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LOFT LOCE TRANSIENT THERMAL ANALYSIS FOR 6 IN., 8 IN., 10 IN., and 12 IN. PRIMARY COOLANT BLOWDOWN PIPING

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DEPARTMENT OF ENERGY

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RESEARCH, ENGINEERING AND CONSTRUCTION REPORT
ENGINEERING ANALYSIS DIVISION

THERMAL ANALYSIS

LOFT LOCE TRANSIENT THERMAL ANALYSIS FOR 6 IN., 8 IN., 10 IN., AND 12 IN. PRIMARY COOLANT BLOWDOWN PIPING

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IDAHO NATIONAL ENGINEERING LABORATORY
LOFT TECHNICAL REPORT
LOFT PROGRAM

TITLE	REPORT NO.
LOFT LOCE Transient Thermal Analysis For 6 In., 8 In., 10 In., and 12 In. Primary Coolant Blowdown Piping	LTR 12 118

AUTHOR	GWA NO.
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SUMMARY

Several sections of the LOFT primary coolant blowdown piping were analyzed for temperature transients occurring during a Loss of Coolant Experiment (LOCE). The LOCE fluid conditions were chosen to conservatively represent the most severe operating conditions occurring in the piping[1,2]. Temperature gradients will be used by the Applied Mechanics Branch to determine thermal stresses and the allowable thermal cycles for the piping. The only other significant thermal cycle (heat-up or cooldown) was not analyzed because the DT's for this cycle for the pipe sections analyzed will be small (<15°F) and will have a very minor effect on the allowable number of thermal cycles.

8 inch - Sch 160, 10 inch - Sch 140, 12 inch - Sch 160, and a special 6 inch section of stainless steel piping were analyzed. The temperature gradients for each case were expressed in the DT form required for the ASME Section III pipe equations[3]. DT values are tabulated in the report and have been forwarded to the Applied Mechanics Branch for stress analysis. Specific details and assumptions used in this analysis are found in appropriate sections of this report. Complete microfiche copies of the computer runs are contained in Appendix B.

1.0 INTRODUCTION

Components used in the primary cooling blowdown loop of LOFT face severe temperature gradients due to the transients experienced during a LOCE. Prior to a LOCE, piping is at a steady state temperature of 610°F [1] in the hot leg of the cooling loop. As the blowdown proceeds, the pressure in the system drops rapidly during a short time interval. As the pressure falls below saturation pressure of the cooling water, boiling commences in the pipes. Since the water temperature is a function of pressure in this case, the inside of the pipe is exposed to a rapid temperature transient. The magnitude of the thermal gradient is increased further by large heat transfer coefficients due to two phase flow and nucleate boiling on the inside pipe surface. Only the conditions of the hot leg portion of the blowdown loop was analyzed here, as it experienced more severe transients than the cold leg. COUPLE/MOD2[4], a two-dimensional finite element heat conduction code, was used to calculate DT's for input into the ASME Section III pipe equations[3].

2.0 ANALYSIS

Figures 1, 2, 3, and 4 show the axisymmetric finite element models of the 6 inch, 8 inch, 10 inch, and 12 inch blowdown loop piping, respectively. The pipe sections examined were not adjacent to any tees, elbows, valves, etc., so a one-dimensional axisymmetric model was assumed. The pipe dimensions are given in Table I. All pipes are of ASME SA312 Grade 316 stainless steel, having temperature dependent properties listed in Table II[5]. Linear interpolation was used to derive values intermediate to the temperatures listed.

Proper heat transfer coefficients and boundary temperatures are vital to an accurate thermal-hydraulic model. The pipe heat transfer

coefficients were selected for the worst case blowdown from data provided by the blowdown specifications[1,6]. During the initial phase of a LOCE, a coefficient of 10,000 Btu/hr-ft^2-°F was used to represent nucleate boiling heat transfer for 13 seconds. After 13 seconds a coefficient of 100 Btu/hr-ft^2-°F was used to represent the time the reactor vessel was filling with emergency core coolant (ECC). This coefficient was used out to 40 seconds, during which time the heat transfer occurs from forced convection of superheated steam on the pipe surface. After 44 seconds a heat transfer coefficient of 1,000 Btu/hr-ft^2-°F was used as representing the ECC flowing through the pipe. The heat transfer coefficients and respective times are listed in Table III.

The outside boundary coefficients were computed as a combination of free air convection and thermal conductivity[7] of 3 inches of insulation with a thermal conductivity of 0.0042 Btu/hr-in-°F. The specific heat of the insulation was ignored in this analysis, but it is so small relative to the pipe that the errors introduced would be negligible. An effective outside convection coefficient of 0.17 Btu/hr-ft^2°F was used in this analysis.

Inside boundary temperatures were selected representing the fastest blowdown anticipated for LOFT[1,6]. These temperatures are given as a function of time in Table IV. Linear interpolation was used to derive temperatures between the times listed. An ambient air temperature of 100°F was used for the outside boundary.

TABLE I

Pipe Dimensions[8]

Model Number	Pipe	Inside Diameter (IN)	Outside Diameter (IN)
1	6"	4.063	6.00
2	8" SCH 160	6.813	8.625
3	10" SCH 140	8.75	10.75
4	12" SCH 160	10.126	12.75

TABLE II

Material Properties for 316 Stainless Steel Pipe[5]

Temp (°F)	Density (lbm/in^3)	Thermal Conductivity (Btu/hr-ft-°F)	Specific Heat (Btu/lbm-°F)
100	0.2841	8.5	0.111
212	0.2841	9.016	0.1181
302	0.2841	9.407	0.1222
392	0.2841	9.799	0.1253
482	0.2841	10.19	0.1275
617	0.2841	10.78	0.1298

TABLE III

Heat Transfer Coefficients Inside LOFT Blowdown Piping

As A Function Of Time

Time (sec)	Heat Transfer Coefficient (Btu/hr-ft^2-°F)
0.0 to 13.0	10,000
15.0 to 40.0	100
40.0 to 44.0	100 → 1,000
44.0 to ∞	1,000

- Outside effective convection coefficient = 0.17 Btu/hr-ft^2-°F

TABLE IV

Fluid Temperatures Inside LOFT Blowdown Piping

As A Function Of Time

Time (sec)	Temp (°F)
0.0	610
2.0	536
7.0	490
13.0	270
40.0	260
100.0	100
∞	100

3.0 RESULTS

Table V gives the DT's for the 4 pipes analyzed. A complete listing of each DT for every time increment is included in Appendix A. DT3 is zero in all cases, as would be expected.

Upon examining the behavior of DT's versus time, one can identify two peaks in the behavior of DT1 and DT2 corresponding to the heat transfer mechanism in operation at that time. During the first phase of a LOCE, when nucleate boiling is the predominant heat transfer mechanism, a large DT2 results from the high rate of heat transfer at the surface of the pipe. DT1 also increases during this phase but in the thicker pipe (12 inch) the magnitude of DT1 resulting from nucleate boiling heat transfer is less than the maximum DT1 occurring during the last phase of a LOCE, when forced convection heat transfer is the predominant mechanism. In the pipes with a wall thickness 1 inch and less (6, 7, and 10 inch), nucleate boiling causes the greatest temperature gradients in the pipe. These results are represented graphically in Figures 5 and 6. It should be apparent from the examination of DT behavior, that the assumptions used in determining heat transfer coefficients are critical in their effects on the maximum thermal gradients.

TABLE V

Maximum DT's In LOFT Primary Coolant Blowdown Piping

For A LOCE Transient

Pipe (in)	Thickness (in)	Maximum DT1 (°F)	Time (Sec)	Maximum DT2 (°F)	Time (sec)
6	0.9685	261.71	14	125.36	13
8	0.906	267.79	14	117.45	13
10	1.000	262.34	14	126.33	13
12	1.312	319.07	99	151.22	13

4.0 REFERENCES

1. LOFT Class 1 Nuclear Piping System, ANC-60139, Aerojet Nuclear Company, Idaho Falls, Idaho (January 15, 1973).

2. I. J. Ingvarsson, LOFT Blowdown Piping Loop Thermal Transient Analysis, LTR 112-41, EG&G Idaho, Inc. (August 29, 1974).

3. American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section III, Nuclear Power Plant Components (1974).

4. E. C. Lemmon and R. L. Moore, COUPLE/MOD2 - A Two-Dimensional Finite Element Steady State and Transient Heat Conduction Code with Inverse Capabilities for Use On A CDC Cyber 76/Cyber 173 Computer RE-A-77-017, EG&G Idaho, Inc., Engineering Division (June 1977).

5. Nuclear Systems Materials Handbook Vol. 1, Part 1, Group 1, Section 4, Hanford Engineering Development Laboratory, Richland, Washington (September 30, 1976 Revision).

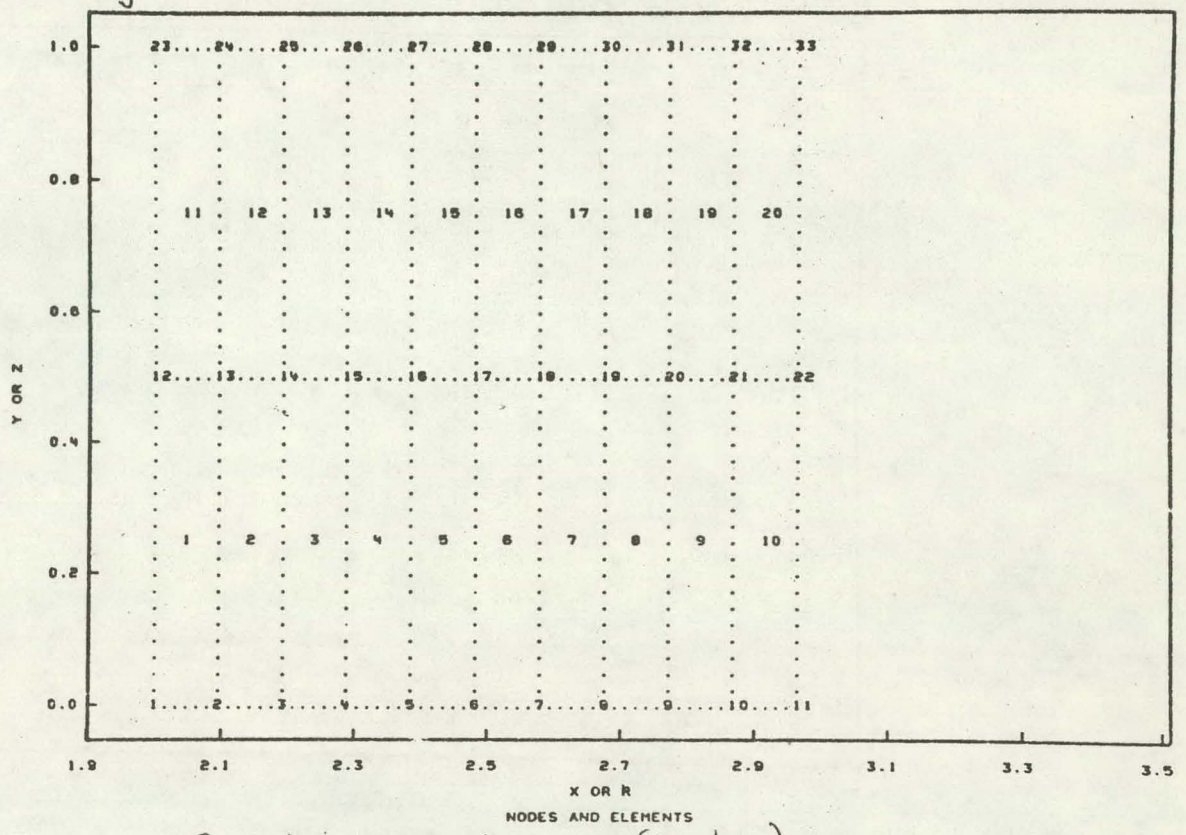
6. Personal communication with N. E. Pace, EG&G Idaho, Inc. (September 1977).

