MASTER

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LOFT TRANSIENT THERMAL ANALYSIS
FOR 10 INCH PRIMARY COOLANT
BLOWDOWN PIPING WELD

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DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE UNDER CONTRACT EY-76-C-07-1570

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WORK REQUEST NO. 52162-600-340

RESEARCH, ENGINEERING AND CONSTRUCTION REPORT ENGINEERING ANALYSIS DIVISION

THERMAL ANALYSIS

LOFT TRANSIENT THERMAL ANALYSIS

FOR 10 INCH PRIMARY COOLANT

BLOWDOWN PIPING WELD

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IDAHO NATIONAL ENGINEERING LABORATORY
LOFT TECHNICAL REPORT
LOFT PROGRAM

TITLE LOFT Transient Thermal Analysis For 10 Inch		REPORT NO. 112-131
Primary Coolant Blowdown Piping Weld		
AUTHOR S. K. Howell <i>S. K. Howell</i>	GWA NO. 52162-600-340	
PERFORMING ORGANIZATION Thermal Analysis	DATE March 3, 1978	
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SUMMARY

A flaw in a weld in the 10 inch primary coolant blowdown piping was discovered by LOFT personnel. As a result of this, a thermal analysis and fracture mechanics analysis was requested by LOFT personnel. The weld and pipe section were analyzed for a complete thermal cycle, heatup and Loss of Coolant Experiment (LOCE), using COUPLE/MOD2⁽¹⁾, a two-dimensional finite element heat conduction code. The finite element representation used in this analysis was generated by the Applied Mechanics Branch. The record of nodal temperatures for the entire transient was written on tape VSN=T9N054, and has been forwarded to the Applied Mechanics Branch for use in their mechanical analysis. Specific details and assumptions used in this analysis are found in appropriate sections of this report. Complete microfiche copies of the computer run are contained in Appendix B.

I. INTRODUCTION

During a LOCE, components in the primary cooling blowdown loop face severe thermal stresses due to the rapid temperature transient experienced during the LOCE. Components also face much smaller thermal stresses during the heatup, a less severe transient. A complete thermal cycle was analyzed here, consisting of a heatup to steady state then a LOCE transient followed by cooling down to 70°F steady state. During the LOCE, pressure falls rapidly during a small time interval which results in a rapid decrease in water temperature. The temperature gradients in the weld and pipe materials are further aggravated by large surface heat transfer coefficients resulting from nucleate boiling and two-phase flow inside the pipe. COUPLE/MOD2⁽¹⁾ a two-dimensional finite-element heat conduction code was used to compute the temperature distribution in the weld and pipe. A time-temperature history of the finite element representation was written on tape VSN=T9N054 for the entire thermal cycle. This tape will be used by the Applied Mechanics Branch for input to their mechanical analysis.

II. ANALYSIS

Figure 1 shows the axisymmetric finite element model of the pipe and weld. Figures 2 to 10 show the finite element mesh divided into smaller regions to distinguish node and element numbers. This mesh was generated and provided by the Applied Mechanics Branch. The pipe surfaces perpendicular to the axis were assumed to be adiabatic, since the weld was not immediately adjacent to any tees, elbows, valves, etc. Both the weld and pipe are of SA312 Grade 316 stainless steel⁽³⁾, having temperature dependent properties listed in Table I⁽²⁾. 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 inside convection coefficients used during

the thermal cycle are listed in Table II. During heatup a coefficient of 100 Btu/hr-ft²-°F was used, being computed from the Dittus-Boelter correlation for turbulent flow inside pipes⁽⁴⁾

$$h = \frac{K}{D} (.023)(Re_D)^{.8} (Pr)^{.4} \quad (1)$$

using a mass flowrate of 18000 lbm/hr⁽⁵⁾. During the initial phase of a LOCE, a coefficient of 10000 Btu/hr-ft²-°F⁽⁶⁾ was used to represent nucleate boiling heat transfer for 13 seconds. After 13 seconds a coefficient of 100 Btu/hr-ft²-°F was used to represent the time the reactor vessel was filling with emergency core coolant (ECC)⁽⁶⁾. 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 1000 Btu/hr-ft²-°F was used, representing the ECC flowing through the pipe.

