MASTER

LOFT TECHNICAL REPORT LTR 114-100

JULY 27, 1978

LOFT LOCA - WHAM6 MODEL AND
CODE APPLICATION

V. T. Berta

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This LTR documents the WHAM 6 analysis of a loss-of-coolant accident (LOCA) pipe break at the reactor vessel. Data derived from this document is to be used to generate loads for the LOCA analysis of the reactor internals.

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1.0 INTRODUCTION

The pipe break for the LOFT loss-of-coolant accident (LOCA) analysis is defined herein with respect to the requirements on break area and break opening time. In addition, the physical characteristics of the pipe break are defined, and the application of the WHAM6 computer code^[1] and modeling technique to the LOCA pipe break are described. As such then, this report constitutes a reference for the LOCA analysis and does not represent a part of that analysis.

The requirements^[2] given for the pipe break for a LOCA condition in LOFT are:

- (1) Break area - full double-ended pipe area (0.1268 m^2)
- (2) Break opening time - 5.0 ms to full area.

In order to completely describe the LOCA pipe break, the following parameters must be known:

- (1) Pressure as a function of time at the break
- (2) The structural geometry of the break
- (3) The single- and two-phase fluid geometry at the break
- (4) The location of the pipe break.

Sections 2.0 and 3.0 define the LOCA pipe break and describe the WHAM6 model of the pipe break in the LOFT system. Section 4.0 describes the WHAM6 code application to the model. Section 5.0 briefly describes the results of the WHAM6 code runs in relation to the pipe break description. Complete card decks describing the LOCA pipe break and system models are contained in Appendices A and B.

2.0 LOCA PIPE BREAK DEFINITION

LOCA pipe breaks, from whatever driving force, start with the growth of flaws. Pipe breaks can occur from the growth of longitudinally or circumferentially oriented flaws in the pipe wall. The characteristics of the pipe break are very similar for the two types of flaws. The chronology of events of a pipe break originating from a longitudinally oriented flaw is shown in Figure 1. A similar chronology for the pipe break originating from a circumferentially oriented flaw is shown in Figure 2. In both cases, the chronology is based on the break area and opening time requirements specified in Section 1.0.

In both types of pipe breaks, a single-phase fluid path for pressure wave propagation through the break exists for a short time after the break area has reached twice the pipe area (double-ended break condition). The pipe continues to split apart in a longitudinal break which propagates the break plane in both directions from the original flaw and which ultimately terminates the pressure wave propagation path from one side of the break to the other. This state is equivalent to the full offset of the pipe which can occur in a circumferential break. The actual offset of the two pipe segments occurs after the pipe has severed completely (or reached double-ended break area). The time of 10 ms after the full area is reached for the single-phase fluid path to terminate was chosen as a conservative value based on the results of pipe rupture studies^[3,4,5].

The drop in pressure from initial to saturation generates decompression waves which propagate in both directions from the break. The velocity imparted to the fluid by the initial decompression waves is more than sufficient to reverse flow downstream of the break location. The governing equation is:

Initial conditions

$t=0$ pipe break begins; pressure at break drops to saturation in 1.0 ms

$0 < t < 5$ ms break propagates longitudinally and opens laterally; flashing front remains at the break; single phase fluid path past the break exists

$t = 5$ ms break area equals twice pipe area (double-ended break); flashing front remains at break exit; single phase fluid path past the break is reduced but still existent

$t = 15$ ms break continues to propagate in both directions; flashing front moves with break area translation; single phase fluid path past the break is reduced to zero

INEL-A-8859

Fig. 1 Pipe break chronology originating from a longitudinal flow.

Initial conditions

$t=0$ pipe break begins; pressure at break drops to saturation in 1.0 ms

$0 < t < 5$ ms break propagates circumferentially; break area increases linearly; flashing front remains at break exit; single phase fluid path past break exists and begins to decrease

$t=5$ ms break complete; break area equals pipe area in both directions (double-ended break); flashing front remains at break exit; single phase fluid path reduced but still existent

$t=15$ ms offset complete; flashing front remains at the end of each pipe; single phase fluid path reduced to zero

INEL-A-8860

Fig. 2 Pipe break chronology originating from a circumferential flaw.

3.0 WHAM6 PIPE BREAK MODEL

The analysis of the LOFT LOCA condition must necessarily include all of the primary coolant system (PCS) water volume. The hydraulic model of the LOFT PCS for the WHAM6 code that has been developed and refined during the LOFT nonnuclear loss-of-coolant experiments (LOCE) and which is used for the LOCE L1-5 zero-power nuclear analysis and prediction is described in Reference 6. This same model with the core simulator in place of the nuclear core was used to predict the LOCE L1-4 standard problem for subcooled blowdown. Examples of the comparisons are shown in Figures 3 through 6. The hydraulic model has proved to be representative of the LOFT PCS as evidenced by the agreement in the comparisons.