7. J. P. Holman, Heat Transfer, 3rd Edition, McGraw-Hill Book Co., Inc., New York (1972).

8. T. Baumeister and L. S. Marks, Standard Handbook for Mechanical Engineers, 7th Edition, McGraw-Hill Book Co., Inc., New York (1967).

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 6IN 316SST PIPE (ID=4.063IN,OD=6.00IN)
UNITS- BTU,IN,SEC,LB,DEG FAR

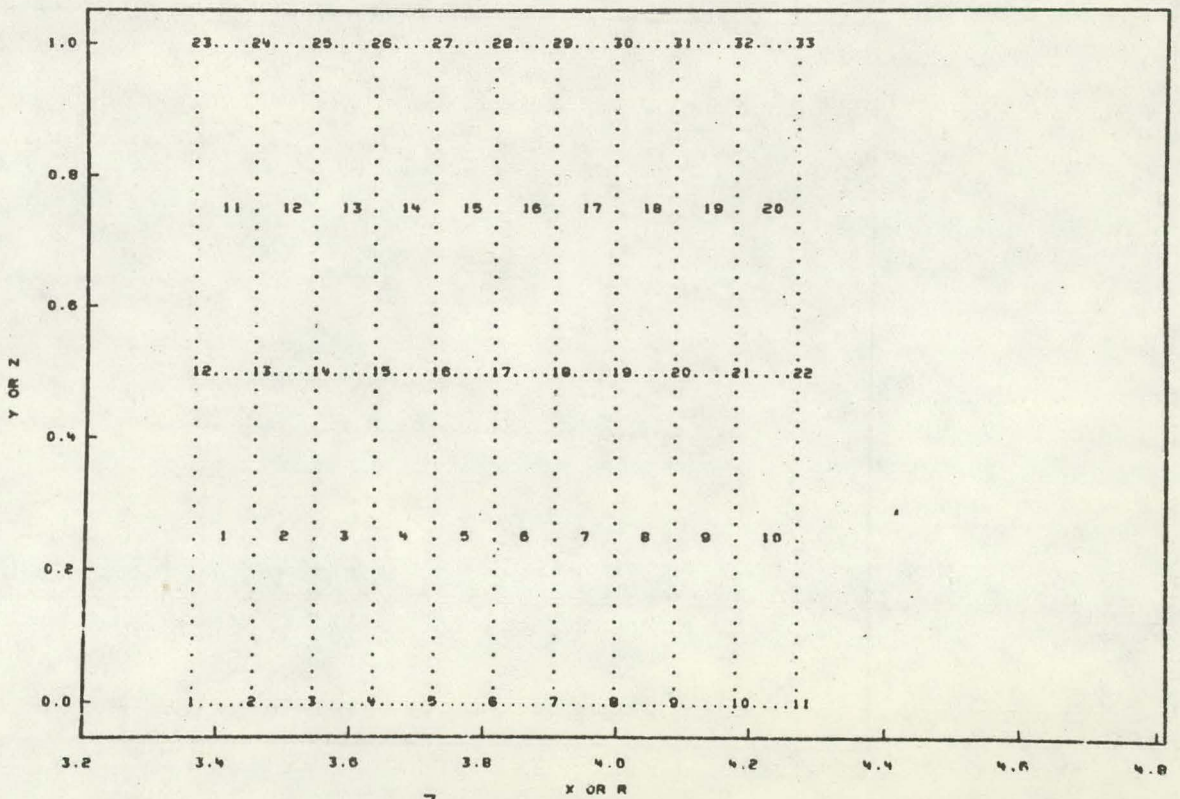
Fig. 1 Node and Element Mesh for 6in. pipe



Radial Direction (inches)

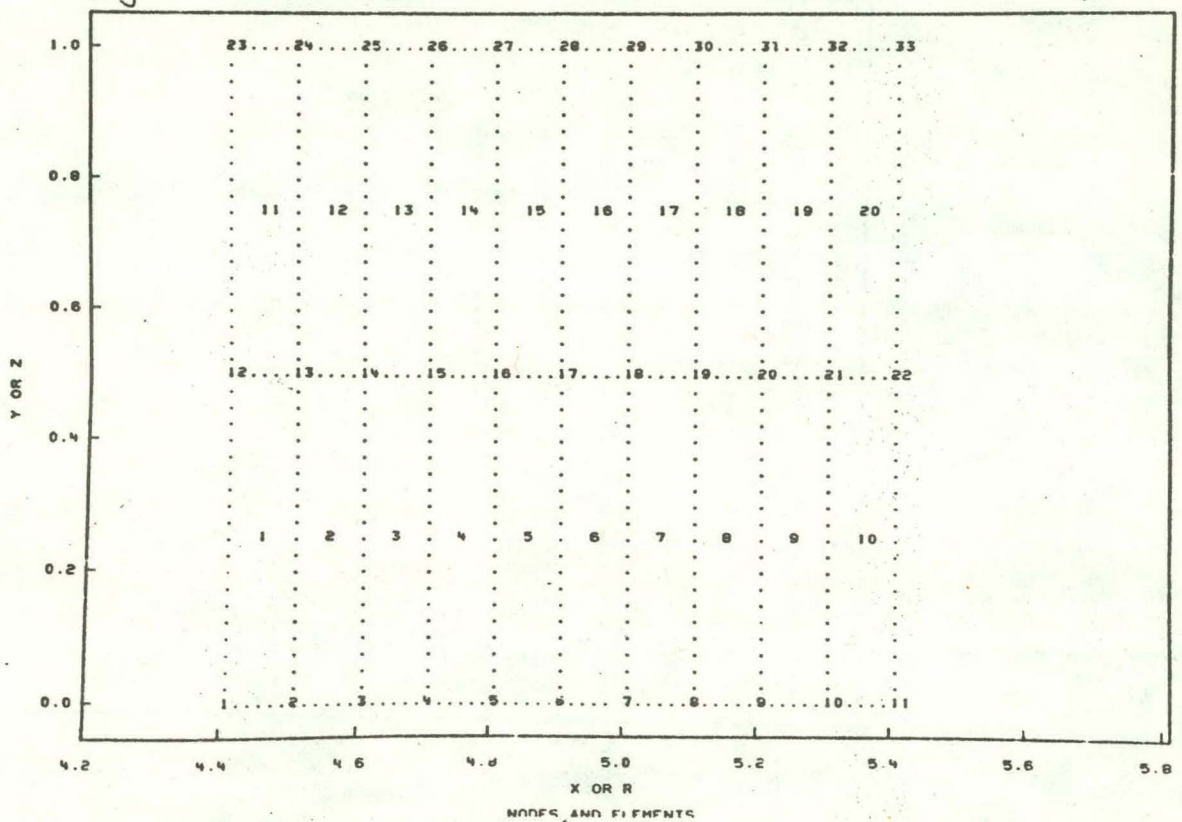
COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 8IN SCH 160 PIPE (ID=6.813IN,OD=8.625IN)
UNITS- BTU,IN,SEC,LB,DEG FAR

Fig. 2 Node and Element Mesh for 8in Pipe



COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 10 IN SCH 140 PIPE(ID=8.75,OD=10.75IN)
UNITS- BTU,IN,SEC,LB,DEG FAR

Fig. 5 Node and Element Mesh for 10 in. Pipe

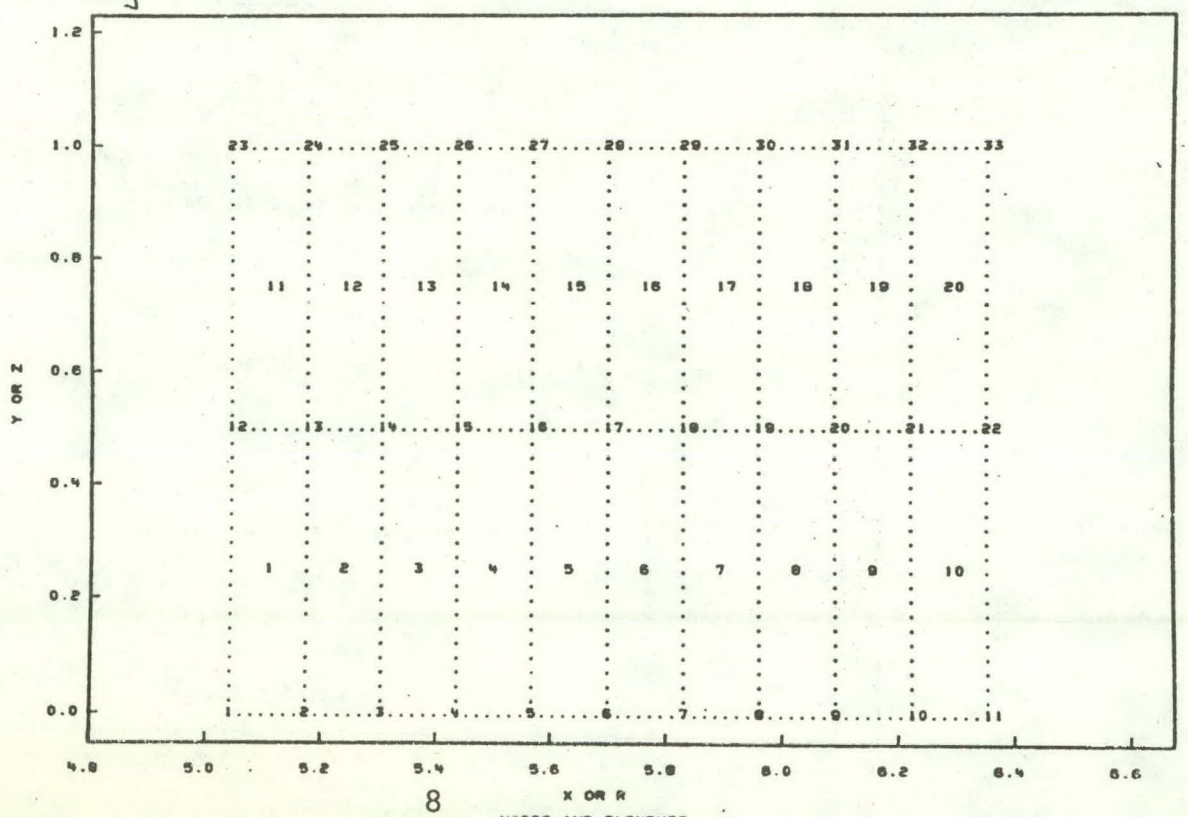


Radial Direction (inches)

