-01	1.676E-01	1.796E+00	3.963E+00	3.907E+05	
5.196E-03	2.642E-07	3.872E-02				
78	1.604E-01	3.169E-01	1.795E+00	4.008E+00	3.942E+05	
5.257E-03	2.699E-07	3.953E-02				

SOLID NODES

NODESL	CPSLD	TS
	BTU/LB F	F

9 1.040E-01 -2.666E+02
10 1.040E-01 -2.628E+02

SOLID TO SOLID CONDUCTOR

ICONSS CONDKIJ QDOTSS
BTU/S FT F BTU/S
910 1.324E-03 -1.479E-01

SOLID TO FLUID CONDUCTOR

ICONSF QDOTSF HCSF HCSFR
BTU/S BTU/S FT**2 F
49 1.707E-01 7.670E-02 0.000E+00

SOLID TO AMBIENT CONDUCTOR

ICONSA QDOTSA HCSA HCSAR
BTU/S BTU/S FT**2 F BTU/S FT**2 F
1011 -1.124E-01 5.560E-04 0.000E+00

TIME OF ANALYSIS WAS 4.031250000000 SECS

APPENDIX GG—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 24

Simulation of Relief Valve in a Pressurized Tank

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Example 24 Input File	339
Example 24 History File	341
Example 24 Output File	342


```

Hist1.dat
Hist3.dat
INODE          NUMBR          NAMEBR
2              2              12 23
BRANCH UPNODE  DNNODE  OPTION  DESCRIPTION
12        1          2          22  "Orifice 12"
23        2          3          22  "Orifice 23"
BRANCH     OPTION -22  AREA  FLOW COEF
12         1
BRANCH     OPTION -22  AREA  FLOW COEF
23         1e-16
INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW
12 0
23 0
NUMBER OF PRESSURE RELIEF ASSEMBLIES IN THE CIRCUIT
1
RELIEF VALVE BR  CRACKING PRESSURE (psid)
23 9.5
CORRESPONDING CONTROL FILE
R\FVLY23Area.DAT

```

EXAMPLE 24 HISTORY FILES

Hist1.dat

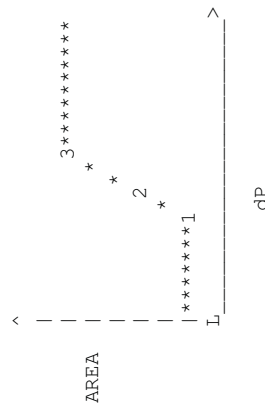
```
2      0.0 35.0 70.0 1.0
      100.0 35.0 70.0 1.0
```

Hist3.dat

```
2      0.0 14.7 70.0 1.0
      100.0 14.7 70.0 1.0
```

RLFVLV23.DAT

```
4      NUMBER OF DELTA-P VS AREA POINTS IN INTERPOLATION TABLE (MAX = 20)
7.0 1.0E-16 DELTA-P (psi), A (in2) (FIRST POINT SHOULD BE RESEAT PRESSURE WITH VERY SMALL AREA)
8.0 0.24
9.0 0.48
10. 0.72 (LAST POINT SHOULD BE MAX POSSIBLE AREA FOR FULLY OPEN VALVE)
```



Area remains close to zero until pressure is greater than the cracking pressure (point 2). Then area is interpolated from the curve. If pressure is greater than the max pressure (point 3), then the valve is fully open at its maximum area. If pressure falls below reseal pressure (point 1), then area returns to nearly zero until pressure once again is greater than the cracking pressure (point 2).

 G F S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow rates, pressures, temperatures and concentrations in a flow network.

RUN DATE:09/24/2012 15:34

TITLE :Simulation of Relief Valve in a Pressurized Tank
 ANALYST :
 FILEIN :F:\GFSSP\Revised User Manual\EX24\EX24.dat
 FILEOUT :EX24.out

OPTION VARIABLES

ADDPROP	BUOYANCY	CONDX	CONJUG	CYCLIC	DALTON	DENCON	ENERGY
T	F	F	F	F	F	F	T
FLOWREG	GRAVITY	HCOEF	HEX	HRATE	IFRMIX	INERTIA	INSUC
0	F	F	F	T	1	F	F
INVAL	MIXTURE	MOVEND	MSORCE	NORMAL	NRSOLVT	OPVALVE	PLOTADD
F	F	F	F	F	T	F	F
PRESREG	PRESS	PRINTI	PRNTADD	PRNTIN	RADIATION	REACTING	ROTATION
0	F	F	T	T	F	F	F
SAVER	SECONDL	SHEAR	SIMULA	SIUNITS	STEADY	THRUST	TPA
F	F	F	T	F	F	F	F
TRANS_MOM	TRANSQ	TRANSV	TVM	TWOD	USRVAR	VARGEO	VARROT
F	F	T	F	F	F	F	F

RLFVLV
 T

NNODES = 3
 NINT = 1
 NBR = 2
 NF = 1
 NVAR = 4
 Nhref = 2

FLUIDS: IDEL

BOUNDARY NODES	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)
1	0.3500E+02	0.7000E+02	0.1784E+00	0.0000E+00
3	0.1470E+02	0.7000E+02	0.7492E-01	0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)
2	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH	UPNODE	DNNODE	OPTION
12	1	2	22
23	2	3	22

BRANCH OPTION -22 FLOW COEF AREA
 12 0.100E+01 0.785E-01
 BRANCH OPTION -22 FLOW COEF AREA
 23 0.100E+01 0.100E-15

ISTEP = 10 TAU = 0.50000E+01

BOUNDARY NODES	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.3500E+02	0.7000E+02	0.1000E+01	0.1784E+00	0.0000E+00
3	0.1470E+02	0.7000E+02	0.1000E+01	0.7492E-01	0.0000E+00

SOLUTION

INTERNAL NODES	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.2331E+02	0.1242E+03	0.1000E+01	0.1078E+00	0.1078E+01	0.0000E+00

NODE	H (BTU/LB)	ENTROPY (BTU/LB-R)	EMU (LBM/FT-SEC)	COND (BTU/FT-S-R)	CP (BTU/LB-R)	GAMA
2	0.1062E+02	-0.9063E-02	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. (BTU/(R-SEC))	LOST WORK (LBF-FT/SEC)
12	0.293E+06	0.117E+02	0.608E-01	0.625E+03	0.233E+06	0.554E+00	0.894E-03	0.369E+03
23	0.299E+36	0.861E+01	0.359E-17	0.474E+02	0.386E-03	0.400E-01	0.284E-21	0.129E-15

```

ISTEP = 20          TAU = 0.10000E+02
BOUNDARY NODES
NODE P (PSI)      TF (F)      Z (COMP)      RHO      QUALITY
(LBM/FT^3)
1  0.3500E+02  0.7000E+02  0.1000E+01  0.1784E+00  0.0000E+00
3  0.1470E+02  0.7000E+02  0.1000E+01  0.7492E-01  0.0000E+00
SOLUTION
INTERNAL NODES
NODE P (PSI)      TF (F)      Z      RHO      EM (LBM)      QUALITY
(LBM/FT^3)
2  0.2276E+02  0.1108E+03  0.1000E+01  0.1077E+00  0.1077E+01  0.0000E+00
NODE H      ENTROPY      EMU      COND      CP      GAMA
BTU/LB      BTU/LB-R      LBM/FT-SEC      BTU/FT-S-R      BTU/LB-R
2  0.7381E+01 -0.9063E-02  0.1260E-04  0.4133E-05  0.2400E+00  0.1400E+01
BRANCHES
BRANCH KFACTOR      DELP      FLOW RATE      VELOCITY      REYN. NO.      MACH NO.      ENTROPY GEN.      LOST WORK
(LBF-S^2/(LBM-FT)^2) (PSI)      (LBM/SEC)      (FT/SEC)      (BTU/(R-SEC))      BTU/(R-SEC)      LBF-FT/SEC
12  0.293E+06  0.122E+02  0.614E-01  0.631E+03  0.235E+06  0.559E+00  0.921E-03  0.380E+03
23  0.299E+36  0.806E+01  0.288E-12  0.385E+07  0.310E+02  0.329E+04  0.150E-06  0.664E-01

```

```

ISTEP = 30          TAU = 0.15000E+02
BOUNDARY NODES
NODE P (PSI)      TF (F)      Z (COMP)      RHO      QUALITY
(LBM/FT^3)
1  0.3500E+02  0.7000E+02  0.1000E+01  0.1784E+00  0.0000E+00
3  0.1470E+02  0.7000E+02  0.1000E+01  0.7492E-01  0.0000E+00
SOLUTION
INTERNAL NODES
NODE P (PSI)      TF (F)      Z      RHO      EM (LBM)      QUALITY
(LBM/FT^3)
2  0.2279E+02  0.1036E+03  0.1000E+01  0.1092E+00  0.1092E+01  0.0000E+00
NODE H      ENTROPY      EMU      COND      CP      GAMA
BTU/LB      BTU/LB-R      LBM/FT-SEC      BTU/FT-S-R      BTU/LB-R
2  0.5669E+01 -0.9063E-02  0.1260E-04  0.4133E-05  0.2400E+00  0.1400E+01
BRANCHES
BRANCH KFACTOR      DELP      FLOW RATE      VELOCITY      REYN. NO.      MACH NO.      ENTROPY GEN.      LOST WORK
(LBF-S^2/(LBM-FT)^2) (PSI)      (LBM/SEC)      (FT/SEC)      (BTU/(R-SEC))      BTU/(R-SEC)      LBF-FT/SEC
12  0.293E+06  0.122E+02  0.613E-01  0.631E+03  0.235E+06  0.559E+00  0.920E-03  0.379E+03