The simulated LOCA in LOFT can occur in either the hot leg piping or the cold leg piping. Both cases must be analyzed to determine the most severe transient on any major core component. Two separate WHAM6 models were defined which are identical in every respect to the representative LOFT PCS model except for the location of the break for the LOCA. The intact loop piping (both cold leg and hot leg piping) was chosen for the LOCA pipe break. The two LOCA cases have the pipe break occurring at the reactor vessel nozzles. These locations create the most severe loading conditions on the major components in the LOFT system. The hydraulic models of the two pipe break cases are identified in Figures 7 and 8.

The existing leg numbers in the representative PCS model were modified to incorporate the pipe break. The models shown in Figures 7 and 8 show the changes in leg and junction definition of the system model^[6] for incorporation of the pipe break. With reference to Figure 7, the break location is placed at junctions 165 and 167. Leg 180 represents the single-phase fluid through the break for pressure wave propagation. Legs 179 and 181 represent the maximum break area in the pipe wall (0.0634 m^2) which is equal to the pipe area. Thus, conditions are established for a double-ended break. Junctions 166

7

Fig. 3 Pressure - broken loop hot leg: L1-4 - WHAM6 comparison.

Fig. 4 Pressure - intact loop hot leg: L1-4 - WHAM6 comparison.

Fig. 5 Pressure - core simulator: L1-4 - WHAM6 comparison.

Fig. 6 Pressure - reactor vessel instrument stalk 1 upper downcomer:
L1-4 - WHAM6 comparison.

and 168 control the size of the break. The break area at each junction is increased linearly to 0.0634 m^2 in 5 ms. The fluid path area is decreased linearly from 0.0634 m^2 to 0.0001 m^2 in 15 ms in accordance with the pipe break chronology discussed in the previous section. The 1.0 ms pressure drop from initial to saturation pressure is input at junctions 166 and 168. After 15 ms, flow and pressure wave propagation occur in legs 178-179 and legs 181-182. Leg 180 does not influence subcooled blowdown after 15 ms even though, for code modeling reasons, it still has a small finite area. Junction 165 represents the end of the reactor vessel nozzle, and junction 167 represents the end of the hot leg pipe.

The same modeling scheme was used for the cold leg LOCA pipe break shown in Figure 8. The complete card decks describing the LOCA pipe break and system models are contained in the appendices; the hot leg break case in Appendix A, and the cold leg break case in Appendix B.

Two additional items were necessary to complete the LOCA hydraulic models. The first is the broken loop configuration. LOFT will almost always have the broken loop in the cold leg break LOCE configuration so this geometry was used. Secondly, the most severe loading will occur for the largest subcooled blowdown pressure range. Therefore, the steady-state isothermal 282°C plant condition was used since this condition would provide the largest pressure range within the operating envelope for the LOFT system.

4.0 WHAM6 CODE APPLICATION

A modification to the WHAM6 computer code was necessary in order to cause the single-phase fluid path for wave propagation to decrease in area as a function of time. The following programming was added to subroutine WHAM after statement B1440 to permit the area of leg 180 (the fluid path) in the hot leg break case to decrease linearly as a function of time:

```

C  -----
C  -----
    IF(T.GT.0.015) GO TO 49
    A(180)=A(180)-0.004551
    IF(A(180).LT.0.0001) A(180)=0.0001
    AF(180)=4.*(A(180)/3.1416)**0.5/DT
49  CONTINUE
C  -----
C  -----

```

Leg 180 was changed to leg 231 in the above programming for the cold leg break.

The models of the complete PCS consist of 244 legs. The WHAM6 pressure and velocity data were stored on tape for all legs at a time step of 0.1 ms. The end time of the two code runs is 0.101 second. The LOCA runs were made with the IBM 360 version of WHAM6, identified as follows:

Hot leg LOCA DSN = L.VTBWHM Tape No. T93712

Cold leg LOCA DSN = L.VTBWHM Tape No. A99195

5.0 LOCA SUBCOOLED BLOWDOWN CHARACTERISTICS

Subcooled blowdown of the reactor vessel and intact loop was complete in about 35 ms for both the hot leg and cold leg LOCA break cases. The steam generator simulator in the broken loop had to depressurize through the 0.0084 m^2 pipe connecting it to the 0.0634 m^2 piping next to the reactor vessel. Thus, the steam generator simulator did not complete depressurization until about 80 ms (which was found for the 0.0084 m^2 double-ended LOCE breaks). The rapid 35 ms depressurization of the system must necessarily cause large pressure gradients to occur when considering the sonic speed of 1041 m/s.

The break conditions for the LOCA are much more severe than those for the experiments that have been and will be conducted in the LOFT system. The depressurization time, 35 ms, is just over twice the time used to define the physics of the pipe break. This justifies the premise that, in establishing conservative requirements, the physics of the problem must be included and accounted for properly to insure that "conservative" does not become "unrealistic" or even "invalid". The requirement of 5 ms for a double-ended area break is indeed conservative and represents an approximation of the limit to which a pipe can physically rupture to such an area. However, because of the location and size of the break, the break opening time loses importance and a value several times larger than the requirement would not produce significant changes in the results. The results of the WHAM6 code runs show that correct structural and fluid geometries at the break are advisable for LOCA analyses.