Page 3

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 12 SCH 160 PIPE (ID=10.126,OD=12.75IN)
UNITS- BTU,IN,SEC,LB,DEG FAR

Fig. 4. Node and Element Mesh for 12 in. Pipe



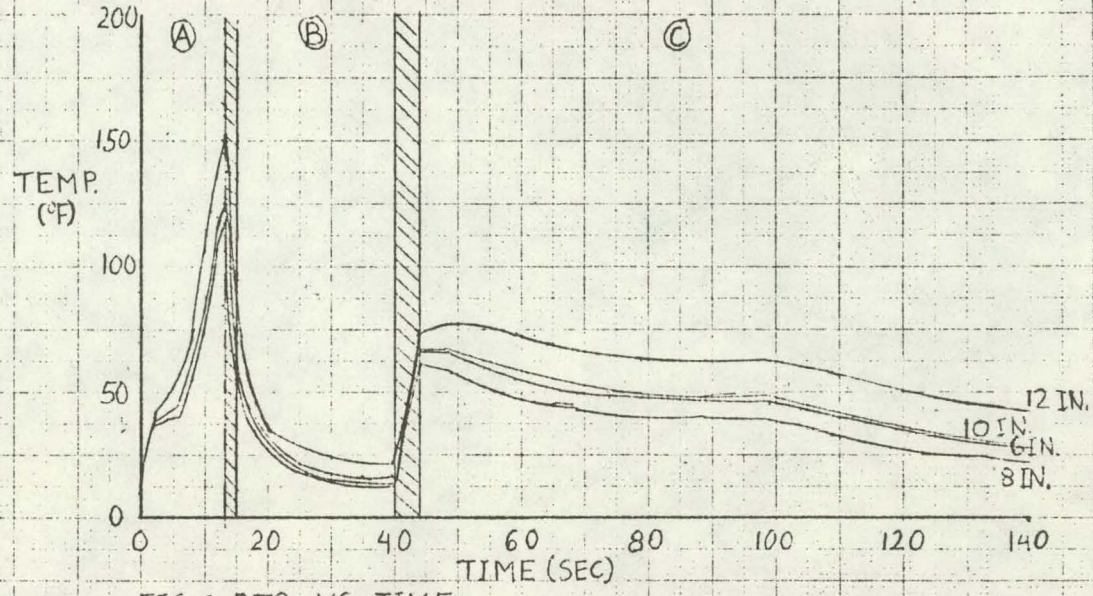


FIG. 6 DT2 VS. TIME

REGION Ⓐ → H = 10000 BTU/HR-°F-FT^2

Ⓑ → H = 100 BTU/HR-°F-FT^2

Ⓒ → H = 1000 BTU/HR-°F-FT^2

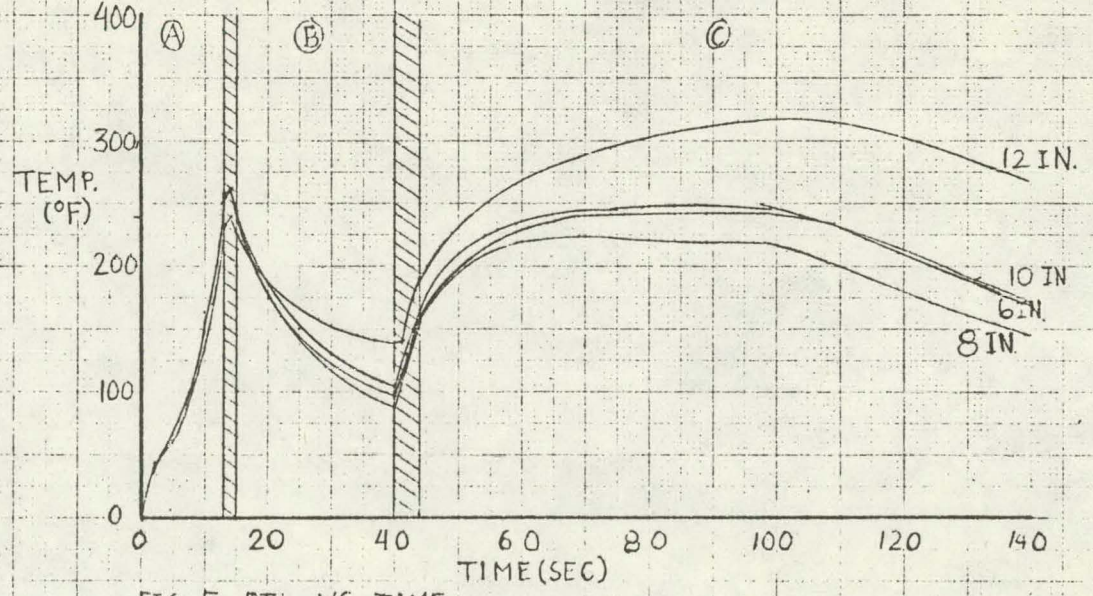


FIG. 5 DT1 VS. TIME

APPENDIX A

COMPUTER INPUT DATA ECHO

AND

DT LISTING FOR 6, 8, 10 AND 12 INCH PIPES

COMPUTER INPUT DATA

FOR 6, 8, 10, AND 12 INCH PIPES

```
0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

 1    TITLE
 2    LOFT LOCA RUN FOR 6IN SST PIPE (ID=4.063IN,OD=6.001N)
 3    UNITS=BTU,IN,SEC,R,LBM,DEG-F
 4
 5    AUTOMESH
 6         11    3     1     0
 7          1   1  2.0315      0.0   1   3   2.0315      1.0                    1
 8         11   1   3.0        0.0   1   1   2.03150     0.0                    1
 9          1   3  2.0315      1.0  11   3   3.0         1.0                    1
10         11   3   3.000      1.0  11   1   3.000       0.0                    1
11
12          1    1   11    1     3
13
14    MATERIAL
15          1    1
16          1          0.2841   316 SST DENSITY IN LB/IN3
17    2.31500E-5                 1.0          1           2
18
19    STEP
20       0.0        170.0                    3     1   000.0        10     2
21
22
23    FUNCTIONS
24          6
25          1     6     2      THERMAL CONDUCTIVITY (BTU/HR-FT-F)
26        100.0       8.5      212.0        9.016     302.0        9.407
27        392.0       9.799    482.0       10.19      617.0       10.78
28          2     6     2      SPECIFIC HEAT (BTU/LBM-F)
29        100.0       0.111    212.0        0.1161    302.0        0.1222
30        392.0       0.1253   482.0        0.1275    617.0        0.1298
31          3     6     1      TIME INCREMENT (SEC)
32          0.0         0.5      12.5         0.5       12.7         1.0
33         43.8         1.0      43.9         5.0      100.0         5.0
34          4     6     1      INSIDE TEMPERATURE (F)
35          0.0       610.0        2.0        536.0       7.0        490.0
36         13.0       270.0       40.0        200.0     100.0        100.0
37          5     6     1      INSIDE CONVECTION COEF.(BTU/SEC-IN2-F)
38          0.0    1.92770E-2     13.0     1.92770E-2    15.0     1.92770E-4
39         40.0    1.92770E-4     44.0     1.92770E-3   100.0     1.92770E-3
40          6     2     1      EFFECTIVE OUTSIDE CONV. COEF. (BTU/HR-FT2-F)
41          0.0         0.17     100.0        0.17
42
43    CONVECTSETS
44          6
45          1     1     1     3    1.0                 5    1.0                4
46         11     1    11    31.92900E-5                6    100.0
47
48    GT123
49          1
50        2.0315      0.5        2.0315      1.0         3.0         1.0

0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

Input Data
for 6 in. Pipe

```
0        1        2        3        4        5        6        7        8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

```
51        3.0      0.5      3.0      0.0      2.0315   0.0
52
53   PLOTS
54        1    0    2
55
56   COUPLE
57
58   END OF DATA
```

(6 in con't)

```
0        1        2        3        4        5        6        7        8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

A-3

LTR 112. 116

```
0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

TITLE
LOFT LOCE RUN FOR 8IN SCH 160 PIPE (ID=6.813IN,OD=8.625IN)
UNITS- BTU,IN,SEC,LB,DEG FAR

AUTOMESH
   11     3     1     0
    1   1  3.4065      0.0   1   3   3.40650     1.0                          1
   11   1  4.3125      0.0   1   1   3.4065      0.0                          1
    1   3  3.4065      1.0  11   3   4.3125      1.0                          1
   11   3  4.3125      1.0  11   1   4.3125      0.0                          1

      1     1    11     1     3

MATERIAL
      1     1
      1          0.2841    316 SST DENSITY IN LB/IN3
2.31500E-5                    1.0          1            2

STEP
    0.0         170.0                     3     1  600.0       10     2
                                0

FUNCTIONS
      6
      1     6     2       THERMAL CONDUCTIVITY (BTU/HR-FT-F)
  100.0         8.5         212.0         9.016     302.0         9.407
  392.0         9.799       482.0        10.19      617.0        10.78
      2     6     2       SPECIFIC HEAT (BTU/LBM-F)
  100.0         0.111       212.0         0.1181    302.0         0.1222
  392.0         0.1253      482.0         0.1275    617.0         0.1298
      3     6     1       TIME INCREMENT (SEC)
    0.0         0.5          12.6         0.5         12.7        1.0
   43.8         1.0          43.9         5.0        100.0        5.0
      4     6     1       INSIDE TEMPERATURE (F)
    0.0       610.0           2.0       530.0          7.0      490.0
   13.0       270.0          40.0       260.0        100.0      100.0
      5     6     1       INSIDE CONVECTION COEF.(BTU/SEC-IN2-F)
    0.0     1.92770E-2       13.0     1.92770E-2      15.0     1.92770E-4
   40.0     1.92770E-4       44.0     1.92770E-3     100.0     1.92770E-3
      6     2     1       EFFECTIVE OUTSIDE CONV. COEF. (BTU/HR-F22-F)
    0.0         0.17         100.0         0.17