```

23 0.295E+36 0.809E+01 0.288E-12 0.380E+07 0.310E+02 0.327E+04 0.148E-06 0.647E-01

ISTEP = 40 TAU = 0.20000E+02

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.3500E+02	0.7000E+02	0.1000E+01	0.1784E+00	0.0000E+00
3	0.1470E+02	0.7000E+02	0.1000E+01	0.7492E-01	0.0000E+00

SOLUTION

INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.2280E+02	0.9819E+02	0.1000E+01	0.1104E+00	0.1104E+01	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.4367E+01	-0.9063E-02	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA P (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.293E+06	0.122E+02	0.613E-01	0.630E+03	0.235E+06	0.559E+00	0.919E-03	0.379E+03
23	0.292E+36	0.811E+01	0.291E-12	0.380E+07	0.312E+02	0.328E+04	0.150E-06	0.650E-01

ISTEP = 50 TAU = 0.25000E+02

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.3500E+02	0.7000E+02	0.1000E+01	0.1784E+00	0.0000E+00
3	0.1470E+02	0.7000E+02	0.1000E+01	0.7492E-01	0.0000E+00

SOLUTION

INTERNAL NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.2281E+02	0.9408E+02	0.1000E+01	0.1112E+00	0.1112E+01	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.3380E+01	-0.9063E-02	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.293E+06	0.122E+02	0.613E-01	0.630E+03	0.235E+06	0.559E+00	0.919E-03	0.379E+03
23	0.290E+36	0.811E+01	0.293E-12	0.380E+07	0.315E+02	0.329E+04	0.152E-06	0.655E-01

ISTEP = 60 TAU = 0.30000E+02

BOUNDARY NODES	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.3500E+02	0.7000E+02	0.1000E+01	0.1784E+00	0.0000E+00
3	0.1470E+02	0.7000E+02	0.1000E+01	0.7492E-01	0.0000E+00

SOLUTION

INTERNAL NODES	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.2282E+02	0.9096E+02	0.1000E+01	0.1119E+00	0.1119E+01	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU	COND	CP	GAMA
2	0.2631E+01	-0.9063E-02	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.293E+06	0.122E+02	0.613E-01	0.630E+03	0.235E+06	0.559E+00	0.918E-03	0.378E+03
23	0.288E+36	0.812E+01	0.295E-12	0.380E+07	0.317E+02	0.330E+04	0.154E-06	0.659E-01

ISTEP = 70 TAU = 0.35000E+02

BOUNDARY NODES	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.3500E+02	0.7000E+02	0.1000E+01	0.1784E+00	0.0000E+00
3	0.1470E+02	0.7000E+02	0.1000E+01	0.7492E-01	0.0000E+00

SOLUTION

INTERNAL NODES	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.2282E+02	0.8858E+02	0.1000E+01	0.1124E+00	0.1124E+01	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU	COND	CP	GAMA
2	0.2631E+01	-0.9063E-02	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

2 0.2060E+01 -0.9063E-02 0.1260E-04 0.4133E-05 0.2400E+00 0.1400E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA P (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.293E+06	0.122E+02	0.613E-01	0.630E+03	0.235E+06	0.559E+00	0.918E-03	0.378E+03
23	0.287E+36	0.813E+01	0.296E-12	0.380E+07	0.318E+02	0.331E+04	0.155E-06	0.662E-01

ISTEP = 80 TAU = 0.40000E+02

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.3500E+02	0.7000E+02	0.1000E+01	0.1784E+00	0.0000E+00
3	0.1470E+02	0.7000E+02	0.1000E+01	0.7492E-01	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.2283E+02	0.8677E+02	0.1000E+01	0.1128E+00	0.1128E+01	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.2283E+02	0.8677E+02	0.1000E+01	0.1128E+00	0.1128E+01	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.1624E+01	-0.9063E-02	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELTA P (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.293E+06	0.122E+02	0.613E-01	0.630E+03	0.235E+06	0.559E+00	0.918E-03	0.378E+03
23	0.286E+36	0.813E+01	0.297E-12	0.380E+07	0.319E+02	0.331E+04	0.156E-06	0.665E-01

ISTEP = 90 TAU = 0.45000E+02

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.3500E+02	0.7000E+02	0.1000E+01	0.1784E+00	0.0000E+00
3	0.1470E+02	0.7000E+02	0.1000E+01	0.7492E-01	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.2283E+02	0.8538E+02	0.1000E+01	0.1131E+00	0.1131E+01	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.2283E+02	0.8538E+02	0.1000E+01	0.1131E+00	0.1131E+01	0.0000E+00

NODE	H	ENTROPY	EMU	COND	CP	GAMA
	BTU/LB	BTU/LB-R	LBM/FT-SEC	BTU/FT-S-R	BTU/LB-R	
2	0.1290E+01	-0.9063E-02	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES

BRANCH	KFACTOR	DEL P	FLOW RATE	VELOCITY	REYN. NO.	MACH NO.	ENTROPY GEN.	LOST WORK
	(LBF-S ² /(LBM-FT) ²)	(PSI)	(LBM/SEC)	(FT/SEC)			BTU/(R-SEC)	LBF-FT/SEC
12	0.293E+06	0.122E+02	0.613E-01	0.630E+03	0.235E+06	0.559E+00	0.918E-03	0.378E+03
23	0.285E+36	0.813E+01	0.298E-12	0.380E+07	0.320E+02	0.332E+04	0.157E-06	0.667E-01

ISTEP = 100 TAU = 0.50000E+02

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO	QUALITY
			(LBM/FT ³)		
1	0.3500E+02	0.7000E+02	0.1000E+01	0.1784E+00	0.0000E+00
3	0.1470E+02	0.7000E+02	0.1000E+01	0.7492E-01	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO	EM (LBM)	QUALITY
				(LBM/FT ³)		
2	0.2283E+02	0.8431E+02	0.1000E+01	0.1133E+00	0.1133E+01	0.0000E+00

NODE	H	ENTROPY	EMU	COND	CP	GAMA
	BTU/LB	BTU/LB-R	LBM/FT-SEC	BTU/FT-S-R	BTU/LB-R	
2	0.1034E+01	-0.9063E-02	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES

BRANCH	KFACTOR	DEL P	FLOW RATE	VELOCITY	REYN. NO.	MACH NO.	ENTROPY GEN.	LOST WORK
	(LBF-S ² /(LBM-FT) ²)	(PSI)	(LBM/SEC)	(FT/SEC)			BTU/(R-SEC)	LBF-FT/SEC
12	0.293E+06	0.122E+02	0.613E-01	0.630E+03	0.235E+06	0.559E+00	0.918E-03	0.378E+03
23	0.284E+36	0.814E+01	0.299E-12	0.380E+07	0.321E+02	0.332E+04	0.158E-06	0.668E-01

TIME OF ANALYSIS WAS 3.125000000000000E-002 SECS

APPENDIX HH—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 25

Driven_Cavity

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Example 25 Input File	350
Example 25 Output File	382

```

GFSSP VERSION
604
GFSSP INSTALLATION PATH
C:\Program Files (x86)\GFSSP604\
ANALYST
akm
INPUT DATA FILE NAME
D:\GFSSP604\Intel\Examples\EX25\Ex25.dat
OUTPUT FILE NAME
Ex25.out
TITLE
Driven_Cavity
SETUP
F
DENCON          GRAVITY          ENERGY          MIXTURE          THRUST          STEADY          TRANSV          SAVER
T               F               F               F               F               T               F               F
HEX             HCOEF             REACTING         INERTIA           CONDX           ADPPROP         PRINTI         ROTATION
F               F               F               T               F               F               F               F
BOUYANCY       HRATE             INVAL           MSORCE           MOVBN          TPA             VARGEO         TVM
F               T               F               F               F               F               F               T
SHEAR          PRNTIN           PRNTADD         OPVALVE          TRANSQ         CONJUG          RADIAT         WINPLOT
T               T               T               F               F               F               F               F
PRESS          INSUC            VARROT          CYCLIC           CHKVALS        WINFILE         DALTON         NOSTATS
F               F               F               F               F               F               F               F
NORMAL         SIMUL            SECONDL        NRSOLVT          IBDF           NOPLT           PRESREG        FLOWREG
F               F               F               T               F               T               0               0
TRANS_MOM     USERVERS         PSMG           ISOLVE           PLOTADD        SIUNITS         TECPLOT        MDGEN
F               F               F               1               F               F               T               T
NUM_USER_VARS IFR_MIX         PRINTD         SATTABL          MSORIN         PRELVLV         LAMINAR        HSTAG
1               1               F               F               F               F               T               T
NNODES        NINT             NBR            NX               NY               NZ               LX             LZ
50             49              85             7               7               1               12            12
RELAXK        RELAXD           RELAXH         RELAXX           CC               NITER           RELAXNR        RELAXHC
1              0.5             1              1e-10           1e-10           500             1              1
RHOREF        EMUREF          INDEX          DESCRIPTION       XCOORD          YCOORD          ZCOORD
1              1               1              "Node 2"         0               0               0
2              2               2              "Node 3"         0.85714         0.85714         0.85714
3              3               3              "Node 4"         2.5714          0.85714         0.85714
4              4               4              "Node 5"         4.2857          0.85714         0.85714
5              5               5              "Node 6"         6               0.85714         0.85714
6              6               6              "Node 7"         7.7143          0.85714         0.85714
7              7               7              "Node 8"         9.4286          0.85714         0.85714
8              8               8              "Node 9"         11.143          0.85714         0.85714
9              9               9              "Node 10"        0.85714         2.5714          0.85714
10             10              10             "Node 11"        2.5714          2.5714          2.5714
11             11              11             "Node 11"        2.5714          2.5714          2.5714