The outside boundary coefficients were computed as a combination of free air convection and three inches of insulation with a thermal conductivity of 0.0042 Btu/hr-in-°F. This method ignores the specific heat capacity of the insulation, but it is so small relative to the stainless steel that errors introduced would be negligible. An effective outside convection coefficient of 0.17 Btu/hr-ft²-°F was used in this analysis⁽⁶⁾.

Inside water temperatures are given as a function of time in Table III⁽⁵⁾. During the heatup a temperature change of 100°F/hr was used from 70°F to 610°F. During the LOCE phase, water temperatures were selected representing the fastest blowdown anticipated for LOFT. An ambient air temperature of 100°F was used for the outside convection temperature. The input data used in COUPLE/MOD2 is listed in Appendix A.

TABLE IMATERIAL PROPERTIES FOR 316 STAINLESS STEEL⁽³⁾

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 IIHEAT TRANSFER COEFFICIENTS INSIDE LOFT BLOWDOWN PIPING^(5,6)
AS A FUNCTION OF TIME

Time (sec)	Heat Transfer Coefficient (Btu/hr-ft ² -°F)
0.0 to 21600.0	100
21600.0 to 21613.0	10000
21613.0 to 21615.0	10000 → 100
21615.0 to 21640.0	100
21640.0 to 21644.0	100 → 1000
21644.0 to 22900.0	1000
22900.0 to 24000.0	100

TABLE IIIFLUID TEMPERATURES INSIDE LOFT BLOWDOWN PIPING^(5,6)
AS A FUNCTION OF TIME

Time (sec)	Temp (°F)
0.0	70
19440.0	610
21600.0	610
21602.0	536
21607.0	490
21613.0	270
21640.0	260
21700.0	100
22900.0	100
23980.0	70
24000.0	70

III. RESULTS

Figures 11 and 12 show the temperature distribution through a radial line of nodes in the center of the weld region as a function of time. Node number 195 is the nodal temperature on the inside surface and node number 205 is the temperature on the outside surface. Nodes 197 to 203 are temperatures of nodes moving outward radially in the weld. Figure 11 shows the temperature distribution during the heatup phase of the transient. As the graph indicates, there is a negligible thermal gradient through the weld during this interval. However, at a time of 21600 seconds blowdown begins and Figure 12 shows the time-temperature history of the weld during this interval. It is apparent from the graph that severe thermal gradients occur between 21600 and 22200 seconds. It would be expected that this phase of the thermal cycle is the limiting factor in terms of thermal stresses as all other thermal gradients are negligible compared with those immediately following blowdown.

The fluid flowrate in the blowdown piping is less than 1% of the primary coolant system flowrate; therefore, all other thermal transients (except heatup and LOCE) will be much less severe in this area than in the active loop and thermal gradients will be small. Therefore, only the heatup (because of its long time duration) and LOCE needed to be analyzed.

A complete record of the time-temperature history for the entire finite element mesh is written on tape VSN=T9N054. The coding used to write on this tape is⁽¹⁾:

```
In a DO      { WRITE(13,3) TIME,(T(I), I=1, Number of nodes)
loop over    {
the number   { 3 FORMAT (10F10.4)
of time steps
```

Since this is a formatted write, this tape may be used on either CDC or IBM.

This information has been forwarded to the Applied Mechanics Branch for use in their stress analysis.

COUPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
 LCFT WELD
 UNITS, BTU, IN, DEG F, SEC

Figure 1. LCFT 10" weld finite element mesh.

LTR112.130

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

J. IN, DEG F. SEC

Figure 2. Finite element mesh in weld region.

LIR112 134

PLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
 LD
 -TU, IN.DEG F, SEC

Figure 3. Finite element mesh in weld region.

LTR12.130

LE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
 D
 ITU, IN, DEG F, SEC

Figure 4. Finite element mesh in weld region.

LTR112.131

PLE MOD 2 (MAY-23.77) UPDATE 1 (MAY-23.77) ECL
 LD
 BTU. IN. DEG F. SEC

Figure 5. Finite element mesh in weld region.