6.0 REFERENCES

1. S. Fabric, Computer Program WHAM for Calculation of Pressure, Velocity, and Force Transients in Liquid Filled Piping Networks, Kaiser Engineers Report No. 67-49-R (November 1967).
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4. R. J. Eiber et al., Investigation of The Initiation and Extent of Ductile Pipe Failure, Phase I Final Report, BMI-1866 (July 1969).
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6. W. H. Grush et al., Experiment Prediction For LOFT Nonnuclear Experiment L1-5, TREE-NUREG-1209 (March 1978).

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APPENDIX A

LOCA HOT LEG BREAK MODEL REFERENCE
(British Units)

WHAV/MOD 006/ 7-01-75 / VTB

DATE 02/01/78

LOFT LOCA ANALYSIS HOT LEG BREAK ON INTACT LOOP ISOTHERMAL CONDITION
PCS IN THE COLD LEG BREAK EXPERIMENT CONFIGURATION

SATURATION PRESSURE (PSIG) V-1 = 950.0
 KINEMATIC VISCOSITY (FT.SQ./SEC) = 0.0
 TOTAL NUMBER OF LEGS = 244
 SATURATION PRESSURE (PSIG) V-2 = 950.0

HYDRAULIC MODEL DESCRIPTION

J	A	UD	PJ	C	W	NO	NND1	NND2	LEG1	LEG2	OK
1	0.6827	0.0	2250.00	3700.	47.21	3	10	9	1	2	0.0
2	0.6827	0.0	2250.00	3700.	47.21	3	9	9	2	3	0.0
3	0.6827	0.0	2250.00	3600.	47.21	2	9	9	3	4	0.0
4	0.6827	0.0	2250.00	3500.	47.21	3	9	3	4	5	0.0
5	0.6827	0.0	2250.00	3416.	47.21	6	3	2	5	6	0.21
6	0.6827	0.0	2250.00	3416.	47.21	7	2	4	6	227	0.0
7	0.6827	0.0	2250.00	3416.	47.21	11	4	3	226	7	0.0
8	0.6827	0.0	2250.00	3450.	47.21	10	3	2	7	8	0.0
9	0.0900	0.0	2250.00	3475.	47.21	6	2	9	8	9	0.0
10	0.0900	0.0	2250.00	3475.	47.21	4	9	2	9	10	0.21
11	0.0900	0.0	2250.00	3475.	47.21	7	2	2	10	11	0.0
12	1.0600	0.0	2250.00	3500.	47.21	9	2	2	11	12	1.00
13	1.0600	0.0	2250.00	3500.	47.21	3	2	2	12	13	1.00
14	1.0600	0.0	2250.00	3500.	47.21	3	2	2	13	14	1.00
15	1.0600	0.0	2250.00	3500.	47.21	3	2	2	14	15	1.00
16	1.0600	0.0	2250.00	3500.	47.21	3	2	2	15	16	1.00
17	1.0600	0.0	2250.00	3500.	47.21	3	2	2	16	17	1.00
18	1.0600	0.0	2250.00	3525.	47.21	3	2	2	17	18	1.00

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19	1.0600	0.0	2250.00	3525.	47.21	6	2	2	18	19	0.21
20	1.0600	0.0	2250.00	3525.	47.21	10	2	2	19	20	0.21
21	1.0600	0.0	2250.00	3550.	47.21	6	2	2	20	21	1.00
22	1.0600	0.0	2250.00	3550.	47.21	3	2	2	21	22	1.00
23	1.0600	0.0	2250.00	3550.	47.21	3	2	2	22	23	1.00
24	1.0600	0.0	2250.00	3550.	47.21	3	2	2	23	24	1.00
25	1.0600	0.0	2250.00	3575.	47.21	3	2	2	24	25	1.00
26	1.0600	0.0	2250.00	3575.	47.21	3	2	2	25	26	1.00
27	1.0600	0.0	2250.00	3575.	47.21	3	2	2	26	27	1.00
28	1.0600	0.0	2250.00	3575.	47.21	9	2	2	27	28	0.0
29	0.0900	0.0	2250.00	3600.	47.21	12	2	2	28	29	0.0
30	0.2464	0.0	2250.00	3600.	47.21	3	2	2	29	30	0.0
31	0.6827	0.0	2250.00	3600.	47.21	6	2	2	30	31	0.0
32	0.0500	0.0	2250.00	3650.	47.21	4	2	2	31	32	0.0
33	0.0900	0.0	2250.00	3650.	47.21	2	2	9	32	33	0.0
34	0.0900	0.0	2250.00	3650.	47.21	5	9	2	33	34	0.21
35	0.0900	0.0	2250.00	3675.	47.21	7	2	9	34	35	0.0
36	0.0900	0.0	2250.00	3700.	47.21	6	9	9	35	36	0.0
37	0.0900	0.0	2250.00	3416.	47.21	4	2	1	36	37	0.0
38	0.3941	0.0	2250.00	3500.	47.21	9	3	9	7	38	0.0
39	0.3941	0.0	2250.00	3550.	47.21	10	9	2	38	39	0.21
40	0.3941	0.0	2250.00	3575.	47.21	7	2	3	39	40	0.0
41	0.6827	0.0	2250.00	3416.	47.21	4	4	5	43	44	0.0
42	0.9500	0.0	2250.00	3416.	47.21	7	5	5	44	45	0.0
43	0.9500	0.0	2250.00	3416.	47.21	7	5	5	45	46	0.0
44	0.9500	0.0	2250.00	3416.	47.21	7	5	5	44	47	0.0
45	0.9500	0.0	2250.00	3416.	47.21	7	5	5	47	46	0.0
46	0.6827	0.0	2250.00	3416.	47.21	4	5	4	46	227	0.0
47	0.0782	0.0	2250.00	3416.	47.21	3	4	9	43	48	0.0
48	0.0782	0.0	2250.00	3416.	47.21	3	9	2	48	49	0.0
49	0.0392	0.0	2250.00	3416.	47.21	5	2	1	49	50	0.0
50	0.0782	0.0	2250.00	3416.	47.21	3	3	9	51	52	0.0
51	0.0782	0.0	2250.00	3416.	47.21	3	9	2	52	53	0.0
52	0.0392	0.0	2250.00	3416.	47.21	5	2	1	53	54	0.0
53	0.0782	0.0	2250.00	3416.	47.21	3	3	9	55	56	0.0