```


NODE	PRES (PSI)	MASS SOURC	HEAT SOURC	THRST AREA
12	1	"Node 12"	4.2857	2.5714
13	1	"Node 13"	6	2.5714
14	1	"Node 14"	7.7143	2.5714
15	1	"Node 15"	9.4286	2.5714
16	1	"Node 16"	11.143	2.5714
17	1	"Node 17"	0.85714	4.2857
18	1	"Node 18"	2.5714	4.2857
19	1	"Node 19"	4.2857	4.2857
20	1	"Node 20"	6	4.2857
21	1	"Node 21"	7.7143	4.2857
22	1	"Node 22"	9.4286	4.2857
23	1	"Node 23"	11.143	4.2857
24	1	"Node 24"	0.85714	6
25	1	"Node 25"	2.5714	6
26	1	"Node 26"	4.2857	6
27	1	"Node 27"	6	6
28	1	"Node 28"	7.7143	6
29	1	"Node 29"	9.4286	6
30	1	"Node 30"	11.143	6
31	1	"Node 31"	0.85714	7.7143
32	1	"Node 32"	2.5714	7.7143
33	1	"Node 33"	4.2857	7.7143
34	1	"Node 34"	6	7.7143
35	1	"Node 35"	7.7143	7.7143
36	1	"Node 36"	9.4286	7.7143
37	1	"Node 37"	11.143	7.7143
38	1	"Node 38"	0.85714	9.4286
39	1	"Node 39"	2.5714	9.4286
40	1	"Node 40"	4.2857	9.4286
41	1	"Node 41"	6	9.4286
42	1	"Node 42"	7.7143	9.4286
43	1	"Node 43"	9.4286	9.4286
44	1	"Node 44"	11.143	9.4286
45	1	"Node 45"	0.85714	11.143
46	1	"Node 46"	2.5714	11.143
47	1	"Node 47"	4.2857	11.143
48	1	"Node 48"	6	11.143
49	1	"Node 49"	7.7143	11.143
50	1	"Node 50"	9.4286	11.143
51	1	"Node 51"	11.143	11.143
2	14.7	0	0	0
3	14.7	0	0	0
4	14.7	0	0	0
5	14.7	0	0	0
6	14.7	0	0	0
7	14.7	0	0	0

BRANCH	UPNODE	DNNODE	OPTION	DESCRIPTION	MDGEN	XCOORD	YCOORD	ZCOORD
12	51	2	2	"Restrict 12"	0	0		
34	3	4	25	"Cartesian 34"	1	1.7143	0.85714	1
45	4	5	25	"Cartesian 45"	1	3.4286	0.85714	1
56	5	6	25	"Cartesian 56"	1	5.1429	0.85714	1
67	6	7	25	"Cartesian 67"	1	6.8571	0.85714	1
78	7	8	25	"Cartesian 78"	1	8.5714	0.85714	1
89	8	9	25	"Cartesian 89"	1	10.286	0.85714	1
1011	10	11	25	"Cartesian 1011"	1	1.7143	2.5714	1
1112	11	12	25	"Cartesian 1112"	1	3.4286	2.5714	1
1213	12	13	25	"Cartesian 1213"	1	5.1429	2.5714	1
1314	13	14	25	"Cartesian 1314"	1	6.8571	2.5714	1
1415	14	15	25	"Cartesian 1415"	1	8.5714	2.5714	1
1516	15	16	25	"Cartesian 1516"	1	10.286	2.5714	1
1718	17	18	25	"Cartesian 1718"	1	1.7143	4.2857	1
1819	18	19	25	"Cartesian 1819"	1	3.4286	4.2857	1
1920	19	20	25	"Cartesian 1920"	1	5.1429	4.2857	1
2021	20	21	25	"Cartesian 2021"	1	6.8571	4.2857	1
2122	21	22	25	"Cartesian 2122"	1	8.5714	4.2857	1
2223	22	23	25	"Cartesian 2223"	1	10.286	4.2857	1
2425	24	25	25	"Cartesian 2425"	1	1.7143	6	1
2526	25	26	25	"Cartesian 2526"	1	3.4286	6	1
2627	26	27	25	"Cartesian 2627"	1	5.1429	6	1
2728	27	28	25	"Cartesian 2728"	1	6.8571	6	1
2829	28	29	25	"Cartesian 2829"	1	8.5714	6	1
2930	29	30	25	"Cartesian 2930"	1	10.286	6	1
3132	31	32	25	"Cartesian 3132"	1	1.7143	7.7143	1
3233	32	33	25	"Cartesian 3233"	1	3.4286	7.7143	1
3334	33	34	25	"Cartesian 3334"	1	5.1429	7.7143	1
3435	34	35	25	"Cartesian 3435"	1	6.8571	7.7143	1
3536	35	36	25	"Cartesian 3536"	1	8.5714	7.7143	1
3637	36	37	25	"Cartesian 3637"	1	10.286	7.7143	1
3839	38	39	25	"Cartesian 3839"	1	1.7143	9.4286	1
3940	39	40	25	"Cartesian 3940"	1	3.4286	9.4286	1
4041	40	41	25	"Cartesian 4041"	1	5.1429	9.4286	1
4142	41	42	25	"Cartesian 4142"	1	6.8571	9.4286	1
4243	42	43	25	"Cartesian 4243"	1	8.5714	9.4286	1
4344	43	44	25	"Cartesian 4344"	1	10.286	9.4286	1
4546	45	46	25	"Cartesian 4546"	1	1.7143	11.143	1
4647	46	47	25	"Cartesian 4647"	1	3.4286	11.143	1
4748	47	48	25	"Cartesian 4748"	1	5.1429	11.143	1
4849	48	49	25	"Cartesian 4849"	1	6.8571	11.143	1
4950	49	50	25	"Cartesian 4950"	1	8.5714	11.143	1
5051	50	51	25	"Cartesian 5051"	1	10.286	11.143	1
310	3	10	25	"Cartesian 310"	1	0.85714	1.7143	1
411	4	11	25	"Cartesian 411"	1	2.5714	1.7143	1
512	5	12	25	"Cartesian 512"	1	4.2857	1.7143	1

613	6	13	25	"Cartesian 613"	1	6	1.7143	1	1
714	7	14	25	"Cartesian 714"	1	7.7143	1.7143	1	1
815	8	15	25	"Cartesian 815"	1	9.4286	1.7143	1	1
916	9	16	25	"Cartesian 916"	1	11.143	1.7143	1	1
1017	10	17	25	"Cartesian 1017"	1	0.85714	3.4286	1	1
1118	11	18	25	"Cartesian 1118"	1	2.5714	3.4286	1	1
1219	12	19	25	"Cartesian 1219"	1	4.2857	3.4286	1	1
1320	13	20	25	"Cartesian 1320"	1	6	3.4286	1	1
1421	14	21	25	"Cartesian 1421"	1	7.7143	3.4286	1	1
1522	15	22	25	"Cartesian 1522"	1	9.4286	3.4286	1	1
1623	16	23	25	"Cartesian 1623"	1	11.143	3.4286	1	1
1724	17	24	25	"Cartesian 1724"	1	0.85714	5.1429	1	1
1825	18	25	25	"Cartesian 1825"	1	2.5714	5.1429	1	1
1926	19	26	25	"Cartesian 1926"	1	4.2857	5.1429	1	1
2027	20	27	25	"Cartesian 2027"	1	6	5.1429	1	1
2128	21	28	25	"Cartesian 2128"	1	7.7143	5.1429	1	1
2229	22	29	25	"Cartesian 2229"	1	9.4286	5.1429	1	1
2330	23	30	25	"Cartesian 2330"	1	11.143	5.1429	1	1
2431	24	31	25	"Cartesian 2431"	1	0.85714	6.8571	1	1
2532	25	32	25	"Cartesian 2532"	1	2.5714	6.8571	1	1
2633	26	33	25	"Cartesian 2633"	1	4.2857	6.8571	1	1
2734	27	34	25	"Cartesian 2734"	1	6	6.8571	1	1
2835	28	35	25	"Cartesian 2835"	1	7.7143	6.8571	1	1
2936	29	36	25	"Cartesian 2936"	1	9.4286	6.8571	1	1
3037	30	37	25	"Cartesian 3037"	1	11.143	6.8571	1	1
3138	31	38	25	"Cartesian 3138"	1	0.85714	8.5714	1	1
3239	32	39	25	"Cartesian 3239"	1	2.5714	8.5714	1	1
3340	33	40	25	"Cartesian 3340"	1	4.2857	8.5714	1	1
3441	34	41	25	"Cartesian 3441"	1	6	8.5714	1	1
3542	35	42	25	"Cartesian 3542"	1	7.7143	8.5714	1	1
3643	36	43	25	"Cartesian 3643"	1	9.4286	8.5714	1	1
3744	37	44	25	"Cartesian 3744"	1	11.143	8.5714	1	1
3845	38	45	25	"Cartesian 3845"	1	0.85714	10.286	1	1
3946	39	46	25	"Cartesian 3946"	1	2.5714	10.286	1	1
4047	40	47	25	"Cartesian 4047"	1	4.2857	10.286	1	1
4148	41	48	25	"Cartesian 4148"	1	6	10.286	1	1
4249	42	49	25	"Cartesian 4249"	1	7.7143	10.286	1	1
4350	43	50	25	"Cartesian 4350"	1	9.4286	10.286	1	1
4451	44	51	25	"Cartesian 4451"	1	11.143	10.286	1	1
BRANCH		OPTION -2	FLOW COEFF	AREA	DIRECTION	WALL	VELOCITY	DIRINDEX	
12			1	1e-06			0	1	
BRANCH		OPTION -24	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX	
34			1.7143	4.4082	1	4	0	1	
BRANCH		OPTION -24	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX	
45			1.7143	2.9388	1	4	0	2	
BRANCH		OPTION -24	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX	
56			1.7143	2.9388	1	4	0	3	