LTR12.13H

IN, DEG F, SEC

Figure 6. Finite element mesh in weld region

Figure 7. Finite element mesh in weld region.

COUPLE MOD 2 (MAY-23.77) UPDATE 1 (MAY-23.77) ECL
 WELD
 BTU, IN, DEG F, SEC

Figure 8. Finite element mesh in weld region.

LIR112 131

UPLE MOD 2 (MAY-23,77) UPDATE 1 (MAY-23,77) ECL
 LD
 BTU, IN, DEG F, SEC

Figure 9. Finite element mesh above weld region.

LR112 138

AMPLE MOD 2 (MAY-23.77) UPDATE 1 (MAY-23.77) ECL
 LD
 BTU. IN.DEG F. SEC

Figure 10. Finite element mesh below weld region.

LVR12.13.1

LOFT weld nodes 195 = ins. surface, 205 = out. surface

Figure 11. Weld temperature during heatup.

LOFT weld nodes 195= ins. surface, 205=out. surface

Figure 12. Weld temperature during blowdown.

IV. REFERENCES

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3. Personal communication with P. K. Nugata, EG&G Idaho (November 1977).
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5. Personal communication with N. E. Pace, EG&G Idaho (November 1977).
6. S. K. Howell, LOFT LOCE Transient Thermal Analysis For 6 In., 8 In., 10 In., and 12 In., Primary Coolant Blowdown Piping, LTR 112-118, EG&G Idaho, Inc. (September 1977).

APPENDIX A

INPUT DATA FOR
COUPLE/MOD2 THERMAL ANALYSIS

123456789012345678902123456789031234567890412345678905123456789061234567890712345678908

TITLE
LCF1, W10
UNITS, RTU, IN, DEG F, SEC

MATERIAL

2.31500E-5 0.2841 316 SST (LB/IN3) 1.0 1
2.31500E-5 0.2841 316 SST (LB/IN3) 1.0 1

NODES

377 0 1 1
1 4.375 0.
2 4.375 0.
3 4.375 0.
4 4.375 0.
5 4.375 0.
6 4.375 0.
7 4.375 0.
8 4.375 0.
9 4.375 0.
10 4.375 0.
11 4.375 0.
12 4.375 0.
13 4.375 0.
14 4.375 0.
15 4.375 0.
16 4.375 0.
17 4.375 0.
18 4.375 0.
19 4.375 0.
20 4.375 0.
21 4.375 0.
22 4.375 0.
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25 4.375 0.
26 4.375 0.
27 4.375 0.
28 4.375 0.
29 4.375 0.
30 4.375 0.
31 4.375 0.
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33 4.375 0.
34 4.375 0.
35 4.375 0.
36 4.375 0.
37 4.375 0.
38 4.375 0.
39 4.375 0.
40 4.375 0.
41 4.375 0.
42 4.375 0.
43 4.375 0.
44 4.375 0.
45 4.375 0.
46 4.375 0.
47 4.375 0.
48 4.375 0.
49 4.375 0.
50 4.375 0.

0 123456789012345678902123456789031234567890412345678905123456789061234567890712345678908

0 123456789012345678902123456789031234567890412345678905123456789061234567890712345678908

107 4.275 9.64
117 4.375 9.64
118 4.375 9.64
120 4.375 9.64
121 4.375 9.64
122 4.375 9.64
123 4.375 9.64
124 4.375 9.64
125 4.375 9.64
126 4.375 9.64
127 4.375 9.64
128 4.375 9.64
129 4.375 9.64
130 4.375 9.64
131 4.375 9.64
132 4.375 9.64
133 4.375 9.64
134 4.375 9.64
135 4.375 9.64
136 4.375 9.64
137 4.375 9.64
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190 4.375 9.64
191 4.375 9.64
192 4.375 9.64
193 4.375 9.64
194 4.375 9.64
195 4.375 9.64
196 4.375 9.64
197 4.375 9.64
198 4.375 9.64
199 4.375 9.64
200 4.375 9.64

LRI12.131

0 1 2 3 4 5 6 7 8
 1234567890123456789012345678901234567890123456789012345678901234567890