54	0.0782	0.0	2250.00	3416.	47.21	3	9	2	56	57	0.0
55	0.0392	0.0	2250.00	3416.	47.21	5	2	1	57	58	0.0
56	0.0782	0.0	2250.00	3416.	47.21	3	4	9	227	59	0.0
57	0.0782	0.0	2250.00	3416.	47.21	3	9	2	59	60	0.0
58	0.0392	0.0	2250.00	3416.	47.21	5	2	1	60	61	0.0
59	0.6979	0.0	2250.00	3416.	47.21	4	5	1	44	62	0.0
60	0.6979	0.0	2250.00	3416.	47.21	4	5	1	47	63	0.0
61	0.6979	0.0	2250.00	3416.	47.21	4	5	1	45	64	0.0
62	0.6979	0.0	2250.00	3416.	47.21	4	5	1	46	65	0.0
63	0.6827	0.0	2250.00	3416.	47.21	4	5	3	47	51	0.0
64	0.6827	0.0	2250.00	3416.	47.21	4	5	3	45	55	0.0
65	0.0782	0.0	2250.00	3416.	47.21	10	4	9	43	66	0.0
66	0.0782	0.0	2250.00	3416.	47.21	10	9	9	66	67	0.0
67	0.0782	0.0	2250.00	3416.	47.21	10	9	9	67	68	0.0
68	0.0782	0.0	2250.00	3416.	47.21	10	9	9	68	69	0.0
69	0.0782	0.0	2250.00	3416.	47.21	7	9	9	69	70	0.0
70	0.0782	0.0	2250.00	3416.	47.21	9	9	9	70	71	0.0
71	0.0782	0.0	2250.00	3416.	47.21	5	9	5	71	90	0.0
72	0.0782	0.0	2250.00	3416.	47.21	10	3	9	55	72	0.0
73	0.0782	0.0	2250.00	3416.	47.21	10	9	9	72	73	0.0
74	0.0782	0.0	2250.00	3416.	47.21	10	9	9	73	74	0.0
75	0.0782	0.0	2250.00	3416.	47.21	10	9	9	74	75	0.0
76	0.0782	0.0	2250.00	3416.	47.21	7	9	9	75	76	0.0
77	0.0782	0.0	2250.00	3416.	47.21	9	9	9	76	77	0.0
78	0.0782	0.0	2250.00	3416.	47.21	5	9	5	77	90	0.0
79	0.0782	0.0	2250.00	3416.	47.21	10	4	9	227	78	0.0
80	0.0782	0.0	2250.00	3416.	47.21	10	9	9	78	79	0.0
81	0.0782	0.0	2250.00	3416.	47.21	10	9	9	79	80	0.0
82	0.0782	0.0	2250.00	3416.	47.21	10	9	9	80	81	0.0
83	0.0782	0.0	2250.00	3416.	47.21	7	9	9	81	82	0.0
84	0.0782	0.0	2250.00	3416.	47.21	9	9	9	82	83	0.0
85	0.0782	0.0	2250.00	3416.	47.21	5	9	5	83	90	0.0
86	0.0782	0.0	2250.00	3416.	47.21	10	3	9	51	84	0.0
87	0.0782	0.0	2250.00	3416.	47.21	10	9	9	84	85	0.0
88	0.0782	0.0	2250.00	3416.	47.21	10	9	9	85	86	0.0
89	0.0782	0.0	2250.00	3416.	47.21	10	9	9	86	87	0.0