BRANCH	OPTION -24	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
67	OPTION -24	1.7143	2.9388	1	4	0	4
BRANCH	OPTION -24	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
78	OPTION -24	1.7143	2.9388	1	4	0	5
BRANCH	OPTION -24	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
89	OPTION -24	1.7143	4.4082	1	4	0	6
BRANCH	OPTION -24	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
1011	OPTION -24	1.7143	4. BRANCH	OPTION -2	WALL	VELOCITY	DIRINDEX
12	OPTION -25	1	1e-06	OPTION -2	WALL	FLOW	AREA
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
34	OPTION -25	1.7143	4.4082	1	0	0	1
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
45	OPTION -25	1.7143	2.9388	1	0	0	2
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
56	OPTION -25	1.7143	2.9388	1	0	0	3
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
67	OPTION -25	1.7143	2.9388	1	0	0	4
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
78	OPTION -25	1.7143	2.9388	1	0	0	5
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
89	OPTION -25	1.7143	4.4082	1	0	0	6
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
1011	OPTION -25	1.7143	4.4082	1	0	0	1
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
112	OPTION -25	1.7143	2.9388	1	0	0	2
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
123	OPTION -25	1.7143	2.9388	1	0	0	3
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
134	OPTION -25	1.7143	2.9388	1	0	0	4
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
145	OPTION -25	1.7143	2.9388	1	0	0	5
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
156	OPTION -25	1.7143	4.4082	1	0	0	6
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
178	OPTION -25	1.7143	4.4082	1	0	0	1
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
189	OPTION -25	1.7143	2.9388	1	0	0	2
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
190	OPTION -25	1.7143	2.9388	1	0	0	3
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
2021	OPTION -25	1.7143	2.9388	1	0	0	4
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
2122	OPTION -25	1.7143	2.9388	1	0	0	5
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
2223	OPTION -25	1.7143	4.4082	1	0	0	6
BRANCH	OPTION -25	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
2425	OPTION -25	1.7143	4.4082	1	0	0	1

BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
2526	1.7143	2.9388	1	0	0	2
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
2627	1.7143	2.9388	1	0	0	3
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
2728	1.7143	2.9388	1	0	0	4
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
2829	1.7143	2.9388	1	0	0	5
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
2930	1.7143	4.4082	1	0	0	6
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
3132	1.7143	4.4082	1	0	0	1
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
3233	1.7143	2.9388	1	0	0	2
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
3334	1.7143	2.9388	1	0	0	3
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
3435	1.7143	2.9388	1	0	0	4
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
3536	1.7143	2.9388	1	0	0	5
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
3637	1.7143	4.4082	1	0	0	6
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
3839	1.7143	4.4082	1	0	0	1
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
3940	1.7143	2.9388	1	0	0	2
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
4041	1.7143	2.9388	1	0	0	3
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
4142	1.7143	2.9388	1	0	0	4
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
4243	1.7143	2.9388	1	0	0	5
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
4344	1.7143	4.4082	1	0	0	6
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
4546	1.7143	4.4082	1	2	100	1
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
4647	1.7143	2.9388	1	2	100	2
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
4748	1.7143	2.9388	1	2	100	3
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
4849	1.7143	2.9388	1	2	100	4
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
4950	1.7143	2.9388	1	2	100	5
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX
5051	1.7143	4.4082	1	2	100	6
BRANCH	AREA	VOLUME	DIRECTION	WALL	VELOCITY	DIRINDEX

1314	3	1213	613	1320
1415	3	1314	714	1421
1516	3	1415	815	1522
1718	2	1017	1724	
1819	3	1718	1118	1825
1920	3	1819	1219	1926
2021	3	1920	1320	2027
2122	3	2021	1421	2128
2223	3	2122	1522	2229
2425	2	1724	2431	
2526	3	2425	1825	2532
2627	3	2526	1926	2633
2728	3	2627	2027	2734
2829	3	2728	2128	2835
2930	3	2829	2229	2936
3132	2	2431	3138	
3233	3	3132	2532	3239
3334	3	3233	2633	3340
3435	3	3334	2734	3441
3536	3	3435	2835	3542
3637	3	3536	2936	3643
3839	2	3138	3845	
3940	3	3839	3239	3946
4041	3	3940	3340	4047
4142	3	4041	3441	4148
4243	3	4142	3542	4249
4344	3	4243	3643	4350
4546	1	3845		
4647	2	4546	3946	
4748	2	4647	4047	
4849	2	4748	4148	
4950	2	4849	4249	
5051	2	4950	4350	
310	1	34		
411	2	34	45	
512	2	45	56	
613	2	56	67	
714	2	67	78	
815	2	78	89	
916	1	89		
1017	2	1011	310	
1118	3	1011	1112	411
1219	3	1112	1213	512
1320	3	1213	1314	613
1421	3	1314	1415	714
1522	3	1415	1516	815
1623	2	1516	916	

2223	2	1623	2330		
2425	3	2526	1825	2532	
2526	3	2627	1926	2633	
2627	3	2728	2027	2734	
2728	3	2829	2128	2835	
2829	3	2930	2229	2936	
2930	2	2330	3037		
3132	3	3233	2532	3239	
3233	3	3334	2633	3340	
3334	3	3435	2734	3441	
3435	3	3536	2835	3542	
3536	3	3637	2936	3643	
3637	2	3037	3744		
3839	3	3940	3239	3946	
3940	3	4041	3340	4047	
4041	3	4142	3441	4148	
4142	3	4243	3542	4249	
4243	3	4344	3643	4350	
4344	2	3744	4451		
4546	2	4647	3946		
4647	2	4748	4047		
4748	2	4849	4148		
4849	2	4950	4249		
4950	2	5051	4350		
5051	2	12	4451		
310	2	1011	1017		
411	3	1011	1112	1118	
512	3	1112	1213	1219	
613	3	1213	1314	1320	
714	3	1314	1415	1421	
815	3	1415	1516	1522	
916	2	1516	1623		
1017	2	1718	1724		
1118	3	1718	1819	1825	
1219	3	1819	1920	1926	
1320	3	1920	2021	2027	
1421	3	2021	2122	2128	
1522	3	2122	2223	2229	
1623	2	2223	2330		
1724	2	2425	2431		
1825	3	2425	2526	2532	
1926	3	2526	2627	2633	
2027	3	2627	2728	2734	
2128	3	2728	2829	2835	
2229	3	2829	2930	2936	
2330	2	2930	3037		
2431	2	3132	3138		

2532	3	3132	3233	3239
2633	3	3233	3334	3340
2734	3	3334	3435	3441
2835	3	3435	3536	3542
2936	3	3536	3637	3643
3037	2	3637	3744	
3138	2	3839	3845	
3239	3	3839	3940	3946
3340	3	3940	4041	4047
3441	3	4041	4142	4148
3542	3	4142	4243	4249
3643	3	4243	4344	4350
3744	2	4344	4451	
3845	1	4546		
3946	2	4546	4647	
4047	2	4647	4748	
4148	2	4748	4849	
4249	2	4849	4950	
4350	2	4950	5051	
4451	2	12	5051	
BRANCH				
12				
UPSTRM BR.	ANGLE			
5051	0.00000			
4451	0.00000			
DNSTRM BR.	ANGLE			
BRANCH				
34				
UPSTRM BR.	ANGLE			
310	0.00000			
DNSTRM BR.	ANGLE			
45	0.00000			
411	0.00000			
BRANCH				
45				
UPSTRM BR.	ANGLE			
34	0.00000			
411	0.00000			
DNSTRM BR.	ANGLE			
56	0.00000			
512	0.00000			
BRANCH				
56				
UPSTRM BR.	ANGLE			
45	0.00000			
512	0.00000			
DNSTRM BR.	ANGLE			

```

67      0.00000
613    0.00000
BRANCH
67
UPSTRM BR.    ANGLE
56      0.00000
613    0.00000
DNSTRM BR.    ANGLE
78      0.00000
714    0.00000
BRANCH
78
UPSTRM BR.    ANGLE
67      0.00000
714    0.00000
DNSTRM BR.    ANGLE
89      0.00000
815    0.00000
BRANCH
89
UPSTRM BR.    ANGLE
78      0.00000
815    0.00000
DNSTRM BR.    ANGLE
916    0.00000
BRANCH
1011
UPSTRM BR.    ANGLE
310    0.00000
1017   0.00000
DNSTRM BR.    ANGLE
1112   0.00000
411    0.00000
1118   0.00000
BRANCH
1112
UPSTRM BR.    ANGLE
1011   0.00000
411    0.00000
1118   0.00000
DNSTRM BR.    ANGLE
1213   0.00000
512    0.00000
1219   0.00000
BRANCH
1213
UPSTRM BR.    ANGLE