4-2

51	107	4.375	9.64
52	107	4.375	9.64
53	107	4.375	9.69
54	107	4.375	9.69
55	107	4.375	9.73
56	107	4.375	9.73
57	107	4.375	9.76
58	107	4.375	9.76
59	107	4.375	9.82
60	107	4.375	9.82
61	107	4.375	9.87
62	107	4.375	9.87
63	107	4.375	9.94
64	107	4.375	9.94
65	107	4.375	10.00
66	107	4.375	10.00
67	107	4.375	10.07
68	107	4.375	10.07
69	107	4.375	10.13
70	107	4.375	10.13
71	107	4.375	10.18
72	107	4.375	10.18
73	107	4.375	10.22
74	107	4.375	10.22
75	107	4.375	10.27
76	107	4.375	10.27
77	107	4.375	10.31
78	107	4.375	10.31
79	107	4.375	10.36
80	107	4.375	10.36
81	107	4.375	10.41
82	107	4.375	10.41
83	107	4.375	10.45
84	107	4.375	10.45
85	107	4.375	10.50
86	107	4.375	10.50
87	107	4.375	10.54
88	107	4.375	10.54
89	107	4.375	10.59
90	107	4.375	10.59
91	107	4.375	10.64
92	107	4.375	10.64
93	107	4.375	10.70
94	107	4.375	10.70
95	107	4.375	10.76
96	107	4.375	10.76
97	107	4.375	10.90
98	107	4.375	10.90
99	107	4.375	11.30
100	107	4.375	11.30

0 1 2 3 4 5 6 7 8
 1234567890123456789012345678901234567890123456789012345678901234567890

0 1 2 3 4 5 6 7 8
 1234567890123456789012345678901234567890123456789012345678901234567890

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102	361	4.375	12.
103	361	4.375	13.
104	361	4.375	13.
105	361	4.375	14.
106	361	4.375	14.
107	361	4.375	15.
108	361	4.375	15.
109	361	4.375	16.
110	361	4.375	16.
111	361	4.375	17.
112	361	4.375	17.

LTR12.13

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101	371	5.375	12.
102	372	4.375	13.
103	373	5.375	14.
104	374	4.375	15.
105	375	5.375	16.
106	376	4.375	17.
107	377	5.375	18.
108	378	4.375	19.
109	379	5.375	20.
110	380	4.375	21.
111	381	5.375	22.
112	382	4.375	23.
113	383	5.375	24.
114	384	4.375	25.
115	385	5.375	26.
116	386	4.375	27.
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LTR12.13H