CONVECTSETS
      6
      1     1     1     3   1.0                   5   1.0                 4
     11     1    11     3   1.92900E-6            6   100.0

DT123
      1
3.4065      0.5         3.4065      1.0         4.3125      1.0

0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

4.3125      0.5         4.3125                  3.4065

PLOTS
      1     0     2

COUPLE

END OF DATA

0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

Input Data for 8 in. Pipe

A-4

LTR 112 116

```
0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

TITLE
LOFT LOCE RUN FOR 10 IN SCH 140 PIPE(ID=8.75,OD=10.75IN)
UNITS- BTU,IN,SEC,LB,DEG FAR

AUTOMESH
   11    3     1     0
 11   3   5.375      1.0 11   1   5.375      0.0                          1
 11   1   5.375      0.0  1   1   4.375      0.0                          1
  1   3   4.375      1.0 11   3   5.375      1.0                          1
  1   1   4.375      0.0  1   3   4.375      1.0                          1

    1    1   11    1    3

MATERIAL
    1     1
    1          0.2841   316 SST DENSITY IN LB/IN3
2.31500E-5                1.0          1            2

STEP
   0.0        170.0                    3    1  600.0       10    2
                        0

FUNCTIONS
    6
    1     6     2      THERMAL CONDUCTIVITY (BTU/HR-FT-F)
  100.0       8.5       212.0       9.016     302.0       9.407
  392.0       9.799     482.0      10.19      617.0      10.78
    2     6     2      SPECIFIC HEAT (BTU/LBM-F)
  100.0       0.111     212.0       0.1181    302.0       0.1222
  392.0       0.1253    482.0       0.1275    617.0       0.1298
    3     6     1      TIME INCREMENT (SEC)
    0.0       0.5      12.6         0.5      12.7         1.0
   43.8       1.0      43.9         5.0     100.0         5.0
    4     6     1      INSIDE TEMPERATURE (F)
    0.0     610.0       2.0       536.0       7.0       490.0
   13.0     270.0      40.0       260.0     100.0       100.0
    5     6     1      INSIDE CONVECTION COEF.(BTU/SEC-IN2-F)
    0.0   1.92770E-2   13.0     1.92770E-2   15.0     1.92770E-4
   40.0   1.92770E-4   44.0     1.92770E-3  100.0     1.92770E-3
    6     2     1      EFFECTIVE OUTSIDE CONV. COEF. (BTU/HR-F22-F)
    0.0       0.17     100.0       0.17

CONVECTIETS
    6
    1     1     1     3   1.0                 5   1.0                  4
   11     1    11     3  1.92900E-5           6   100.0

DT123
    1
4.375      0.5       4.375      1.0       5.375      1.0

0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

5.375      0.5       5.375      0.0       4.375      0.0

PLOTS
    1     0     2

COUPLE

END OF DATA

0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

Input Data for 10 in. Pipe

```
0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

TITLE
LOFT LOCE RUN FOR 12 SCH 160 PIPE (ID=10.126,OD=12.75IN)
UNITS- BTU,IN,SEC,LB,DEG FAR

AUTOMESH
   11     3     1     0
 11   16.375     0.0       1   1 5.0630    0.0                                  1
  1   15.0630    0.0       1   3 5.0630    1.0                                  1
  1   35.0630    1.0      11   3 6.375     1.0                                  1
 11   36.375     1.0      11   1 6.375     0.0                                  1

    1    1   11    1    3

MATERIAL
    1    1
    1        0.2841    316 SST DENSITY IN LB/IN3
2.31500E-5                 1.0          1          2

STEP
   0.0       170.0                    3    1  600.0      10    2
                    0

FUNCTIONS
    6
    1     6     2       THERMAL CONDUCTIVITY (BTU/HR-FT-F)
  100.0      8.5         212.0       9.016      302.0      9.407
  392.0      9.799       482.0      10.19       617.0     10.78
    2     6     2       SPECIFIC HEAT (BTU/LBM-F)
  100.0      0.111       212.0       0.1181     302.0      0.1222
  392.0      0.1253      482.0       0.1275     617.0      0.1298
    3     6     1       TIME INCREMENT (SEC)
    0.0      0.5         12.6        0.5        12.7       1.0
   43.8      1.0         43.9        5.0       100.0       5.0
    4     6     1       INSIDE TEMPERATURE (F)
    0.0    610.0          2.0      536.0         7.0      490.0
   13.0    270.0         40.0      260.0       100.0      100.0
    5     6     1       INSIDE CONVECTION COEF.(BTU/SEC-IN2-F)
    0.0    1.92770E-2    13.0      1.92770E-2   15.0      1.92770E-4
   40.0    1.92770E-4    44.0      1.92770E-3  100.0      1.92770E-3
    6     2     1       EFFECTIVE OUTSIDE CONV. COEF. (BTU/HR-F22-F)
    0.0      0.17        100.0       0.17

CONVECTSETS
    6
    1     1     1     3    1.0                 5   1.0                  4
   11     1    11     31.92900E-6             6   100.0

DT123
    1
5.0630     0.5       5.0630     1.0       6.375      1.0

0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

6.375      0.5       6.375      0.0       5.0630     0.0

PLOTS
    1     0     2

COUPLE

END OF DATA

0        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

Input Data for 12 in Pipe

A-9

LTR 112. 118

DT OUTPUT TABLES

FOR 6, 8, 10, 12 in. Pipes

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL

LOFT LOCE RUN FOR 6IN 316SST PIPE (ID=+.0631+.03=6.001N)

UNITS= BTU,IN,SEC,LB,DEG FAH

SUMMARY DT TABLE FOR DTSET 1

DTSET	TIME	DT1	DT2	DT21	DT20	TAVE	TA	TB	DT3
1	0.0000	-.7815	.6231	.6231	-.0220	609.5703	609.5724	609.5724	0.0000
1	.5000	8.5700	9.1380	9.1380	-2.2045	608.1175	607.1547	607.1547	0.0000
1	1.0000	15.5853	15.0931	15.0931	-4.9040	606.1930	604.2811	604.2811	0.0000
1	1.5000	20.5367	20.0790	20.0790	-8.0265	603.9623	601.2158	601.2158	0.0000
1	2.0000	37.9788	37.1059	37.1059	-11.2351	601.4883	597.9682	597.9682	0.0000
1	2.5000	44.8309	39.4521	39.4521	-12.9421	599.4268	596.4206	596.4207	0.0000
1	3.0000	50.4010	40.0930	40.0930	-14.3184	598.3151	595.0319	595.0319	0.0000
1	3.5000	55.2735	40.8823	40.8823	-15.5709	597.3256	593.6244	593.6244	0.0000
1	4.0000	61.1828	41.1151	41.1151	-16.7382	595.3389	592.1793	592.1793	0.0000
1	4.5000	66.3102	41.6503	41.6503	-17.8335	593.8477	590.7002	590.7002	0.0000
1	5.0000	71.3407	42.2083	42.2083	-18.8735	592.3462	589.1922	589.1922	0.0000
1	5.5000	76.2729	42.7860	42.7860	-19.8604	590.8376	587.6568	587.6568	0.0000
1	6.0000	81.1206	43.3600	43.3600	-20.8031	589.3136	586.1021	586.1021	0.0000
1	6.5000	85.8647	43.9470	43.9470	-21.7070	587.7752	584.5237	584.5237	0.0000
1	7.0000	90.5035	44.5042	44.5042	-22.5781	586.2207	582.9245	582.9245	0.0000
1	7.5000	100.7206	52.0907	52.0907	-23.0771	583.5722	579.5020	579.5020	0.0000
1	8.0000	116.2450	60.1052	60.1052	-27.9556	580.3644	575.7253	575.7253	0.0000
1	8.5000	124.6059	66.0237	66.0237	-31.0002	577.3180	571.7920	571.7920	0.0000
1	9.0000	137.5306	75.5093	75.5093	-34.1593	573.8652	567.7241	567.7241	0.0000
1	9.5000	150.9445	86.0542	86.0542	-37.4000	570.2230	563.5227	563.5227	0.0000
1	10.0000	164.7432	97.4057	97.4057	-40.6969	566.4069	559.1878	559.1878	0.0000
1	10.5000	178.9714	96.0355	96.0355	-44.0377	562.4265	554.7211	554.7211	0.0000
1	11.0000	193.4598	102.3272	102.3272	-47.4013	558.2923	550.1254	550.1254	0.0000
1	11.5000	208.2032	108.3855	108.3855	-50.7774	554.0127	545.4041	545.4041	0.0000
1	12.0000	223.1658	114.2324	114.2324	-54.1572	549.5942	540.5602	540.5603	0.0000
1	12.5000	238.3150	119.8659	119.8659	-57.5325	545.0437	535.5979	535.5980	0.0000
1	13.0000	253.6207	125.3031	125.3031	-60.8966	540.3672	530.5211	530.5211	0.0000
1	14.0000	261.7140	110.8056	110.8056	-60.7016	535.2399	527.1077	527.1077	0.0000
1	15.0000	235.4103	84.4013	84.4013	-50.5904	537.1456	533.5177	533.5177	0.0000
1	16.0000	216.0168	43.5074	41.9344	-43.6074	537.6772	535.6474	535.6474	0.0000
1	17.0000	204.7110	30.0883	29.7477	-38.6660	537.6903	536.2377	536.2377	0.0000
1	18.0000	193.5731	24.3022	22.3412	-34.6022	537.4699	536.2321	536.2321	0.0000
1	19.0000	183.2601	31.2033	18.0207	-31.2033	537.1214	535.9674	535.9674	0.0000
1	20.0000	175.2113	26.5089	15.0832	-28.5089	536.6894	535.5703	535.5704	0.0000
1	21.0000	167.4141	26.2279	13.1429	-26.2279	536.1962	535.0927	535.0927	0.0000
1	22.0000	160.3460	24.3349	11.8606	-24.3349	535.6540	534.5585	534.5585	0.0000
1	23.0000	153.8945	22.7607	11.0234	-22.7607	535.0736	533.9603	533.9603	0.0000
1	24.0000	147.9457	21.4484	10.5036	-21.4484	534.4588	533.3662	533.3662	0.0000
1	25.0000	142.5022	20.3509	10.1996	-20.3509	533.8149	532.7216	532.7216	0.0000
1	26.0000	137.5765	19.4292	10.0502	-19.4292	533.1457	532.0508	532.0508	0.0000
1	27.0000	132.9951	18.6514	10.0100	-18.6514	532.4541	531.3570	531.3570	0.0000
1	28.0000	128.7215	17.9913	10.0460	-17.9913	531.7420	530.6429	530.6429	0.0000
1	29.0000	124.7957	17.4277	10.1345	-17.4277	531.0134	529.9110	529.9110	0.0000
1	30.0000	121.1648	16.9432	10.2502	-16.9432	530.2684	529.1631	529.1631	0.0000
1	31.0000	117.8008	16.5239	10.4043	-16.5239	529.5091	528.4010	528.4010	0.0000
1	32.0000	114.6845	16.1585	10.5835	-16.1585	528.7369	527.6262	527.6262	0.0000
1	33.0000	111.7944	15.8378	10.7809	-15.8378	527.9532	526.8400	526.8400	0.0000
1	34.0000	109.1136	15.5544	10.9930	-15.5544	527.1591	526.0435	526.0435	0.0000
1	35.0000	106.6242	15.3023	11.0002	-15.3023	526.3555	525.2377	525.2377	0.0000
1	36.0000	104.3114	15.0760	11.2291	-15.0760	525.5434	524.4237	524.4237	0.0000