90	0.0782	0.0	2250.00	3416.	47.21	7	9	9	87	88	0.0
91	0.0782	0.0	2250.00	3416.	47.21	9	9	9	88	89	0.0
92	0.0782	0.0	2250.00	3416.	47.21	5	9	5	89	90	0.0
93	0.4108	0.0	2250.00	3416.	47.21	10	5	9	44	91	0.0
94	0.4108	0.0	2250.00	3416.	47.21	9	9	2	91	92	0.0
95	0.3559	0.0	2250.00	3416.	47.21	4	2	2	92	93	0.0
96	0.4108	0.0	2250.00	3416.	47.21	11	2	9	93	94	0.0
97	0.4108	0.0	2250.00	3416.	47.21	11	9	2	94	95	0.0
98	0.3559	0.0	2250.00	3416.	47.21	2	2	6	95	111	0.0
99	0.4108	0.0	2250.00	3416.	47.21	10	5	9	45	96	0.0
100	0.4108	0.0	2250.00	3416.	47.21	9	9	2	96	97	0.0
101	0.3559	0.0	2250.00	3416.	47.21	4	2	2	97	98	0.0
102	0.4108	0.0	2250.00	3416.	47.21	11	2	9	98	99	0.0
103	0.4108	0.0	2250.00	3416.	47.21	11	9	2	99	100	0.0
104	0.3559	0.0	2250.00	3416.	47.21	2	2	6	100	111	0.0
105	0.4108	0.0	2250.00	3416.	47.21	10	5	9	46	101	0.0
106	0.4108	0.0	2250.00	3416.	47.21	9	9	2	101	102	0.0
107	0.3559	0.0	2250.00	3416.	47.21	4	2	2	102	103	0.0
108	0.4108	0.0	2250.00	3416.	47.21	11	2	9	103	104	0.0
109	0.4108	0.0	2250.00	3416.	47.21	11	9	2	104	105	0.0
110	0.3559	0.0	2250.00	3416.	47.21	2	2	6	105	111	0.0
111	0.4108	0.0	2250.00	3416.	47.21	10	5	9	47	106	0.0
112	0.4108	0.0	2250.00	3416.	47.21	9	9	2	106	107	0.0
113	0.3559	0.0	2250.00	3416.	47.21	4	2	2	107	108	0.0
114	0.4108	0.0	2250.00	3416.	47.21	11	2	9	108	109	0.0
115	0.4108	0.0	2250.00	3416.	47.21	11	9	2	109	110	0.0
116	0.3559	0.0	2250.00	3416.	47.21	2	2	6	110	111	0.0
117	6.6800	0.0	2250.00	3416.	47.21	7	5	6	90	111	0.0
118	6.6800	0.0	2250.00	3416.	47.21	2	6	2	111	112	0.0
119	1.6110	0.0	2250.00	3416.	47.21	2	2	4	112	113	0.0
120	4.2800	0.0	2250.00	3416.	47.21	2	4	2	113	114	9.84
121	4.2800	0.0	2250.00	3416.	47.21	2	2	2	114	115	0.0
122	1.9800	0.0	2250.00	3416.	47.21	2	2	2	115	116	6.94
123	1.9800	0.0	2250.00	3416.	47.21	2	2	2	116	117	1.98
124	1.9800	0.0	2250.00	3416.	47.36	6	2	2	117	118	1.98
125	1.9800	0.0	2250.00	3416.	47.96	5	2	2	118	119	1.98

126	1.9800	0.0	2250.00	3416.	47.21	6	2	2	119	120	1.98
127	1.9800	0.0	2250.00	3416.	47.21	2	2	2	120	121	3.24
128	1.9300	0.0	2250.00	3416.	47.21	2	2	2	121	122	0.0
129	1.2800	0.0	2250.00	3416.	47.21	2	2	2	122	123	0.0
130	2.8300	0.0	2250.00	3416.	47.21	5	2	9	123	124	0.0
131	2.8300	0.0	2250.00	3416.	47.21	5	9	9	124	125	0.0
132	2.8300	0.0	2250.00	3416.	47.21	5	9	9	125	126	0.0
133	2.8300	0.0	2250.00	3416.	47.21	6	9	9	126	127	0.0
134	2.8300	0.0	2250.00	3416.	47.21	6	9	4	127	128	0.0
135	0.2700	0.0	2250.00	3416.	47.21	5	4	9	113	129	0.0
136	0.2700	0.0	2250.00	3416.	47.21	5	9	9	129	130	0.0
137	0.2700	0.0	2250.00	3416.	47.21	10	9	9	130	131	0.0
138	0.2700	0.0	2250.00	3416.	47.21	10	9	9	131	132	0.0
139	0.2700	0.0	2250.00	3416.	47.21	10	9	9	132	133	0.0
140	0.2700	0.0	2250.00	3416.	47.21	7	9	9	133	134	0.0
141	0.2700	0.0	2250.00	3416.	47.21	4	9	4	134	135	0.0
142	0.6827	0.0	2250.00	3416.	47.21	5	4	4	128	135	0.0
143	0.2700	0.0	2250.00	3416.	47.21	5	4	9	113	159	0.0
144	0.2700	0.0	2250.00	3416.	47.21	5	9	9	159	160	0.0
145	0.2700	0.0	2250.00	3416.	47.21	10	9	9	160	161	0.0
146	0.2700	0.0	2250.00	3416.	47.21	10	9	9	161	162	0.0
147	0.2700	0.0	2250.00	3416.	47.21	10	9	9	162	163	0.0
148	0.2700	0.0	2250.00	3416.	47.21	7	9	9	163	164	0.0
149	0.2700	0.0	2250.00	3416.	47.21	4	9	4	164	226	0.0
150	0.6827	0.0	2250.00	3416.	47.21	5	4	4	128	226	0.0
151	0.2700	0.0	2250.00	3416.	47.21	8	4	1	226	137	0.0
152	0.2700	0.0	2250.00	3416.	47.21	8	4	1	135	136	0.0
153	2.8300	0.0	2250.00	3416.	47.21	2	4	9	128	138	0.0
154	2.8300	0.0	2250.00	3416.	47.21	2	9	9	138	139	0.0
155	2.8300	0.0	2250.00	3416.	47.21	3	9	6	139	140	0.0
156	2.8300	0.0	2250.00	3416.	47.21	2	6	9	140	141	0.0
157	2.8300	0.0	2250.00	3416.	47.21	2	9	1	141	142	0.0
158	0.2340	0.0	2250.00	3416.	47.21	3	6	9	140	143	0.0
159	0.2340	0.0	2250.00	3416.	47.21	3	9	2	143	144	0.0
160	0.3760	0.0	2250.00	3416.	47.21	3	2	2	144	145	0.0
161	0.0744	0.0	2250.00	3416.	47.21	2	2	3	145	146	0.0