```

1112	0.00000
512	0.00000
1219	0.00000
DNSTRM BR.	ANGLE
1314	0.00000
613	0.00000
1320	0.00000
BRANCH	
1314	
UPSTRM BR.	ANGLE
1213	0.00000
613	0.00000
1320	0.00000
DNSTRM BR.	ANGLE
1415	0.00000
714	0.00000
1421	0.00000
BRANCH	
1415	
UPSTRM BR.	ANGLE
1314	0.00000
714	0.00000
1421	0.00000
DNSTRM BR.	ANGLE
1516	0.00000
815	0.00000
1522	0.00000
BRANCH	
1516	
UPSTRM BR.	ANGLE
1415	0.00000
815	0.00000
1522	0.00000
DNSTRM BR.	ANGLE
916	0.00000
1623	0.00000
BRANCH	
1718	
UPSTRM BR.	ANGLE
1017	0.00000
1724	0.00000
DNSTRM BR.	ANGLE
1819	0.00000
1118	0.00000
1825	0.00000
BRANCH	
1819	

UPSTRM BR.	ANGLE
1718	0.00000
1118	0.00000
1825	0.00000
DNSTRM BR.	ANGLE
1920	0.00000
1219	0.00000
1926	0.00000
BRANCH	
1920	
UPSTRM BR.	ANGLE
1819	0.00000
1219	0.00000
1926	0.00000
DNSTRM BR.	ANGLE
2021	0.00000
1320	0.00000
2027	0.00000
BRANCH	
2021	
UPSTRM BR.	ANGLE
1920	0.00000
1320	0.00000
2027	0.00000
DNSTRM BR.	ANGLE
2122	0.00000
1421	0.00000
2128	0.00000
BRANCH	
2122	
UPSTRM BR.	ANGLE
2021	0.00000
1421	0.00000
2128	0.00000
DNSTRM BR.	ANGLE
2223	0.00000
1522	0.00000
2229	0.00000
BRANCH	
2223	
UPSTRM BR.	ANGLE
2122	0.00000
1522	0.00000
2229	0.00000
DNSTRM BR.	ANGLE
1623	0.00000
2330	0.00000

BRANCH			
2425			
UPSTRM BR.	ANGLE		
1724	0.00000		
2431	0.00000		
DNSTRM BR.	ANGLE		
2526	0.00000		
1825	0.00000		
2532	0.00000		
BRANCH			
2526			
UPSTRM BR.	ANGLE		
2425	0.00000		
1825	0.00000		
2532	0.00000		
DNSTRM BR.	ANGLE		
2627	0.00000		
1926	0.00000		
2633	0.00000		
BRANCH			
2627			
UPSTRM BR.	ANGLE		
2526	0.00000		
1926	0.00000		
2633	0.00000		
DNSTRM BR.	ANGLE		
2728	0.00000		
2027	0.00000		
2734	0.00000		
BRANCH			
2728			
UPSTRM BR.	ANGLE		
2627	0.00000		
2027	0.00000		
2734	0.00000		
DNSTRM BR.	ANGLE		
2829	0.00000		
2128	0.00000		
2835	0.00000		
BRANCH			
2829			
UPSTRM BR.	ANGLE		
2728	0.00000		
2128	0.00000		
2835	0.00000		
DNSTRM BR.	ANGLE		
2930	0.00000		

2229	0.00000
2936	0.00000
BRANCH	
2930	
UPSTRM BR.	ANGLE
2829	0.00000
2229	0.00000
2936	0.00000
DNSTRM BR.	ANGLE
2330	0.00000
3037	0.00000
BRANCH	
3132	
UPSTRM BR.	ANGLE
2431	0.00000
3138	0.00000
DNSTRM BR.	ANGLE
3233	0.00000
2532	0.00000
3239	0.00000
BRANCH	
3233	
UPSTRM BR.	ANGLE
3132	0.00000
2532	0.00000
3239	0.00000
DNSTRM BR.	ANGLE
3334	0.00000
2633	0.00000
3340	0.00000
BRANCH	
3334	
UPSTRM BR.	ANGLE
3233	0.00000
2633	0.00000
3340	0.00000
DNSTRM BR.	ANGLE
3435	0.00000
2734	0.00000
3441	0.00000
BRANCH	
3435	
UPSTRM BR.	ANGLE
3334	0.00000
2734	0.00000
3441	0.00000
DNSTRM BR.	ANGLE

3536	0.00000
2835	0.00000
3542	0.00000
BRANCH	
3536	
UPSTRM BR.	ANGLE
3435	0.00000
2835	0.00000
3542	0.00000
DNSTRM BR.	ANGLE
3637	0.00000
2936	0.00000
3643	0.00000
BRANCH	
3637	
UPSTRM BR.	ANGLE
3536	0.00000
2936	0.00000
3643	0.00000
DNSTRM BR.	ANGLE
3037	0.00000
3744	0.00000
BRANCH	
3839	
UPSTRM BR.	ANGLE
3138	0.00000
3845	0.00000
DNSTRM BR.	ANGLE
3940	0.00000
3239	0.00000
3946	0.00000
BRANCH	
3940	
UPSTRM BR.	ANGLE
3839	0.00000
3239	0.00000
3946	0.00000
DNSTRM BR.	ANGLE
4041	0.00000
3340	0.00000
4047	0.00000
BRANCH	
4041	
UPSTRM BR.	ANGLE
3940	0.00000
3340	0.00000
4047	0.00000

DNSTRM BR.	ANGLE
4142	0.00000
3441	0.00000
4148	0.00000
BRANCH	
4142	
UPSTRM BR.	ANGLE
4041	0.00000
3441	0.00000
4148	0.00000
DNSTRM BR.	ANGLE
4243	0.00000
3542	0.00000
4249	0.00000
BRANCH	
4243	
UPSTRM BR.	ANGLE
4142	0.00000
3542	0.00000
4249	0.00000
DNSTRM BR.	ANGLE
4344	0.00000
3643	0.00000
4350	0.00000
BRANCH	
4344	
UPSTRM BR.	ANGLE
4243	0.00000
3643	0.00000
4350	0.00000
DNSTRM BR.	ANGLE
3744	0.00000
4451	0.00000
BRANCH	
4546	
UPSTRM BR.	ANGLE
3845	0.00000
DNSTRM BR.	ANGLE
4647	0.00000
3946	0.00000
BRANCH	
4647	
UPSTRM BR.	ANGLE
4546	0.00000
3946	0.00000
DNSTRM BR.	ANGLE
4748	0.00000

4047	0.00000
BRANCH	
4748	
UPSTRM BR.	ANGLE
4647	0.00000
4047	0.00000
DNSTRM BR.	ANGLE
4849	0.00000
4148	0.00000
BRANCH	
4849	
UPSTRM BR.	ANGLE
4748	0.00000
4148	0.00000
DNSTRM BR.	ANGLE
4950	0.00000
4249	0.00000
BRANCH	
4950	
UPSTRM BR.	ANGLE
4849	0.00000
4249	0.00000
DNSTRM BR.	ANGLE
5051	0.00000
4350	0.00000
BRANCH	
5051	
UPSTRM BR.	ANGLE
4950	0.00000
4350	0.00000
DNSTRM BR.	ANGLE
12	0.00000
4451	0.00000
BRANCH	
310	
UPSTRM BR.	ANGLE
34	0.00000
DNSTRM BR.	ANGLE
1011	0.00000
1017	0.00000
BRANCH	
411	
UPSTRM BR.	ANGLE
34	0.00000
45	0.00000
DNSTRM BR.	ANGLE
1011	0.00000

1112	0.00000
1118	0.00000
BRANCH	
512	
UPSTRM BR.	ANGLE
45	0.00000
56	0.00000
DNSTRM BR.	ANGLE
1112	0.00000
1213	0.00000
1219	0.00000
BRANCH	
613	
UPSTRM BR.	ANGLE
56	0.00000
67	0.00000
DNSTRM BR.	ANGLE
1213	0.00000
1314	0.00000
1320	0.00000
BRANCH	
714	
UPSTRM BR.	ANGLE
67	0.00000
78	0.00000
DNSTRM BR.	ANGLE
1314	0.00000
1415	0.00000
1421	0.00000
BRANCH	
815	
UPSTRM BR.	ANGLE
78	0.00000
89	0.00000
DNSTRM BR.	ANGLE
1415	0.00000
1516	0.00000
1522	0.00000
BRANCH	
916	
UPSTRM BR.	ANGLE
89	0.00000
DNSTRM BR.	ANGLE
1516	0.00000
1623	0.00000
BRANCH	
1017	

UPSTRM BR.	ANGLE
1011	0.00000
310	0.00000
DNSTRM BR.	ANGLE
1718	0.00000
1724	0.00000
BRANCH	
1118	
UPSTRM BR.	ANGLE
1011	0.00000
1112	0.00000
411	0.00000
DNSTRM BR.	ANGLE
1718	0.00000
1819	0.00000
1825	0.00000
BRANCH	
1219	
UPSTRM BR.	ANGLE
1112	0.00000
1213	0.00000
512	0.00000
DNSTRM BR.	ANGLE
1819	0.00000
1920	0.00000
1926	0.00000
BRANCH	
1320	
UPSTRM BR.	ANGLE
1213	0.00000
1314	0.00000
613	0.00000
DNSTRM BR.	ANGLE
1920	0.00000
2021	0.00000
2027	0.00000
BRANCH	
1421	
UPSTRM BR.	ANGLE
1314	0.00000
1415	0.00000
714	0.00000
DNSTRM BR.	ANGLE
2021	0.00000
2122	0.00000
2128	0.00000
BRANCH	