DT Output for 6 in Pipe

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL

LOFT LOCE RUN FOR 6IN 316SST PIPE (ID=4.6631IN,OD=5.00IN)

UNITS- BTU,IN,SEC,LB,DEG FAH

SUMMARY DT TABLE FOR DTSET=1

DTSET	TIME	DT1	DT2	DT21	DT20	TAVE	TA	TB	DT3
1	37.0000	102.1626	14.3734	11.3755	-14.3734	524.7237	523.6023	523.6023	0.0000
1	38.0000	100.1948	14.0894	11.5195	-14.0894	523.8970	522.7741	522.7741	0.0000
1	39.0000	98.1946	14.5219	11.6573	-14.5219	523.0841	521.9400	521.9400	0.0000
1	40.0000	96.5747	14.3888	11.7866	-14.3888	522.2257	521.1004	521.1004	0.0000
1	41.0000	167.2445	25.0670	25.0670	-17.8595	518.6516	516.4400	516.4400	0.0000
1	42.0000	123.9579	48.9061	40.9061	-22.8950	514.0733	510.2860	510.2860	0.0000
1	43.0000	142.3570	54.6734	54.6734	-23.2066	508.6453	503.7988	503.7988	0.0000
1	44.0000	108.4319	44.5445	44.5445	-33.1353	503.0174	497.4846	497.4846	0.0000
1	49.0000	196.2516	83.3459	83.3458	-39.7859	483.0726	478.1340	478.1340	0.0000
1	54.0000	217.9911	58.2998	58.2998	-42.0011	465.0237	461.1143	461.1143	0.0000
1	59.0000	269.1143	54.4091	54.4091	-42.5464	449.3942	445.1226	445.1226	0.0000
1	64.0000	235.4844	51.7734	51.7734	-42.5129	433.8724	429.7395	429.7395	0.0000
1	69.0000	235.0842	50.0416	50.0416	-42.3377	418.7963	414.7490	414.7490	0.0000
1	74.0000	241.0565	48.2109	48.2109	-42.1462	404.0177	400.0254	400.0254	0.0000
1	79.0000	242.0576	48.1099	48.1099	-41.9770	389.4459	385.4899	385.4899	0.0000
1	84.0000	242.4559	47.6709	47.6709	-41.8333	375.0257	371.0948	371.0948	0.0000
1	89.0000	242.5871	47.3409	47.3409	-41.7194	360.7226	356.8093	356.8093	0.0000
1	94.0000	242.5116	47.1273	47.1273	-41.6230	346.5125	342.6113	342.6113	0.0000
1	99.0000	242.3487	46.9762	46.9762	-41.5443	332.3792	328.4862	328.4862	0.0000
1	104.0000	237.4860	44.9067	44.9067	-40.2061	319.5371	315.8849	315.8849	0.0000
1	109.0000	229.4653	40.5861	40.5861	-38.4576	307.7804	304.3887	304.3887	0.0000
1	114.0000	220.3938	37.5432	37.5432	-36.5264	296.8219	293.6489	293.6489	0.0000
1	119.0000	210.9638	35.1202	35.1202	-34.8004	286.5334	283.5507	283.5507	0.0000
1	124.0000	201.2529	32.9269	32.9269	-32.9778	276.8359	274.0240	274.0240	0.0000
1	129.0000	191.7740	31.1855	30.9639	-31.1858	267.6727	265.0173	265.0173	0.0000
1	134.0000	182.5434	29.3824	29.1016	-29.3824	259.0011	256.4904	256.4904	0.0000
1	139.0000	173.6292	28.0624	27.5429	-28.0624	250.7860	248.4104	248.4104	0.0000
1	144.0000	165.0808	26.5217	26.0230	-26.5217	242.9987	240.7483	240.7483	0.0000
1	149.0000	156.8581	25.2562	24.6049	-25.2562	235.6078	233.4790	233.4790	0.0000
1	154.0000	148.9015	23.9605	23.2753	-23.9605	228.5973	226.5814	226.5814	0.0000
1	159.0000	141.0122	22.7306	22.0244	-22.7306	221.9450	220.0357	220.0357	0.0000
1	164.0000	134.3745	21.5631	20.8446	-21.5631	215.6322	213.8236	213.8236	0.0000
1	169.0000	127.9771	20.4546	19.7308	-20.4546	209.6416	207.9283	207.9283	0.0000
1	174.0000	121.1079	19.4019	18.6777	-19.4019	203.9568	202.3336	202.3336	0.0000

CURRENT EXTREME VALUES ARE

DT1-MAX	DT1-MIN	DT2-MAX	DT3-MAX	DT3-MIN
261.7140	-.7816	125.3631	.0000	-.0000

(6in con't)

A-9

LTR 112 118

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 8IN SCH 160 PIPE (ID=6.813IN,OD=8.625IN)
UNITS- BTU,IN,SEC,LB,DEG FAR
SUMMARY DT TABLE FOR DTSET 1

DTSET	TIME	DT1	DT2	DT2I	DT2O	TAVE	TA	TB	DT3
1	0.0000	-.6816	.0134	.0134	-.0124	609.6348	609.6359	609.6359	0.0000
1	.5000	6.8739	9.1127	9.1127	-2.2630	608.1324	607.1878	607.1878	0.0000
1	1.0000	16.5607	18.8695	18.8695	-5.1014	606.1273	604.2759	604.2759	0.0000
1	1.5000	27.4751	28.1670	28.1670	-8.2139	603.7822	601.1472	601.1472	0.0000
1	2.0000	39.3418	36.9057	36.9057	-11.5107	601.1442	597.8267	597.8267	0.0000
1	2.5000	46.3213	38.2250	38.2250	-13.2279	599.3686	596.1600	596.1600	0.0000
1	3.0000	52.3815	38.5830	38.5830	-14.6171	597.7214	594.6506	594.6506	0.0000
1	3.5000	58.0968	38.8485	38.8485	-15.8632	596.0984	593.1155	593.1155	0.0000
1	4.0000	63.5856	39.1399	39.1399	-17.0073	594.4791	591.5413	591.5414	0.0000
1	4.5000	68.8959	39.4704	39.4704	-18.0684	592.8559	589.9331	589.9331	0.0000
1	5.0000	74.0588	39.8372	39.8372	-19.0602	591.2240	588.2959	588.2959	0.0000
1	5.5000	79.0969	40.2350	40.2350	-19.9937	589.5799	586.6328	586.6328	0.0000
1	6.0000	84.0275	40.6588	40.6588	-20.8778	587.9212	584.9457	584.9457	0.0000
1	6.5000	88.8635	41.1040	41.1040	-21.7201	586.2462	583.2359	583.2359	0.0000
1	7.0000	93.6153	41.5669	41.5669	-22.5270	584.5533	581.5037	581.5037	0.0000
1	7.5000	103.9002	48.8803	48.8803	-24.9951	581.7284	577.9244	577.9244	0.0000
1	8.0000	115.6672	56.6898	56.6898	-27.8491	578.5195	573.9841	573.9841	0.0000
1	8.5000	128.2548	64.1831	64.1831	-30.8798	575.0465	569.8677	569.8677	0.0000
1	9.0000	141.4692	71.2845	71.2845	-34.0259	571.3431	565.5937	565.5937	0.0000
1	9.5000	155.1956	78.0167	78.0167	-37.2518	567.4294	561.1634	561.1634	0.0000
1	10.0000	169.3464	84.4145	84.4145	-40.5310	563.3209	556.5782	556.5782	0.0000
1	10.5000	183.8497	90.5119	90.5119	-43.8426	559.0305	551.8413	551.8413	0.0000
1	11.0000	198.6456	96.3394	96.3394	-47.1700	554.5691	546.9567	546.9567	0.0000
1	11.5000	213.6855	101.9235	101.9235	-50.5006	549.9459	541.9290	541.9290	0.0000
1	12.0000	228.9293	107.2893	107.2893	-53.8248	545.1685	536.7624	536.7624	0.0000
1	12.5000	244.3387	112.4568	112.4568	-57.1342	540.2444	531.4619	531.4619	0.0000
1	13.0000	259.8611	117.4452	117.4452	-60.4224	535.1805	526.0323	526.0323	0.0000
1	14.0000	267.7927	102.2533	102.2533	-59.9935	529.3984	521.9369	521.9369	0.0000
1	15.0000	239.9947	56.4366	56.4366	-49.3246	530.9770	527.8412	527.8412	0.0000
1	16.0000	221.4774	42.2081	35.1571	-42.2081	531.2089	529.4849	529.4849	0.0000
1	17.0000	206.9471	36.8576	24.0006	-36.8576	530.9670	529.7144	529.7144	0.0000
1	18.0000	194.6347	32.6289	17.6087	-32.6289	530.5198	529.4307	529.4307	0.0000
1	19.0000	183.8354	29.2236	13.7399	-29.2236	529.9604	528.9319	528.9319	0.0000
1	20.0000	174.2030	26.4625	11.3366	-26.4625	529.3276	528.3232	528.3232	0.0000
1	21.0000	165.5313	24.2167	9.8411	-24.2167	528.6402	527.6460	527.6461	0.0000
1	22.0000	157.6792	22.3853	8.9324	-22.3853	527.9098	526.9196	526.9196	0.0000
1	23.0000	150.5415	20.8870	8.4129	-20.8870	527.1437	526.1545	526.1545	0.0000
1	24.0000	144.0349	19.6562	8.1550	-19.6562	526.3476	525.3574	525.3574	0.0000
1	25.0000	138.0911	18.6395	8.0735	-18.6395	525.5256	524.5335	524.5335	0.0000
1	26.0000	132.6524	17.7944	8.1102	-17.7944	524.6813	523.6864	523.6864	0.0000
1	27.0000	127.6695	17.0867	8.2247	-17.0867	523.8173	522.8194	522.8194	0.0000
1	28.0000	123.0992	16.4894	8.3889	-16.4894	522.9362	521.9351	521.9351	0.0000
1	29.0000	118.9034	15.9809	8.5826	-15.9809	522.0398	521.0356	521.0356	0.0000
1	30.0000	115.0465	15.5444	8.7921	-15.5444	521.1300	520.1228	520.1228	0.0000
1	31.0000	111.5041	15.1665	9.0073	-15.1665	520.2084	519.1983	519.1983	0.0000
1	32.0000	108.2431	14.8365	9.2216	-14.8365	519.2763	518.2636	518.2636	0.0000
1	33.0000	105.2409	14.5461	9.4303	-14.5461	518.3350	517.3198	517.3198	0.0000
1	34.0000	102.4753	14.2885	9.6303	-14.2885	517.3854	516.3682	516.3682	0.0000
1	35.0000	99.9262	14.0584	9.8198	-14.0584	516.4286	515.4096	515.4096	0.0000
1	36.0000	97.5752	13.8517	9.9975	-13.8517	515.4655	514.4450	514.4450	0.0000