162	0.2340	0.0	2250.00	3416.	47.21	3	6	9	140	147	0.0
163	0.2340	0.0	2250.00	3416.	47.21	3	9	2	147	148	0.0
164	0.3760	0.0	2250.00	3416.	47.21	3	2	2	148	149	0.0
165	0.0744	0.0	2250.00	3416.	47.21	2	2	3	149	150	0.0
166	0.2340	0.0	2250.00	3416.	47.21	3	6	9	140	155	0.0
167	0.2340	0.0	2250.00	3416.	47.21	3	9	2	155	156	0.0
168	0.3760	0.0	2250.00	3416.	47.21	3	2	2	156	157	0.0
169	0.0744	0.0	2250.00	3416.	47.21	2	2	3	157	158	0.0
170	0.2340	0.0	2250.00	3416.	47.21	3	6	9	140	151	0.0
171	0.2340	0.0	2250.00	3416.	47.21	3	9	2	151	152	0.0
172	0.3760	0.0	2250.00	3416.	47.21	3	2	2	152	153	0.0
173	0.0744	0.0	2250.00	3416.	47.21	2	2	3	153	154	0.0
174	0.0013	0.0	2250.00	3416.	47.21	11	3	3	146	150	0.0
175	0.0013	0.0	2250.00	3416.	47.21	11	3	3	150	158	0.0
176	0.0013	0.0	2250.00	3416.	47.21	11	3	3	158	154	0.0
177	0.0013	0.0	2250.00	3416.	47.21	11	3	3	154	146	0.0
178	0.6827	0.0	2250.00	3416.	47.21	9	4	3	135	165	0.0
179	0.6827	0.0	2250.00	3416.	47.21	2	3	10	165	166	0.0
180	0.6827	0.0	2250.00	3416.	47.21	2	3	3	165	167	0.0
181	0.6827	0.0	2250.00	3416.	47.21	2	3	10	167	168	0.0
182	0.6827	0.0	2250.00	3416.	47.21	16	3	3	167	169	0.0
183	0.0156	0.0	2250.00	3416.	47.21	16	3	2	169	170	0.17
184	0.0156	0.0	2250.00	3416.	47.21	8	2	2	170	171	0.17
185	0.0156	0.0	2250.00	3416.	47.21	6	2	2	171	172	0.17
186	0.0156	0.0	2250.00	3416.	47.21	9	2	2	172	173	0.17
187	0.0156	0.0	2250.00	3416.	47.21	14	2	2	173	174	0.17
188	0.0156	0.0	2250.00	3416.	47.21	7	2	2	174	175	0.17
189	0.0156	0.0	2250.00	3416.	47.21	7	2	7	175	176	0.0
190	0.6827	0.0	2250.00	3416.	47.21	9	3	2	169	177	0.50
191	0.6827	0.0	2250.00	3416.	47.21	13	2	2	177	178	0.10
192	0.6827	0.0	2250.00	3416.	47.21	9	2	2	178	179	0.0
193	0.8956	0.0	2250.00	3416.	47.21	4	2	2	179	180	0.10
194	0.8956	0.0	2250.00	3416.	47.21	6	2	2	180	181	0.0
195	3.4200	0.0	2250.00	3416.	47.21	9	2	6	181	182	0.0
196	0.3083	0.0	2250.00	3416.	47.21	22	6	2	182	183	4.50
197	0.3083	0.0	2250.00	3416.	47.96	16	2	2	183	184	4.50