1522
UPSTRM BR. ANGLE
1415 0.00000
1516 0.00000
815 0.00000
DNSTRM BR. ANGLE
2122 0.00000
2223 0.00000
2229 0.00000
BRANCH
1623
UPSTRM BR. ANGLE
1516 0.00000
916 0.00000
DNSTRM BR. ANGLE
2223 0.00000
2330 0.00000
BRANCH
1724
UPSTRM BR. ANGLE
1718 0.00000
1017 0.00000
DNSTRM BR. ANGLE
2425 0.00000
2431 0.00000
BRANCH
1825
UPSTRM BR. ANGLE
1718 0.00000
1819 0.00000
1118 0.00000
DNSTRM BR. ANGLE
2425 0.00000
2526 0.00000
2532 0.00000
BRANCH
1926
UPSTRM BR. ANGLE
1819 0.00000
1920 0.00000
1219 0.00000
DNSTRM BR. ANGLE
2526 0.00000
2627 0.00000
2633 0.00000
BRANCH
2027

UPSTRM BR.	ANGLE
1920	0.00000
2021	0.00000
1320	0.00000
DNSTRM BR.	ANGLE
2627	0.00000
2728	0.00000
2734	0.00000
BRANCH	
2128	
UPSTRM BR.	ANGLE
2021	0.00000
2122	0.00000
1421	0.00000
DNSTRM BR.	ANGLE
2728	0.00000
2829	0.00000
2835	0.00000
BRANCH	
2229	
UPSTRM BR.	ANGLE
2122	0.00000
2223	0.00000
1522	0.00000
DNSTRM BR.	ANGLE
2829	0.00000
2930	0.00000
2936	0.00000
BRANCH	
2330	
UPSTRM BR.	ANGLE
2223	0.00000
1623	0.00000
DNSTRM BR.	ANGLE
2930	0.00000
3037	0.00000
BRANCH	
2431	
UPSTRM BR.	ANGLE
2425	0.00000
1724	0.00000
DNSTRM BR.	ANGLE
3132	0.00000
3138	0.00000
BRANCH	
2532	
UPSTRM BR.	ANGLE

2425	0.00000
2526	0.00000
1825	0.00000
DNSTRM BR.	ANGLE
3132	0.00000
3233	0.00000
3239	0.00000
BRANCH	
2633	
UPSTRM BR.	ANGLE
2526	0.00000
2627	0.00000
1926	0.00000
DNSTRM BR.	ANGLE
3233	0.00000
3334	0.00000
3340	0.00000
BRANCH	
2734	
UPSTRM BR.	ANGLE
2627	0.00000
2728	0.00000
2027	0.00000
DNSTRM BR.	ANGLE
3334	0.00000
3435	0.00000
3441	0.00000
BRANCH	
2835	
UPSTRM BR.	ANGLE
2728	0.00000
2829	0.00000
2128	0.00000
DNSTRM BR.	ANGLE
3435	0.00000
3536	0.00000
3542	0.00000
BRANCH	
2936	
UPSTRM BR.	ANGLE
2829	0.00000
2930	0.00000
2229	0.00000
DNSTRM BR.	ANGLE
3536	0.00000
3637	0.00000
3643	0.00000

BRANCH			
3037			
UPSTRM BR.	ANGLE		
2930	0.00000		
2930	0.00000		
DNSTRM BR.	ANGLE		
3637	0.00000		
3744	0.00000		
BRANCH			
3138			
UPSTRM BR.	ANGLE		
3132	0.00000		
2431	0.00000		
DNSTRM BR.	ANGLE		
3839	0.00000		
3845	0.00000		
BRANCH			
3239			
UPSTRM BR.	ANGLE		
3132	0.00000		
3233	0.00000		
2532	0.00000		
DNSTRM BR.	ANGLE		
3839	0.00000		
3940	0.00000		
3946	0.00000		
BRANCH			
3340			
UPSTRM BR.	ANGLE		
3233	0.00000		
3334	0.00000		
2633	0.00000		
DNSTRM BR.	ANGLE		
3940	0.00000		
4041	0.00000		
4047	0.00000		
BRANCH			
3441			
UPSTRM BR.	ANGLE		
3334	0.00000		
3435	0.00000		
2734	0.00000		
DNSTRM BR.	ANGLE		
4041	0.00000		
4142	0.00000		
4148	0.00000		
BRANCH			

3542
 UPSTRM BR. ANGLE
 3435 0.00000
 3536 0.00000
 2835 0.00000
 DNSTRM BR. ANGLE
 4142 0.00000
 4243 0.00000
 4249 0.00000
 BRANCH
 3643
 UPSTRM BR. ANGLE
 3536 0.00000
 3637 0.00000
 2936 0.00000
 DNSTRM BR. ANGLE
 4243 0.00000
 4344 0.00000
 4350 0.00000
 BRANCH
 3744
 UPSTRM BR. ANGLE
 3637 0.00000
 3037 0.00000
 DNSTRM BR. ANGLE
 4344 0.00000
 4451 0.00000
 BRANCH
 3845
 UPSTRM BR. ANGLE
 3839 0.00000
 3138 0.00000
 DNSTRM BR. ANGLE
 4546 0.00000
 BRANCH
 3946
 UPSTRM BR. ANGLE
 3839 0.00000
 3940 0.00000
 3239 0.00000
 DNSTRM BR. ANGLE
 4546 0.00000
 4647 0.00000
 BRANCH
 4047
 UPSTRM BR. ANGLE
 3940 0.00000

4041 0.00000
3340 0.00000
DNSTRM BR. ANGLE
4647 0.00000
4748 0.00000
BRANCH

4148
UPSTRM BR. ANGLE
4041 0.00000
4142 0.00000
3441 0.00000
DNSTRM BR. ANGLE
4748 0.00000
4849 0.00000
BRANCH

4249
UPSTRM BR. ANGLE
4142 0.00000
4243 0.00000
3542 0.00000
DNSTRM BR. ANGLE
4849 0.00000
4950 0.00000
BRANCH

4350
UPSTRM BR. ANGLE
4243 0.00000
4344 0.00000
3643 0.00000
DNSTRM BR. ANGLE
4950 0.00000
5051 0.00000
BRANCH

4451
UPSTRM BR. ANGLE
4344 0.00000
3744 0.00000
DNSTRM BR. ANGLE
12 0.00000
5051 0.00000

NUMBER OF BRANCHES WITH INERTIA

84
34
45
56
67
78

89
1011
1112
1213
1314
1415
1516
1718
1819
1920
2021
2122
2223
2425
2526
2627
2728
2829
2930
3132
3233
3334
3435
3536
3637
3839
3940
4041
4142
4243
4344
4546
4647
4748
4849
4950
5051
310
411
512
613
714
815
916
1017
1118
1219

1320
1421
1522
1623
1724
1825
1926
2027
2128
2229
2330
2431
2532
2633
2734
2835
2936
3037
3138
3239
3340
3441
3542
3643
3744
3845
3946
4047
4148
4249
4350
4451

 G F S P (Version 604)
 Generalized Fluid System Simulation Program
 March 2012

Developed by NASA/Marshall Space Flight Center
 Copyright (C) by Marshall Space Flight Center

A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

RUN DATE:10/15/2012 15:56

TITLE :Driven_Cavity
 ANALYST :akm
 FILEIN :D:\GFSSP604Intel\Examples\EX25\Ex25Oct15.dat
 FILEOUT :Ex25Oct15.out

OPTION VARIABLES

ADDPROP	F	BUOYANCY	COND	F	CONJUG	F	CYCLIC	F	DALTON	T	DENCON	F	ENERGY
FLOWREG	0	GRAVITY	HCOEF	F	HEX	F	HRATE	T	IFRMIX	T	INERTIA	F	INSUC
INVAL	F	MIXTURE	MOVEND	F	MSORCE	F	NORMAL	F	NRSOLVT	F	OPVALVE	F	PLOTADD
PRESREG	0	PRESS	PRINTI	F	PRNTADD	T	PRNTIN	T	RADIATION	F	REACTING	F	ROTATION
SAVER	F	SECONDL	SHEAR	T	SIMULA	F	SIUNITS	F	STEADY	T	THRUST	F	TPA
TRANS_MOM	F	TRANSQ	TRANSV	F	TVM	T	TWOD	F	USRVAR	F	VARGEO	F	VARROT