DT Output for 8 in. Pipe

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 8IN SCH 160 PIPE (ID=6.813IN,OD=6.625IN)
UNITS- BTU,IN,SEC,LB,DEG FAR
SUMMARY DT TABLE FOR DTSET 1

DTSET	TIME	DT1	DT2	DT2I	DT2O	TAVE	TA	TB	DT3
1	37.0000	95.4057	13.6647	10.1630	-13.6647	514.4968	513.4750	513.4750	0.0000
1	38.0000	93.4023	13.4948	10.3162	-13.4948	513.5233	512.5005	512.5005	0.0000
1	39.0000	91.5512	13.3395	10.4571	-13.3395	512.5456	511.5221	511.5221	0.0000
1	40.0000	89.8397	13.1971	10.5863	-13.1971	511.5643	510.5402	510.5402	0.0000
1	41.0000	100.8064	23.5170	23.5170	-16.7321	507.9701	505.7190	505.7190	0.0000
1	42.0000	117.7894	38.5527	38.5527	-21.7762	502.9184	499.3965	499.3965	0.0000
1	43.0000	136.6580	51.2881	51.2881	-27.0435	497.1770	492.7053	492.7053	0.0000
1	44.0000	155.1229	60.5102	60.5102	-31.8680	491.2073	486.1397	486.1397	0.0000
1	49.0000	191.6959	57.2079	57.2079	-37.9402	469.6146	465.1744	465.1745	0.0000
1	54.0000	209.6003	51.6119	51.6119	-39.3647	450.6392	446.6218	446.6218	0.0000
1	59.0000	218.5477	47.5450	47.5450	-39.3756	432.9849	429.2048	429.2049	0.0000
1	64.0000	222.7300	44.8490	44.8490	-38.9932	416.1200	412.4836	412.4836	0.0000
1	69.0000	224.2850	43.0778	43.0778	-38.5431	399.7737	396.2313	396.2313	0.0000
1	74.0000	224.3929	41.8925	41.8925	-38.1194	383.7941	380.3171	380.3171	0.0000
1	79.0000	223.7243	41.0713	41.0713	-37.7409	368.0899	364.6614	364.6614	0.0000
1	84.0000	222.6595	40.4787	40.4787	-37.4049	352.6050	349.2143	349.2143	0.0000
1	89.0000	221.4196	40.0311	40.0311	-37.1050	337.3006	333.9404	333.9404	0.0000
1	94.0000	220.1264	39.6853	39.6853	-36.8353	322.1501	318.8145	318.8145	0.0000
1	99.0000	218.8374	39.4054	39.4054	-36.5925	307.1313	303.8166	303.8166	0.0000
1	104.0000	212.6344	36.4276	36.4276	-35.1492	293.5564	290.4815	290.4815	0.0000
1	109.0000	203.5643	33.1892	33.1070	-33.1892	281.2241	278.4027	278.4027	0.0000
1	114.0000	193.4776	31.1882	30.3053	-31.1882	269.8276	267.2177	267.2177	0.0000
1	119.0000	183.1188	29.2668	27.9391	-29.2668	259.2249	256.7982	256.7982	0.0000
1	124.0000	172.8634	27.4550	25.8907	-27.4550	249.3240	247.0608	247.0608	0.0000
1	129.0000	162.9041	25.7567	24.0778	-25.7567	240.0553	237.9422	237.9422	0.0000
1	134.0000	153.3430	24.1662	22.4450	-24.1662	231.3702	229.3932	229.3932	0.0000
1	139.0000	144.2314	22.6753	20.9550	-22.6753	223.2233	221.3731	221.3731	0.0000
1	144.0000	135.5888	21.2768	19.5829	-21.2768	215.5787	213.8464	213.8464	0.0000
1	149.0000	127.4143	19.9642	18.3122	-19.9642	208.4042	206.7818	206.7818	0.0000
1	154.0000	119.6962	18.7317	17.1302	-18.7317	201.6698	200.1499	200.1499	0.0000
1	159.0000	112.4236	17.5741	16.0283	-17.5741	195.3483	193.9244	193.9244	0.0000
1	164.0000	105.5711	16.4863	14.9992	-16.4863	189.4140	188.0802	188.0802	0.0000
1	169.0000	99.1190	15.4639	14.0372	-15.4639	183.8432	182.5937	182.5937	0.0000
1	174.0000	93.0435	14.5028	13.1380	-14.5028	178.6128	177.4422	177.4422	0.0000

CURRENT EXTREME VALUES ARE

DT1-MAX	DT1-MIN	DT2-MAX	DT3-MAX	DT3-MIN
267.7927	-.6816	117.4452	.0000	-.0000

(8in con't)

A-11

LWR12 118

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 10 IN SCH 140 PIPE(ID=8.75,OD=10.75IN)
UNITS- BTU,IN,SEC,LB,DEG FAR
SUMMARY DT TABLE FOR DTSET 1

DTSET	TIME	DT1	DT2	DT2I	DT2O	TAVE	TA	TB	DT3
1	0.0000	-.7418	.0127	.0127	-.0118	609.6058	609.6069	609.6069	0.0000
1	.5000	6.5724	9.1744	9.1744	-2.2046	608.1591	607.1943	607.1943	0.0000
1	1.0000	15.9214	19.2033	19.2033	-4.9733	606.2594	604.3251	604.3251	0.0000
1	1.5000	26.4019	28.8827	28.8827	-6.0067	604.0523	601.2696	601.2696	0.0000
1	2.0000	37.7539	38.0704	38.0704	-11.2234	601.5875	598.0582	598.0582	0.0000
1	2.5000	44.3740	39.8430	39.8430	-12.9116	599.9696	596.5087	596.5087	0.0000
1	3.0000	50.1124	40.5314	40.5314	-14.2951	598.4796	595.1433	595.1433	0.0000
1	3.5000	55.5707	41.0704	41.0704	-15.5558	597.0089	593.7588	593.7588	0.0000
1	4.0000	60.8610	41.6023	41.6028	-16.7374	595.5378	592.3344	592.3344	0.0000
1	4.5000	66.0213	42.1504	42.1504	-17.8919	594.0602	590.8737	590.8737	0.0000
1	5.0000	71.0740	42.7149	42.7149	-19.0067	592.5726	589.3818	589.3818	0.0000
1	5.5000	76.0398	43.2944	43.2944	-19.9152	591.0723	587.8623	587.8623	0.0000
1	6.0000	80.9191	43.8861	43.8861	-20.8777	589.5576	586.3179	586.3180	0.0000
1	6.5000	85.7338	44.4873	44.4873	-21.8015	588.0271	584.7504	584.7504	0.0000
1	7.0000	90.4874	45.0958	45.0958	-22.6913	586.4796	583.1608	583.1608	0.0000
1	7.5000	100.6190	52.5868	52.5868	-25.1992	583.8462	579.7505	579.7505	0.0000
1	8.0000	112.1834	60.7207	60.7207	-28.0845	580.8568	575.9844	575.9844	0.0000
1	8.5000	124.5161	68.6109	68.6109	-31.1377	577.6325	572.0647	572.0647	0.0000
1	9.0000	137.4402	76.1517	76.1517	-34.3031	574.2047	568.0141	568.0142	0.0000
1	9.5000	150.8598	83.3518	83.3518	-37.5506	570.5900	563.8335	563.8335	0.0000
1	10.0000	164.6490	90.2371	90.2371	-40.8580	566.8012	559.5220	559.5221	0.0000
1	10.5000	178.8994	96.8351	96.8351	-44.2072	562.8492	555.0807	555.0808	0.0000
1	11.0000	193.4084	103.1714	103.1714	-47.5834	558.7435	550.5117	550.5117	0.0000
1	11.5000	208.1815	109.2691	109.2691	-50.9744	554.4920	545.8178	545.8178	0.0000
1	12.0000	223.1846	115.1495	115.1495	-54.3713	550.1012	541.0017	541.0017	0.0000
1	12.5000	238.3834	120.8305	120.8305	-57.7656	545.5775	536.0671	536.0671	0.0000
1	13.0000	253.7479	126.3288	126.3288	-61.1508	540.9268	531.0176	531.0176	0.0000
1	14.0000	262.3445	111.7448	111.7448	-61.1491	535.7616	527.5739	527.5739	0.0000
1	15.0000	237.8044	66.4579	66.4579	-51.4738	537.3159	533.5689	533.5690	0.0000
1	16.0000	221.7176	44.9302	43.8689	-44.9302	537.5885	535.4761	535.4761	0.0000
1	17.0000	209.3315	39.9423	31.3519	-39.9423	537.3771	535.8750	535.8750	0.0000
1	18.0000	198.9294	35.9168	23.8133	-35.9168	536.9533	535.6847	535.6847	0.0000
1	19.0000	189.8107	32.5890	18.9999	-32.5890	536.4183	535.2426	535.2426	0.0000
1	20.0000	181.8417	29.8124	15.8120	-29.8124	535.8141	534.6778	534.6778	0.0000
1	21.0000	174.2347	27.4877	13.6297	-27.4877	535.1613	534.0428	534.0428	0.0000
1	22.0000	167.4684	25.5387	12.1968	-25.5387	534.4712	533.3614	533.3614	0.0000
1	23.0000	161.2578	23.9032	11.2150	-23.9032	533.7510	532.6453	532.6454	0.0000
1	24.0000	155.5359	22.5289	10.5675	-22.5269	533.0058	531.9018	531.9018	0.0000
1	25.0000	150.2507	21.3715	10.1605	-21.3715	532.2392	531.1354	531.1354	0.0000
1	26.0000	145.3587	20.3942	9.9265	-20.3942	531.4542	530.3495	530.3495	0.0000
1	27.0000	140.8234	19.5058	9.8174	-19.5558	530.6530	529.5468	529.5468	0.0000
1	28.0000	136.6133	18.8605	9.7981	-18.8605	529.8377	528.7295	528.7295	0.0000
1	29.0000	132.7008	18.2571	9.8427	-18.2571	529.0097	527.8993	527.8993	0.0000
1	30.0000	129.0615	17.7378	9.9322	-17.7378	528.1706	527.0578	527.0578	0.0000
1	31.0000	125.6737	17.2884	10.0522	-17.2884	527.3215	526.2062	526.2062	0.0000
1	32.0000	122.5178	16.8968	10.1920	-16.8968	526.4635	525.3458	525.3458	0.0000
1	33.0000	119.5759	16.5535	10.3439	-16.5535	525.5975	524.4776	524.4776	0.0000
1	34.0000	116.8321	16.2505	10.5017	-16.2505	524.7244	523.6023	523.6023	0.0000
1	35.0000	114.2715	15.9814	10.6612	-15.9814	523.8449	522.7208	522.7208	0.0000
1	36.0000	111.8807	15.7408	10.8191	-15.7408	522.9597	521.8338	521.8338	0.0000