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87	67	63	60	73	73	1
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103	83	79	76	89	89	2
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105	85	81	78	91	91	1
106	86	82	79	92	92	2
107	87	83	80	93	93	1
108	88	84	81	94	94	1
109	89	85	82	95	95	2
110	90	86	83	96	96	1
111	91	87	84	97	97	1
112	92	88	85	98	98	2
113	93	89	86	99	99	1
114	94	90	87	100	100	1
115	95	91	88	101	101	2
116	96	92	89	102	102	1
117	97	93	90	103	103	1
118	98	94	91	104	104	2
119	99	95	92	105	105	1
120	100	96	93	106	106	1
121	101	97	94	107	107	2
122	102	98	95	108	108	1
123	103	99	96	109	109	1
124	104	100	97	110	110	2
125	105	101	98	111	111	1
126	106	102	99	112	112	1
127	107	103	100	113	113	2
128	108	104	101	114	114	1
129	109	105	102	115	115	1
130	110	106	103	116	116	2
131	111	107	104	117	117	1
132	112	108	105	118	118	1
133	113	109	106	119	119	2
134	114	110	107	120	120	1
135	115	111	108	121	121	1
136	116	112	109	122	122	2
137	117	113	110	123	123	1
138	118	114	111	124	124	1
139	119	115	112	125	125	2
140	120	116	113	126	126	1
141	121	117	114	127	127	1
142	122	118	115	128	128	2
143	123	119	116	129	129	1
144	124	120	117	130	130	1
145	125	121	118	131	131	2
146	126	122	119	132	132	1
147	127	123	120	133	133	1
148	128	124	121	134	134	2
149	129	125	122	135	135	1
150	130	126	123	136	136	1
151	131	127	124	137	137	2
152	132	128	125	138	138	1
153	133	129	126	139	139	1
154	134	130	127	140	140	2
155	135	131	128	141	141	1
156	136	132	129	142	142	1
157	137	133	130	143	143	2
158	138	134	131	144	144	1
159	139	135	132	145	145	1
160	140	136	133	146	146	2
161	141	137	134	147	147	1
162	142	138	135	148	148	1
163	143	139	136	149	149	2
164	144	140	137	150	150	1
165	145	141	138	151	151	1
166	146	142	139	152	152	2
167	147	143	140	153	153	1
168	148	144	141	154	154	1
169	149	145	142	155	155	2
170	150	146	143	156	156	1
171	151	147	144	157	157	1
172	152	148	145	158	158	2
173	153	149	146	159	159	1
174	154	150	147	160	160	1
175	155	151	148	161	161	2
176	156	152	149	162	162	1
177	157	153	150	163	163	1
178	158	154	151	164	164	2
179	159	155	152	165	165	1
180	160	156	153	166	166	1
181	161	157	154	167	167	2
182	162	158	155	168	168	1
183	163	159	156	169	169	1
184	164	160	157	170	170	2
185	165	161	158	171	171	1
186	166	162	159	172	172	1
187	167	163	160	173	173	2
188	168	164	161	174	174	1
189	169	165	162	175	175	1
190	170	166	163	176	176	2
191	171	167	164	177	177	1
192	172	168	165	178	178	1
193	173	169	166	179	179	2
194	174	170	167	180	180	1
195	175	171	168	181	181	1
196	176	172	169	182	182	2
197	177	173	170	183	183	1
198	178	174	171	184	184	1
199	179	175	172	185	185	2
200	180	176	173	186	186	1
201	181	177	174	187	187	1
202	182	178	175	188	188	2
203	183	179	176	189	189	1
204	184	180	177	190	190	1
205	185	181	178	191	191	2
206	186	182	179	192	192	1
207	187	183	180	193	193	1
208	188	184	181	194	194	2
209	189	185	182	195	195	1
210	190	186	183	196	196	1
211	191	187	184	197	197	2
212	192	188	185	198	198	1
213	193	189	186	199	199	1
214	194	190	187	200	200	2
215	195	191	188	201	201	1
216	196	192	189	202	202	1
217	197	193	190	203	203	2
218	198	194	191	204	204	1
219	199	195	192	205	205	1
220	200	196	193	206	206	2
221	201	197	194	207	207	1
222	202	198	195	208	208	1
223	203	199	196	209	209	2
224	204	200	197	210	210	1
225	205	201	198	211	211	1
226	206	202	199	212	212	2
227	207	203	200	213	213	1
228	208	204	201	214	214	1
229	209	205	202	215	215	2
230	210	206	203	216	216	1
231	211	207	204	217	217	1
232	212	208	205	218	218	2
233	213	209	206	219	219	1
234	214	210	207	220	220	1
235	215	211	208	221	221	2
236	216	212	209	222	222	1
237	217	213	210	223	223	1
238	218	214	211	224	224	2
239	219	215	212	225	225	1
240	220	216	213	226	226	1
241	221	217	214	227	227	2
242	222	218	215	228	228	1
243	223	219	216	229	229	1
244	224	220	217	230	230	2
245	225	221	218	231	231	1
246	226	222	219	232	232	1
247	227	223	220	233	233	2
248	228	224	221	234	234	1
249	229	225	222	235	235	1
250	230	226	223	236	236	2
251	231	227	224	237	237	1
252	232	228	225	238	238	1
253	233	229	226	239	239	2
254	234	230	227	240	240	1
255	235	231	228	241	241	1
256	236	232	229	242	242	2
257	237	233	230	243	243	1
258	238	234	231	244	244	1
259	239	235	232	245	245	2
260	240	236	233	246	246	1
261	241	237	234	247	247	1
262	242	238	235	248	248	2
263	243	239	236	249	249	1
264	244	240	237	250	250	1