RLFVLV
 F

NNODES = 50
 NINT = 49
 NBR = 85
 NF = 0
 NVAR = 134
 Nhref = 2

RHOREF = 1.0000 LBM/FT**3
 EMUREF = 0.1000E+01 LBM/FT-SEC

BOUNDARY NODES			
NODE	P (PSI)	AREA (IN^2)	HEAT (BTU/S)
2	0.1470E+02	0.0000E+00	
INPUT SPECIFICATIONS FOR INTERNAL NODES			
NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)
3	0.0000E+00	0.0000E+00	0.0000E+00
4	0.0000E+00	0.0000E+00	0.0000E+00
5	0.0000E+00	0.0000E+00	0.0000E+00
6	0.0000E+00	0.0000E+00	0.0000E+00
7	0.0000E+00	0.0000E+00	0.0000E+00
8	0.0000E+00	0.0000E+00	0.0000E+00
9	0.0000E+00	0.0000E+00	0.0000E+00
10	0.0000E+00	0.0000E+00	0.0000E+00
11	0.0000E+00	0.0000E+00	0.0000E+00
12	0.0000E+00	0.0000E+00	0.0000E+00
13	0.0000E+00	0.0000E+00	0.0000E+00
14	0.0000E+00	0.0000E+00	0.0000E+00
15	0.0000E+00	0.0000E+00	0.0000E+00
16	0.0000E+00	0.0000E+00	0.0000E+00
17	0.0000E+00	0.0000E+00	0.0000E+00
18	0.0000E+00	0.0000E+00	0.0000E+00
19	0.0000E+00	0.0000E+00	0.0000E+00
20	0.0000E+00	0.0000E+00	0.0000E+00
21	0.0000E+00	0.0000E+00	0.0000E+00
22	0.0000E+00	0.0000E+00	0.0000E+00
23	0.0000E+00	0.0000E+00	0.0000E+00
24	0.0000E+00	0.0000E+00	0.0000E+00
25	0.0000E+00	0.0000E+00	0.0000E+00
26	0.0000E+00	0.0000E+00	0.0000E+00
27	0.0000E+00	0.0000E+00	0.0000E+00
28	0.0000E+00	0.0000E+00	0.0000E+00
29	0.0000E+00	0.0000E+00	0.0000E+00
30	0.0000E+00	0.0000E+00	0.0000E+00
31	0.0000E+00	0.0000E+00	0.0000E+00
32	0.0000E+00	0.0000E+00	0.0000E+00
33	0.0000E+00	0.0000E+00	0.0000E+00
34	0.0000E+00	0.0000E+00	0.0000E+00
35	0.0000E+00	0.0000E+00	0.0000E+00
36	0.0000E+00	0.0000E+00	0.0000E+00
37	0.0000E+00	0.0000E+00	0.0000E+00
38	0.0000E+00	0.0000E+00	0.0000E+00
39	0.0000E+00	0.0000E+00	0.0000E+00
40	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH	UPNODE	DNNODE	OPTION
41	0.0000E+00	0.0000E+00	0.0000E+00
42	0.0000E+00	0.0000E+00	0.0000E+00
43	0.0000E+00	0.0000E+00	0.0000E+00
44	0.0000E+00	0.0000E+00	0.0000E+00
45	0.0000E+00	0.0000E+00	0.0000E+00
46	0.0000E+00	0.0000E+00	0.0000E+00
47	0.0000E+00	0.0000E+00	0.0000E+00
48	0.0000E+00	0.0000E+00	0.0000E+00
49	0.0000E+00	0.0000E+00	0.0000E+00
50	0.0000E+00	0.0000E+00	0.0000E+00
51	0.0000E+00	0.0000E+00	0.0000E+00
12	51	2	2
34	3	4	25
45	4	5	25
56	5	6	25
67	6	7	25
78	7	8	25
89	8	9	25
1011	10	11	25
1112	11	12	25
1213	12	13	25
1314	13	14	25
1415	14	15	25
1516	15	16	25
1718	17	18	25
1819	18	19	25
1920	19	20	25
2021	20	21	25
2122	21	22	25
2223	22	23	25
2425	24	25	25
2526	25	26	25
2627	26	27	25
2728	27	28	25
2829	28	29	25
2930	29	30	25
3132	31	32	25
3233	32	33	25
3334	33	34	25
3435	34	35	25
3536	35	36	25
3637	36	37	25
3839	38	39	25
3940	39	40	25
4041	40	41	25

4142	41	42	25
4243	42	43	25
4344	43	44	25
4445	44	45	25
4546	45	46	25
4647	46	47	25
4748	47	48	25
4849	48	49	25
4950	49	50	25
5051	50	51	25
310	3	10	25
411	4	11	25
512	5	12	25
613	6	13	25
714	7	14	25
815	8	15	25
916	9	16	25
1017	10	17	25
1118	11	18	25
1219	12	19	25
1320	13	20	25
1421	14	21	25
1522	15	22	25
1623	16	23	25
1724	17	24	25
1825	18	25	25
1926	19	26	25
2027	20	27	25
2128	21	28	25
2229	22	29	25
2330	23	30	25
2431	24	31	25
2532	25	32	25
2633	26	33	25
2734	27	34	25
2835	28	35	25
2936	29	36	25
3037	30	37	25
3138	31	38	25
3239	32	39	25
3340	33	40	25
3441	34	41	25
3542	35	42	25
3643	36	43	25
3744	37	44	25
3845	38	45	25
3946	39	46	25
4047	40	47	25

4148	41	48	25
4249	42	49	25
4350	43	50	25
4451	44	51	25

BRANCH OPTION -2: FLOW COEF AREA
 12 0.100E+01 0.100E-05

SOLUTION INTERNAL NODE	NODES P (PSI)	EM (LBM)
3	0.1456E+02	0.0000E+00
4	0.1462E+02	0.0000E+00
5	0.1467E+02	0.0000E+00
6	0.1467E+02	0.0000E+00
7	0.1464E+02	0.0000E+00
8	0.1460E+02	0.0000E+00
9	0.1457E+02	0.0000E+00
10	0.1458E+02	0.0000E+00
11	0.1460E+02	0.0000E+00
12	0.1463E+02	0.0000E+00
13	0.1465E+02	0.0000E+00
14	0.1464E+02	0.0000E+00
15	0.1462E+02	0.0000E+00
16	0.1460E+02	0.0000E+00
17	0.1460E+02	0.0000E+00
18	0.1459E+02	0.0000E+00
19	0.1459E+02	0.0000E+00
20	0.1461E+02	0.0000E+00
21	0.1463E+02	0.0000E+00
22	0.1465E+02	0.0000E+00
23	0.1466E+02	0.0000E+00
24	0.1462E+02	0.0000E+00
25	0.1458E+02	0.0000E+00
26	0.1455E+02	0.0000E+00
27	0.1455E+02	0.0000E+00
28	0.1460E+02	0.0000E+00
29	0.1468E+02	0.0000E+00
30	0.1474E+02	0.0000E+00
31	0.1461E+02	0.0000E+00
32	0.1458E+02	0.0000E+00
33	0.1454E+02	0.0000E+00
34	0.1453E+02	0.0000E+00
35	0.1459E+02	0.0000E+00
36	0.1469E+02	0.0000E+00
37	0.1478E+02	0.0000E+00
38	0.1455E+02	0.0000E+00

BRANCHES	BRANCH	(LBF-S^2/(LBM-FT)^2)	KFACTOR	DELTA (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
	39	0.1455E+02	0.0000E+00							
	40	0.1455E+02	0.0000E+00							
	41	0.1458E+02	0.0000E+00							
	42	0.1464E+02	0.0000E+00							
	43	0.1468E+02	0.0000E+00							
	44	0.1476E+02	0.0000E+00							
	45	0.1436E+02	0.0000E+00							
	46	0.1455E+02	0.0000E+00							
	47	0.1466E+02	0.0000E+00							
	48	0.1471E+02	0.0000E+00							
	49	0.1468E+02	0.0000E+00							
	50	0.1466E+02	0.0000E+00							
	51	0.1470E+02	0.0000E+00							
	12	0.322E+15	-0.316E-13	-0.115E-10	-0.165E-02	0.155E-06	0.000E+00	0.136E-23	0.486E-18	
	34	0.322E+15	-0.634E-01	-0.220E+00	-0.185E+02	0.228E+01	0.000E+00	0.962E+07	0.344E+13	
	45	0.322E+15	-0.456E-01	-0.338E+00	-0.284E+02	0.349E+01	0.000E+00	0.347E+08	0.124E+14	
	56	0.322E+15	-0.344E-02	-0.369E+00	-0.310E+02	0.381E+01	0.000E+00	0.451E+08	0.161E+14	
	67	0.322E+15	0.286E-01	-0.331E+00	-0.278E+02	0.342E+01	0.000E+00	0.327E+08	0.117E+14	
	78	0.322E+15	0.410E-01	-0.244E+00	-0.205E+02	0.252E+01	0.000E+00	0.131E+08	0.467E+13	
	89	0.322E+15	0.289E-01	-0.128E+00	-0.107E+02	0.132E+01	0.000E+00	0.189E+07	0.675E+12	
	1011	0.322E+15	-0.237E-01	-0.167E+00	-0.140E+02	0.172E+01	0.000E+00	0.418E+07	0.149E+13	
	1112	0.322E+15	-0.317E-01	-0.279E+00	-0.234E+02	0.289E+01	0.000E+00	0.196E+08	0.700E+13	
	1213	0.322E+15	-0.146E-01	-0.328E+00	-0.276E+02	0.340E+01	0.000E+00	0.319E+08	0.114E+14	
	1314	0.322E+15	0.599E-02	-0.318E+00	-0.267E+02	0.329E+01	0.000E+00	0.290E+08	0.104E+14	
	1415	0.322E+15	0.231E-01	-0.256E+00	-0.215E+02	0.264E+01	0.000E+00	0.151E+08	0.538E+13	
	1516	0.322E+15	0.205E-01	-0.144E+00	-0.121E+02	0.149E+01	0.000E+00	0.271E+07	0.971E+12	
	1718	0.322E+15	0.195E-01	-0.976E-01	-0.820E+01	0.101E+01	0.000E+00	0.838E+06	0.300E+12	
	1819	0.322E+15	-0.190E-02	-0.189E+00	-0.158E+02	0.195E+01	0.000E+00	0.604E+07	0.216E+13	
	1920	0.322E+15	-0.185E-01	-0.250E+00	-0.210E+02	0.258E+01	0.000E+00	0.140E+08	0.502E+13	
	2021	0.322E+15	-0.224E-01	-0.270E+00	-0.227E+02	0.279E+01	0.000E+00	0.178E+08	0.636E+13	
	2122	0.322E+15	-0.223E-01	-0.233E+00	-0.196E+02	0.241E+01	0.000E+00	0.114E+08	0.409E+13	
	2223	0.322E+15	-0.119E-01	-0.134E+00	-0.112E+02	0.138E+01	0.000E+00	0.215E+07	0.768E+12	
	2425	0.322E+15	0.368E-01	-0.367E-01	-0.308E+01	0.380E+00	0.000E+00	0.446E+05	0.160E+11	
	2526	0.322E+15	0.289E-01	-0.870E-01	-0.731E+01	0.900E+00	0.000E+00	0.594E+06	0.212E+12	
	2627	0.322E+15	-0.241E-02	-0.132E+00	-0.111E+02	0.137E+01	0.000E+00	0.209E+07	0.748E+12	
	2728	0.322E+15	-0.457E-01	-0.160E+00	-0.135E+02	0.166E+01	0.000E+00	0.371E+07	0.133E+13	
	2829	0.322E+15	-0.855E-01	-0.138E+00	-0.116E+02	0.143E+01	0.000E+00	0.237E+07	0.846E+12	
	2930	0.322E+15	-0.535E-01	-0.796E-01	-0.668E+01	0.823E+00	0.000E+00	0.454E+06	0.162E+11	
	3132	0.322E+15	0.279E-01	0.921E-02	0.773E+00	0.952E-01	0.000E+00	0.703E+03	0.252E+09	
	3233	0.322E+15	0.364E-01	0.183E-01	0.153E+01	0.189E+00	0.000E+00	0.550E+04	0.197E+10	
	3334	0.322E+15	0.892E-02	0.258E-01	0.217E+01	0.267E+00	0.000E+00	0.155E+05	0.556E+11	
	3435	0.322E+15	-0.620E-01	0.465E-01	0.390E+01	0.481E+00	0.000E+00	0.904E+05	0.323E+11	
	3536	0.322E+15	-0.101E+00	0.451E-01	0.378E+01	0.466E+00	0.000E+00	0.824E+05	0.295E+11	