196	0.3083	0.0	2250.00	3416.	47.21	21	2	6	184	185	0.0
199	0.3200	0.0	2250.00	3416.	47.21	22	6	2	182	186	4.20
200	0.3200	0.0	2250.00	3416.	47.96	13	2	2	186	187	4.20
201	0.3200	0.0	2250.00	3416.	47.21	21	2	6	187	185	0.0
202	0.3345	0.0	2250.00	3416.	47.21	22	6	2	182	188	4.00
203	0.3345	0.0	2250.00	3416.	47.96	9	2	2	188	189	4.00
204	0.3345	0.0	2250.00	3416.	47.21	21	2	6	189	185	0.0
205	0.3263	0.0	2250.00	3416.	47.21	22	6	2	182	190	3.70
206	0.3263	0.0	2250.00	3416.	47.96	7	2	2	190	191	3.70
207	0.3263	0.0	2250.00	3416.	47.21	21	2	6	191	185	0.0
208	0.3390	0.0	2250.00	3416.	47.21	22	6	2	182	192	3.50
209	0.3390	0.0	2250.00	3416.	47.96	4	2	2	192	193	3.50
210	0.3390	0.0	2250.00	3416.	47.21	21	2	6	193	185	0.0
211	0.3800	0.0	2250.00	3416.	47.21	8	6	2	185	194	0.0
212	0.8956	0.0	2250.00	3416.	47.21	4	2	2	194	195	0.10
213	0.8956	0.0	2250.00	3416.	47.21	5	2	2	195	196	0.0
214	0.6827	0.0	2250.00	3416.	47.21	5	2	2	196	197	0.50
215	0.6827	0.0	2250.00	3416.	47.21	7	2	2	197	198	0.17
216	0.6827	0.0	2250.00	3416.	47.21	13	2	3	198	199	0.0
217	0.6827	0.0	2250.00	3416.	47.21	7	3	2	199	200	0.17
218	0.6827	0.0	2250.00	3416.	47.21	6	2	2	200	201	0.0
219	0.3941	0.0	2250.00	3416.	47.21	8	2	11	201	202	0.0
220	0.3941	0.0	2250.00	3416.	47.21	9	11	2	202	203	0.10
221	0.3941	0.0	2250.00	3416.	47.21	12	2	2	203	204	0.0
222	0.6827	0.0	2250.00	3416.	47.21	12	2	3	204	205	0.0
223	0.6827	0.0	2250.00	3416.	47.21	7	3	2	199	206	0.17
224	0.6827	0.0	2250.00	3416.	47.21	6	2	2	206	207	0.0
225	0.3941	0.0	2250.00	3416.	47.21	8	2	11	207	208	0.0
226	0.3941	0.0	2250.00	3416.	47.21	8	11	2	208	209	0.17
227	0.3941	0.0	2250.00	3416.	47.21	6	2	3	209	205	0.0
228	0.6827	0.0	2250.00	3416.	47.21	12	3	2	205	210	0.17
229	0.6827	0.0	2250.00	3416.	47.21	8	2	2	210	211	0.10
230	0.6827	0.0	2250.00	3416.	47.21	10	2	2	211	212	0.50
231	0.6827	0.0	2250.00	3416.	47.21	9	2	9	212	213	0.0
232	0.6827	0.0	2250.00	3416.	47.21	5	9	4	213	43	0.0
233	0.3941	0.0	2250.00	3500.	47.21	7	3	2	5	214	0.21

234	0.3941	0.0	2250.00	3500.	47.21	5	2	2	214	215	0.21
235	0.3941	0.0	2250.00	3525.	47.21	11	2	9	215	216	0.0
236	0.3941	0.0	2250.00	3550.	47.21	10	9	3	216	217	0.0
237	0.3941	0.0	2250.00	3550.	47.21	10	3	2	217	218	0.21
238	0.3941	0.0	2250.00	3600.	47.21	7	2	1	218	219	0.0
239	0.3941	0.0	2250.00	3575.	47.21	10	3	2	217	220	0.21
240	0.3941	0.0	2250.00	3600.	47.21	7	2	1	220	221	0.0
241	0.3941	0.0	2250.00	3600.	47.21	10	3	2	40	222	0.21
242	0.3941	0.0	2250.00	3600.	47.21	7	2	1	222	223	0.0
243	0.3941	0.0	2250.00	3600.	47.21	10	3	2	40	224	0.21
244	0.3941	0.0	2250.00	3600.	47.21	7	2	1	224	225	0.0

INPUT WAVEFORM IS CALCULATED INTERNALLY.

CASE NO	=	1
VALVE INPUT WAVE DURATION(SECS)V-1	=	1.00000
VALVE INPUT WAVE DURATION(SECS)V-2	=	0.00100
VALVE PASSAGE AREA(FT.SQ.)V-1	=	0.0
VALVE PASSAGE AREA(FT.SQ.)V-2	=	0.68270
DISCHARGE COEFFICIENT,CD	=	1.00000

VALVE OPENING TIME(SECS) V-1	=	1.000000
VALVE OPENING TIME(SECS) V-2	=	0.00500
VALVE AREA OPENING DELAY(SECS)V-1	=	1.00000
VALVE AREA OPENING DELAY(SECS)V-2	=	0.0
VALVE INITIATION DELAY(SECS)V-1	=	0.0
VALVE INITIATION DFLAY(SECS)V-2	=	0.0

SYSTEM ENERGY LOSS FACTORS SUPPLIED EXTERNALLY.