DT Output for 10 in. Pipe.

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 10 IN SCH 140 PIPE(ID=8.75,OD=10.75IN)
UNITS- BTU,IN,SEC,LB,DEG FAR
SUMMARY DT TABLE FOR DTSET 1

DTSET	TIME	DT1	DT2	DT2I	DT2O	TAVE	TA	TB	DT3
1	37.0000	109.6473	15.5245	10.9733	-15.5245	522.0694	520.9418	520.9418	0.0000
1	38.0000	107.5599	15.3288	11.1219	-15.3288	521.1746	520.0456	520.0456	0.0000
1	39.0000	105.6080	15.1508	11.2640	-15.1508	520.2757	519.1454	519.1454	0.0000
1	40.0000	103.7820	14.9882	11.3969	-14.9882	519.3732	518.2419	518.2420	0.0000
1	41.0000	113.9951	24.4162	24.4162	-18.3603	516.0277	513.6297	513.6297	0.0000
1	42.0000	130.0604	40.0726	40.0726	-23.2586	511.3203	507.5550	507.5550	0.0000
1	43.0000	148.0322	53.7418	53.7418	-28.4477	505.9829	501.1616	501.1616	0.0000
1	44.0000	165.7127	63.9630	63.9630	-33.2739	500.4517	494.9491	494.9491	0.0000
1	49.0000	202.5252	62.5269	62.5269	-40.1624	480.5718	475.6747	475.6747	0.0000
1	54.0000	222.2577	57.3783	57.3783	-42.2627	463.0449	458.5950	458.5950	0.0000
1	59.0000	233.5340	53.3000	53.3000	-42.7614	446.6791	442.4806	442.4806	0.0000

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 10 IN SCH 140 PIPE(ID=8.75,OD=10.75IN)
UNITS- BTU,IN,SEC,LB,DEG FAR
SUMMARY DT TABLE FOR DTSET 1

DTSET	TIME	DT1	DT2	DT2I	DT2O	TAVE	TA	TB	DT3
1	37.0000	109.6473	15.5245	10.9733	-15.5245	522.0694	520.9418	520.9418	0.0000
1	38.0000	107.5599	15.3288	11.1219	-15.3288	521.1746	520.0456	520.0456	0.0000
1	39.0000	105.6060	15.1508	11.2640	-15.1508	520.2757	519.1454	519.1454	0.0000
1	40.0000	103.7820	14.9882	11.3989	-14.9882	519.3732	518.2419	518.2420	0.0000
1	41.0000	113.9451	24.4162	24.4162	-18.3603	516.0277	513.6297	513.6297	0.0000
1	42.0000	130.0604	40.0726	40.0726	-23.2586	511.3203	507.5550	507.5550	0.0000
1	43.0000	148.0322	53.7418	53.7418	-28.4477	505.9829	501.1616	501.1616	0.0000
1	44.0000	165.7127	63.9630	63.9630	-33.2739	500.4517	494.9491	494.9491	0.0000
1	49.0000	202.5252	62.5269	62.5269	-40.1624	480.5718	475.6747	475.6747	0.0000
1	54.0000	222.2577	57.3783	57.3783	-42.2627	463.0449	458.5950	458.5950	0.0000
1	59.0000	233.5340	53.3000	53.3000	-42.7614	446.6791	442.4806	442.4806	0.0000
1	64.0000	240.0494	50.4711	50.4711	-42.6875	430.9984	426.9491	426.9491	0.0000
1	69.0000	243.7226	48.5700	48.5700	-42.4587	415.7600	411.8045	411.8045	0.0000
1	74.0000	245.7615	47.3002	47.3002	-42.2130	400.8234	396.9296	396.9296	0.0000
1	79.0000	246.7468	46.4483	46.4483	-41.9945	386.1021	382.2502	382.2502	0.0000
1	84.0000	247.1210	45.8703	45.8703	-41.8095	371.5424	367.7201	367.7201	0.0000
1	89.0000	247.1360	45.4723	45.4723	-41.6546	357.1102	353.3094	353.3094	0.0000
1	94.0000	246.9604	45.1987	45.1987	-41.5251	342.7798	338.9940	338.9940	0.0000
1	99.0000	246.6420	45.0057	45.0057	-41.4152	328.5355	324.7607	324.7607	0.0000
1	104.0000	241.9479	41.9545	41.9545	-40.0977	315.5889	312.0611	312.0611	0.0000
1	109.0000	233.4375	38.4572	38.4572	-38.2205	303.7420	300.4795	300.4795	0.0000
1	114.0000	224.1020	36.2579	35.4666	-36.2579	292.7111	289.6698	289.6698	0.0000
1	119.0000	214.2704	34.3430	32.9305	-34.3430	282.3687	279.5184	279.5184	0.0000
1	124.0000	204.3353	32.5171	30.7366	-32.5171	272.6348	269.9548	269.9548	0.0000
1	129.0000	194.5219	30.7883	28.7976	-30.7883	263.4515	260.9264	260.9264	0.0000
1	134.0000	184.9597	29.1541	27.0532	-29.1541	254.7740	252.3917	252.3917	0.0000
1	139.0000	175.7223	27.6094	25.4616	-27.6094	246.5655	244.3161	244.3161	0.0000
1	144.0000	166.8416	26.1491	23.9959	-26.1491	238.7939	236.6688	236.6688	0.0000
1	149.0000	158.3357	24.7678	22.6360	-24.7678	231.4330	229.4246	229.4246	0.0000
1	154.0000	150.2111	23.4600	21.3668	-23.4600	224.4594	222.5607	222.5607	0.0000
1	159.0000	142.4662	22.2211	20.1771	-22.2211	217.8518	216.0563	216.0563	0.0000
1	164.0000	135.0923	21.0471	19.0592	-21.0471	211.5906	209.8926	209.8926	0.0000
1	169.0000	128.0783	19.9343	18.0057	-19.9343	205.6576	204.0516	204.0516	0.0000
1	174.0000	121.4112	18.8794	17.0143	-18.8794	200.0355	198.5164	198.5164	0.0000

CURRENT EXTREME VALUES ARE

DT1-MAX	DT1-MIN	DT2-MAX	DT3-MAX	DT3-MIN
262.3445	-.7418	126.3288	.0000	-.0000

(10 in con't)

A-13

LER 12-118

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 12 SCH 160 PIPE (ID=10.126,OD=12.75IN)
UNITS- BTU,IN,SEC,LB,DEG FAR
SUMMARY DT TABLE FOR DTSET 1