3637	0.322E+15	-0.826E-01	0.738E-02	0.620E+00	0.763E-01	0.000E+00	0.361E+03	0.129E+09
3839	0.322E+15	0.126E-03	0.801E-01	0.673E+01	0.829E+00	0.000E+00	0.464E+06	0.166E+12
3940	0.322E+15	-0.178E-02	0.187E+00	0.157E+02	0.194E+01	0.000E+00	0.593E+07	0.212E+13
4041	0.322E+15	-0.289E-01	0.287E+00	0.241E+02	0.297E+01	0.000E+00	0.213E+08	0.763E+13
4142	0.322E+15	-0.625E-01	0.338E+00	0.284E+02	0.350E+01	0.000E+00	0.349E+08	0.125E+14
4243	0.322E+15	-0.380E-01	0.273E+00	0.229E+02	0.282E+01	0.000E+00	0.183E+08	0.655E+13
4344	0.322E+15	-0.746E-01	0.132E+00	0.111E+02	0.136E+01	0.000E+00	0.206E+07	0.735E+12
4546	0.322E+15	-0.190E+00	0.432E+00	0.363E+02	0.447E+01	0.000E+00	0.726E+08	0.260E+14
4647	0.322E+15	-0.112E+00	0.687E+00	0.577E+02	0.710E+01	0.000E+00	0.292E+09	0.104E+15
4748	0.322E+15	-0.488E-01	0.766E+00	0.643E+02	0.792E+01	0.000E+00	0.405E+09	0.145E+15
4849	0.322E+15	0.323E-01	0.695E+00	0.584E+02	0.719E+01	0.000E+00	0.303E+09	0.108E+15
4950	0.322E+15	0.204E-01	0.553E+00	0.464E+02	0.572E+01	0.000E+00	0.152E+09	0.545E+14
5051	0.322E+15	-0.411E-01	0.346E+00	0.291E+02	0.358E+01	0.000E+00	0.375E+08	0.134E+14
310	0.322E+15	-0.216E-01	0.220E+00	0.185E+02	0.228E+01	0.000E+00	0.962E+07	0.344E+13
411	0.322E+15	0.181E-01	0.118E+00	0.987E+01	0.122E+01	0.000E+00	0.146E+07	0.523E+12
512	0.322E+15	0.320E-01	0.308E-01	0.259E+01	0.319E+00	0.000E+00	0.263E+05	0.942E+10
613	0.322E+15	0.209E-01	-0.375E-01	-0.315E+01	0.388E+00	0.000E+00	0.475E+05	0.170E+11
714	0.322E+15	-0.171E-02	-0.872E-01	-0.733E+01	0.902E+00	0.000E+00	0.598E+06	0.214E+12
815	0.322E+15	-0.197E-01	-0.116E+00	-0.974E+01	0.120E+01	0.000E+00	0.140E+07	0.502E+12
916	0.322E+15	-0.281E-01	-0.128E+00	-0.107E+02	0.132E+01	0.000E+00	0.189E+07	0.675E+12
1017	0.322E+15	-0.263E-01	0.387E+00	0.325E+02	0.400E+01	0.000E+00	0.522E+08	0.187E+14
1118	0.322E+15	0.169E-01	0.230E+00	0.193E+02	0.238E+01	0.000E+00	0.109E+08	0.391E+13
1219	0.322E+15	0.467E-01	0.800E-01	0.672E+01	0.828E+00	0.000E+00	0.462E+06	0.165E+12
1320	0.322E+15	0.428E-01	-0.477E-01	-0.401E+01	0.493E+00	0.000E+00	0.979E+05	0.350E+11
1421	0.322E+15	0.144E-01	-0.150E+00	-0.126E+02	0.155E+01	0.000E+00	0.302E+07	0.108E+13
1522	0.322E+15	-0.310E-01	-0.227E+00	-0.191E+02	0.235E+01	0.000E+00	0.106E+08	0.378E+13
1623	0.322E+15	-0.634E-01	-0.272E+00	-0.229E+02	0.282E+01	0.000E+00	0.182E+08	0.651E+13
1724	0.322E+15	-0.120E-01	0.485E+00	0.407E+02	0.501E+01	0.000E+00	0.103E+09	0.367E+14
1825	0.322E+15	0.524E-02	0.321E+00	0.270E+02	0.332E+01	0.000E+00	0.298E+08	0.106E+14
1926	0.322E+15	0.361E-01	0.141E+00	0.119E+02	0.146E+01	0.000E+00	0.253E+07	0.905E+12
2027	0.322E+15	0.521E-01	-0.272E-01	-0.228E+01	0.281E+00	0.000E+00	0.180E+05	0.645E+10
2128	0.322E+15	0.288E-01	-0.187E+00	-0.157E+02	0.193E+01	0.000E+00	0.585E+07	0.209E+13
2229	0.322E+15	-0.343E-01	-0.327E+00	-0.275E+02	0.338E+01	0.000E+00	0.315E+08	0.113E+14
2330	0.322E+15	-0.759E-01	-0.406E+00	-0.341E+02	0.420E+01	0.000E+00	0.603E+08	0.216E+14
2431	0.322E+15	0.113E-01	0.521E+00	0.438E+02	0.539E+01	0.000E+00	0.128E+09	0.457E+14
2532	0.322E+15	0.239E-02	0.371E+00	0.312E+02	0.384E+01	0.000E+00	0.461E+08	0.165E+14
2633	0.322E+15	0.985E-02	0.187E+00	0.157E+02	0.193E+01	0.000E+00	0.585E+07	0.209E+13
2734	0.322E+15	0.212E-01	0.713E-03	0.599E-01	0.737E-02	0.000E+00	0.326E+00	0.117E+06
2835	0.322E+15	0.494E-02	-0.209E+00	-0.175E+02	0.216E+01	0.000E+00	0.821E+07	0.294E+13
2936	0.322E+15	-0.102E-01	-0.385E+00	-0.324E+02	0.398E+01	0.000E+00	0.515E+08	0.184E+14
3037	0.322E+15	-0.394E-01	-0.485E+00	-0.408E+02	0.502E+01	0.000E+00	0.103E+09	0.369E+14
3138	0.322E+15	0.539E-01	0.512E+00	0.430E+02	0.503E+01	0.000E+00	0.121E+09	0.433E+14
3239	0.322E+15	0.261E-01	0.362E+00	0.304E+02	0.374E+01	0.000E+00	0.428E+08	0.153E+14
3340	0.322E+15	-0.121E-01	0.179E+00	0.150E+02	0.185E+01	0.000E+00	0.516E+07	0.185E+13
3441	0.322E+15	-0.499E-01	-0.199E+00	-0.167E+01	0.206E+00	0.000E+00	0.711E+04	0.254E+10
3542	0.322E+15	-0.504E-01	-0.207E+00	-0.174E+02	0.215E+01	0.000E+00	0.805E+07	0.288E+13
3643	0.322E+15	0.122E-01	-0.348E+00	-0.292E+02	0.360E+01	0.000E+00	0.378E+08	0.135E+14

3744	0.322E+15	0.202E-01	-0.478E+00	-0.402E+02	0.494E+01	0.000E+00	0.985E+08	0.352E+14
3845	0.322E+15	0.191E+00	0.432E+00	0.363E+02	0.447E+01	0.000E+00	0.726E+08	0.260E+14
3946	0.322E+15	0.991E-03	0.255E+00	0.214E+02	0.264E+01	0.000E+00	0.149E+08	0.533E+13
4047	0.322E+15	-0.109E+00	0.792E-01	0.665E+01	0.819E+00	0.000E+00	0.447E+06	0.160E+12
4148	0.322E+15	-0.129E+00	-0.709E-01	-0.596E+01	0.733E+00	0.000E+00	0.321E+06	0.115E+12
4249	0.322E+15	-0.345E-01	-0.142E+00	-0.119E+02	0.147E+01	0.000E+00	0.259E+07	0.926E+12
4350	0.322E+15	0.239E-01	-0.206E+00	-0.173E+02	0.213E+01	0.000E+00	0.792E+07	0.283E+13
4451	0.322E+15	0.574E-01	-0.346E+00	-0.291E+02	0.358E+01	0.000E+00	0.375E+08	0.134E+14

TIME OF ANALYSIS WAS 4.281250000000 SECS