	1	2	3	4	5	6	7	8
251	347	345	346	353	353	353	353	353
252	347	346	347	353	353	353	353	353
253	347	346	347	353	353	353	353	353
254	347	346	347	353	353	353	353	353
255	347	346	347	353	353	353	353	353
256	347	346	347	353	353	353	353	353
257	347	346	347	353	353	353	353	353
258	347	346	347	353	353	353	353	353
259	347	346	347	353	353	353	353	353
260	347	346	347	353	353	353	353	353
261	347	346	347	353	353	353	353	353
262	347	346	347	353	353	353	353	353
263	347	346	347	353	353	353	353	353
264	347	346	347	353	353	353	353	353
265	347	346	347	353	353	353	353	353
266	347	346	347	353	353	353	353	353
267	347	346	347	353	353	353	353	353
268	347	346	347	353	353	353	353	353
269	347	346	347	353	353	353	353	353
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271	347	346	347	353	353	353	353	353
272	347	346	347	353	353	353	353	353
273	347	346	347	353	353	353	353	353
274	347	346	347	353	353	353	353	353
275	347	346	347	353	353	353	353	353

STEP 21600.0 24000.0 4 1 70.0 1

FUNCTIONS

	1	2	3	4	5	6	7	8
281	100.0	6	2	1	1	1	1	1
282	392.0	4.749	212.0	5.016	302.0	9.407	10.78	10.78
283	100.0	6	2	1	1	1	1	1
284	392.0	4.749	212.0	5.016	302.0	9.407	10.78	10.78
285	100.0	6	2	1	1	1	1	1
286	392.0	4.749	212.0	5.016	302.0	9.407	10.78	10.78
287	100.0	6	2	1	1	1	1	1
288	392.0	4.749	212.0	5.016	302.0	9.407	10.78	10.78
289	100.0	6	2	1	1	1	1	1
290	392.0	4.749	212.0	5.016	302.0	9.407	10.78	10.78
291	100.0	6	2	1	1	1	1	1
292	392.0	4.749	212.0	5.016	302.0	9.407	10.78	10.78
293	100.0	6	2	1	1	1	1	1
294	392.0	4.749	212.0	5.016	302.0	9.407	10.78	10.78
295	100.0	6	2	1	1	1	1	1
296	392.0	4.749	212.0	5.016	302.0	9.407	10.78	10.78
297	100.0	6	2	1	1	1	1	1
298	392.0	4.749	212.0	5.016	302.0	9.407	10.78	10.78
299	100.0	6	2	1	1	1	1	1
300	392.0	4.749	212.0	5.016	302.0	9.407	10.78	10.78

0 1234567890 1 2 3 4 5 6 7 8

0 1234567890 1 2 3 4 5 6 7 8

21644.0 1000.0 22900.0 1000.0 24000.0 100.0

INITIAL

CONNECT SETS

102

-1	17	21.929000	-6	5	1.0
-1	20	21.929000	-6	5	1.0
-1	24	41.929000	-6	5	1.0
-1	30	61.929000	-6	5	1.0
-1	34	111.929000	-6	5	1.0

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123456789012345678901234567890123456789012345678901234567890

21644.0 1000.0 22900.0 1000.0 24000.0 100.0

INITIAL

CONNECT SETs

102	17	21.929000	-6	5	1.0
17	-1	20	-6	5	1.0
20	-1	24	-6	5	1.0
24	-1	30	-6	5	1.0
30	-1	349	-6	5	1.0
349	-1	355	-6	5	1.0
355	-1	359	-6	5	1.0
359	-1	362	-6	5	1.0
362	-1	376	-6	5	1.0
376	-1	40	-7	5	1.0
40	-1	19	-7		100.0
19	-1	23	-7		100.0
23	-1	29	-7		100.0
29	-1	343	-7		100.0
343	-1	394	-7		100.0
394	-1	395	-7		100.0
395	-1	361	-7		100.0
361	-1	377	-7		100.0

PLOTS

1 0 2 0 1 45 60 75

COUPLE

END OF DATA

0 1 2 3 4 5 6 7 8
123456789012345678901234567890123456789012345678901234567890

A-7

LTR12.13M

APPENDIX B

MICROFICHE COPY OF COMPUTER RUN

(see Distirbution)