DTSET	TIME	DT1	DT2	DT2I	DT2O	TAVE	TA	TB	DT3
1	0.0000	-.9841	.0189	.0189	-.0175	609.4782	609.4797	609.4797	0.0000
1	.5000	5.7330	9.1579	9.1579	-2.0436	608.1807	607.1648	607.1648	0.0000
1	1.0000	14.3036	19.7418	19.7418	-4.6374	606.4892	604.3719	604.3719	0.0000
1	1.5000	23.7692	30.2877	30.2877	-7.4614	604.5805	601.4364	601.4364	0.0000
1	2.0000	33.9011	40.5354	40.5354	-10.4428	602.4958	598.4148	598.4148	0.0000
1	2.5000	39.5587	43.5253	43.5253	-12.0016	601.2258	597.0568	597.0568	0.0000
1	3.0000	44.3544	45.1234	45.1234	-13.2719	600.0982	595.9738	595.9738	0.0000
1	3.5000	48.9610	46.4328	46.4328	-14.4654	598.9882	594.9096	594.9096	0.0000
1	4.0000	53.5067	47.6667	47.6667	-15.6226	597.8721	593.8195	593.8195	0.0000
1	4.5000	58.0192	48.8695	48.8695	-16.7525	596.7452	592.6980	592.6980	0.0000
1	5.0000	62.5071	50.0522	50.0522	-17.8583	595.6061	591.5469	591.5469	0.0000
1	5.5000	66.9752	51.2184	51.2184	-18.9419	594.4540	590.3669	590.3669	0.0000
1	6.0000	71.4271	52.3697	52.3697	-20.0046	593.2884	589.1662	589.1662	0.0000
1	6.5000	75.8656	53.5066	53.5066	-21.0478	592.1088	587.9410	587.9410	0.0000
1	7.0000	80.2933	54.6297	54.6297	-22.0727	590.9151	586.6948	586.6948	0.0000
1	7.5000	89.7082	62.5992	62.5992	-24.6143	588.7427	583.7020	583.7020	0.0000
1	8.0000	100.4725	71.6092	71.6092	-27.5304	586.2680	580.3374	580.3374	0.0000
1	8.5000	111.8752	80.5866	80.5866	-30.5974	583.6225	576.8520	576.8520	0.0000
1	9.0000	123.7503	89.3401	89.3401	-33.7627	580.8362	573.2880	573.2880	0.0000
1	9.5000	136.0346	97.8435	97.8435	-37.0065	577.9202	569.6503	569.6503	0.0000
1	10.0000	148.6861	106.1020	106.1020	-40.3154	574.8819	565.9375	565.9375	0.0000
1	10.5000	161.6699	114.1277	114.1277	-43.6788	571.7274	562.1479	562.1479	0.0000
1	11.0000	174.9551	121.9339	121.9339	-47.0872	568.4623	558.2803	558.2803	0.0000
1	11.5000	188.5139	129.5338	129.5338	-50.5322	565.0914	554.3343	554.3343	0.0000
1	12.0000	202.3211	136.9402	136.9402	-54.0067	561.6195	550.3100	550.3100	0.0000
1	12.5000	216.3573	144.1667	144.1667	-57.5048	558.0500	546.2074	546.2074	0.0000
1	13.0000	230.6008	151.2225	151.2225	-61.0205	554.3870	542.0277	542.0277	0.0000
1	14.0000	239.2818	139.0914	139.0914	-61.8805	550.7565	540.1248	540.1248	0.0000
1	15.0000	221.0812	96.9964	96.9964	-54.6230	552.4072	546.3812	546.3812	0.0000
1	16.0000	209.4686	72.1682	72.1682	-49.6253	552.9749	549.2182	549.2182	0.0000
1	17.0000	201.1595	56.5966	56.5966	-45.8199	553.0282	550.3934	550.3934	0.0000
1	18.0000	194.6402	46.2603	46.2603	-42.7119	552.8234	550.7457	550.7457	0.0000
1	19.0000	189.1843	40.0615	39.0560	-40.0615	552.4798	550.6806	550.6806	0.0000
1	20.0000	184.4245	37.7458	33.8325	-37.7458	552.0551	550.3965	550.3965	0.0000
1	21.0000	180.1622	35.6960	29.9275	-35.6960	551.5785	549.9921	549.9922	0.0000
1	22.0000	176.2811	33.8698	26.9401	-33.8698	551.0662	549.5178	549.5178	0.0000
1	23.0000	172.7079	32.2378	24.6153	-32.2378	550.5274	548.9998	548.9998	0.0000
1	24.0000	169.3922	30.7779	22.7836	-30.7779	549.9680	548.4524	548.4524	0.0000
1	25.0000	166.2979	29.4716	21.3275	-29.4716	549.3921	547.8837	547.8838	0.0000
1	26.0000	163.3973	28.3033	20.1633	-28.3033	548.8024	547.2988	547.2988	0.0000
1	27.0000	160.6688	27.2588	19.2290	-27.2588	548.2011	546.7007	546.7007	0.0000
1	28.0000	158.0947	26.3255	18.4782	-26.3255	547.5897	546.0917	546.0917	0.0000
1	29.0000	155.6607	25.4917	17.8752	-25.4917	546.9697	545.4732	545.4732	0.0000
1	30.0000	153.3545	24.7470	17.3920	-24.7470	546.3419	544.8465	544.8465	0.0000
1	31.0000	151.1657	24.0817	17.0066	-24.0817	545.7073	544.2126	544.2126	0.0000
1	32.0000	149.0855	23.4871	16.7015	-23.4871	545.0666	543.5723	543.5723	0.0000
1	33.0000	147.1058	22.9555	16.4623	-22.9555	544.4203	542.9262	542.9262	0.0000
1	34.0000	145.2199	22.4797	16.2775	-22.4797	543.7691	542.2749	542.2749	0.0000
1	35.0000	143.4216	22.0535	16.1376	-22.0535	543.1134	541.6190	541.6190	0.0000
1	36.0000	141.7054	21.6710	16.0347	-21.6710	542.4536	540.9588	540.9588	0.0000

DT Output for 12 in. Pipe

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 12 SCH 160 PIPE (ID=10.126,OD=12.75IN)
UNITS- BTU,IN,SEC,LB,DEG FAR
SUMMARY DT TABLE FOR DTSET 1

DTSET	TIME	DT1	DT2	DT2I	DT2O	TAVE	TA	TB	DT3
1	37.0000	140.0663	21.3273	15.9623	-21.3273	541.7901	540.2948	540.2948	0.0000
1	38.0000	138.4998	21.0180	15.9152	-21.0180	541.1232	539.6273	539.6273	0.0000
1	39.0000	137.0018	20.7389	15.8869	-20.7389	540.4531	538.9566	538.9566	0.0000
1	40.0000	135.5664	20.4866	15.8793	-20.4866	539.7802	538.2830	538.2830	0.0000
1	41.0000	144.4033	28.4642	28.4642	-23.3417	537.0848	534.2691	534.2691	0.0000
1	42.0000	158.5728	45.0761	45.0761	-27.7144	533.2453	528.8272	528.8272	0.0000
1	43.0000	174.5917	60.8021	60.8021	-32.5067	528.9071	523.1164	523.1164	0.0000
1	44.0000	190.4366	73.5399	73.5399	-37.0980	524.4607	517.6921	517.6921	0.0000
1	49.0000	226.3672	78.3241	78.3241	-45.4025	509.1642	502.7909	502.7909	0.0000
1	54.0000	249.1508	75.5601	75.5601	-49.3294	495.7027	489.8219	489.8219	0.0000
1	59.0000	265.4016	72.3562	72.3562	-51.3639	483.0525	477.4605	477.4606	0.0000
1	64.0000	277.6606	69.7717	69.7717	-52.4887	470.8561	465.4254	465.4254	0.0000

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
LOFT LOCE RUN FOR 12 SCH 160 PIPE (ID=10.126,OD=12.75IN)
UNITS- BTU,IN,SEC,LB,DEG FAR
SUMMARY DT TABLE FOR DTSET 1

DTSET	TIME	DT1	DT2	DT21	DT20	TAVE	TA	TB	DT3
1	37.0000	140.0663	21.3273	15.9623	-21.3273	541.7901	540.2948	540.2948	0.0000
1	38.0000	138.4998	21.0180	15.9152	-21.0180	541.1232	539.6273	539.6273	0.0000
1	39.0000	137.0018	20.7389	15.8688	-20.7389	540.4531	538.9566	538.9566	0.0000
1	40.0000	135.5684	20.4866	15.8793	-20.4866	539.7802	538.2830	538.2830	0.0000
1	41.0000	144.4033	28.4642	28.4642	-23.3417	537.0848	534.2691	534.2691	0.0000
1	42.0000	158.5728	45.0761	45.0761	-27.7144	533.2453	528.8272	528.8272	0.0000
1	43.0000	174.5917	60.8021	60.8021	-32.5067	528.9071	523.1164	523.1164	0.0000
1	44.0000	190.4386	73.5399	73.5399	-37.0980	524.4607	517.6921	517.6921	0.0000
1	49.0000	226.3672	78.3241	78.3241	-45.4025	509.1642	502.7909	502.7909	0.0000
1	54.0000	249.1508	75.5601	75.5601	-49.3294	495.7027	489.8219	489.8219	0.0000
1	59.0000	265.4016	72.3562	72.3562	-51.3639	483.0525	477.4605	477.4606	0.0000
1	64.0000	277.6406	69.7717	69.7717	-52.4887	470.8561	465.4254	465.4254	0.0000
1	69.0000	287.1983	67.8756	67.8756	-53.1781	458.9354	453.5947	453.5947	0.0000
1	74.0000	294.8847	66.5569	66.5569	-53.6683	447.1868	441.8939	441.8939	0.0000
1	79.0000	301.2319	65.6888	65.6888	-54.0761	435.5446	430.2729	430.2729	0.0000
1	84.0000	306.6018	65.1638	65.1638	-54.4553	423.9658	418.6975	418.6975	0.0000
1	89.0000	311.2520	64.8951	64.8951	-54.8306	412.4207	407.1438	407.1438	0.0000
1	94.0000	315.3659	64.8151	64.8151	-55.2099	400.8876	395.5935	395.5935	0.0000
1	99.0000	319.0769	64.8839	64.8839	-55.5965	389.3524	384.0340	384.0340	0.0000
1	104.0000	318.1672	61.7304	61.7304	-54.8113	378.7907	373.7330	373.7330	0.0000
1	109.0000	314.1663	57.8068	57.8068	-53.3885	369.0101	364.2508	364.2508	0.0000
1	114.0000	308.6072	54.2653	54.2653	-51.7636	359.7740	355.2645	355.2645	0.0000
1	119.0000	302.0456	51.2292	51.2292	-50.0875	350.9855	346.6885	346.6885	0.0000
1	124.0000	294.8729	48.5658	48.5658	-48.4256	342.5847	338.4746	338.4746	0.0000
1	129.0000	287.3348	46.8075	46.2173	-46.8075	334.5297	330.5882	330.5882	0.0000
1	134.0000	279.6000	45.2445	44.1195	-45.2445	326.7892	323.0019	323.0019	0.0000
1	139.0000	271.7880	43.7394	42.2216	-43.7394	319.3380	315.6938	315.6938	0.0000
1	144.0000	263.9818	42.2908	40.4855	-42.2908	312.1561	308.6458	308.6458	0.0000
1	149.0000	256.2394	40.8966	38.8824	-40.8966	305.2269	301.8429	301.8429	0.0000
1	154.0000	248.6002	39.5553	37.3900	-39.5553	298.5360	295.2717	295.2717	0.0000
1	159.0000	241.0947	38.2629	35.9905	-38.2629	292.0717	288.9213	288.9213	0.0000
1	164.0000	233.7441	37.0163	34.6699	-37.0163	285.8235	282.7820	262.7820	0.0000
1	169.0000	226.5625	35.8128	33.4179	-35.8128	279.7824	276.8453	276.8453	0.0000
1	174.0000	219.5588	34.6502	32.2265	-34.6502	273.9403	271.1032	271.1032	0.0000

CURRENT EXTREME VALUES ARE

DT1-MAX	DT1-MIN	DT2-MAX	DT3-MAX	DT3-MIN
319.0769	-.9841	151.2225	.0000	-.0000

(12 in con't)

APPENDIX B

MICROFICHE COPIES

OF COMPUTER RUNS

The following are complete copies of the 6, 8, 10, and 12 inch Primary Coolant piping thermal analysis computer runs.

(See Distribution)