LOSS FACTOR	LEG DIAMETER RANGE (FT)
5.00	0 TO 10.0000

TIME INCREMENTS(SEC) = 0.0001000

LTR 114-100

END TIME(SECS) = 0.1010

RESULTS PRINTED AFTER EVERY 50 TIME INCREMENTS

MINIMUM FLUID VELOCITY ABOVE WHICH CHECK VALVES STAY OPEN (FT/SEC) = 0.0

PRESSURIZER PRESSURE STAYS CONSTANT.

PUMP 1 PRESENCE IGNORED.

PUMP 2 PRESENCE IGNORED.

WHAM-6 PUMP MODEL IS USED.

P(T) AND V(T) ON TAPE FOR 246 LEGS

DATA RECORDED EVERY 1 TIME STEPS

LEGS STORED ON TAPE:

1 2 3 4 5 6 7 8 9 10 11 12

13 14 15 16 17 18 19 20 21 22 23 24

25 26 27 28 29 30 31 32 33 34 35 36

37 38 39 40 41 42 43 44 45 46 47 48

49 50 51 52 53 54 55 56 57 58 59 60

97 98 99 100 101 102 103 104 105 106 107 108

109 110 111 112 113 114 115 116 117 118 119 120

~~121 122 123 124 125 126 127 128 129 130 131 132~~

133 134 135 136 137 138 139 140 141 142 143 144

145 146 147 148 149 150 151 152 153 154 155 156

~~157 158 159 160 161 162 163 164 165 166 167 168~~

169 170 171 172 173 174 175 176 177 178 179 180

181 182 183 184 185 186 187 188 189 190 191 192

~~193 194 195 196 197 198 199 200 201 202 203 204~~

205	206	207	208	209	210	211	212	213	214	215	216
61	62	63	64	65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96
217	218	219	220	221	222	223	224	225	226	227	228
229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244								

APPENDIX B

LOCA COLD LEG BREAK MODEL REFERENCE
(British Units)

WHAM/HDD 006/ 7-01-75 / VTB

DATE 02/04/78

LOFT LOCA ANALYSIS

LEG BREAK ON INTACT LOOP

ISOTHERMAL CONDITION

PCS IN THE COLD LEG BREAK EXPERIMENT CONFIGURATION

SATURATION PRESSURE(PSIG)V-1 = 950.0
 KINEMATIC VISCOSITY(FT.SQ./SEC) = 0.0
 TOTAL NUMBER OF LEGS = 244
 SATURATION PRESSURE(PSIG)V-2 = 950.0

HYDRAULIC MODEL DESCRIPTION

J	A	UO	PO	C	W	NO	NND1	NND2	LEG1	LEG2	OK
1	0.6827	0.0	2250.00	3700.	47.21	3	10	9	1	2	0.0
2	0.6827	0.0	2250.00	3700.	47.21	3	9	9	2	3	0.0
3	0.6827	0.0	2250.00	3600.	47.21	2	9	9	3	4	0.0
4	0.5327	0.0	2250.00	3500.	47.21	3	9	3	4	5	0.0
5	0.6827	0.0	2250.00	3416.	47.21	6	3	2	5	6	0.21
6	0.6827	0.0	2250.00	3416.	47.21	7	2	4	6	227	0.0
7	0.6827	0.0	2250.00	3416.	47.21	11	4	3	226	7	0.0
8	0.6827	0.0	2250.00	3450.	47.21	10	3	2	7	8	0.0
9	0.0900	0.0	2250.00	3475.	47.21	6	2	9	8	9	0.0
10	0.0900	0.0	2250.00	3475.	47.21	4	9	2	9	10	0.21
11	0.0900	0.0	2250.00	3475.	47.21	7	2	2	10	11	0.0
12	1.0600	0.0	2250.00	3500.	47.21	9	2	2	11	12	1.00
13	1.0600	0.0	2250.00	3500.	47.21	3	2	2	12	13	1.00
14	1.0600	0.0	2250.00	3500.	47.21	3	2	2	13	14	1.00
15	1.0600	0.0	2250.00	3500.	47.21	3	2	2	14	15	1.00
16	1.0600	0.0	2250.00	3500.	47.21	3	2	2	15	16	1.00
17	1.0600	0.0	2250.00	3500.	47.21	3	2	2	16	17	1.00
18	1.0600	0.0	2250.00	3525.	47.21	3	2	2	17	18	1.00
19	1.0600	0.0	2250.00	3525.	47.21	6	2	2	18	19	0.21

20	1.0600	0.0	2250.00	3525.	47.21	10	2	2	19	20	0.21
21	1.0600	0.0	2250.00	3550.	47.21	6	2	2	20	21	1.00
22	1.0600	0.0	2250.00	3550.	47.21	0	2	2	21	22	1.00
23	1.0600	0.0	2250.00	3550.	47.21	3	2	2	22	23	1.00
24	1.0600	0.0	2250.00	3550.	47.21	3	2	2	23	24	1.00
25	1.0600	0.0	2250.00	3575.	47.21	0	2	2	24	25	1.00
26	1.0600	0.0	2250.00	3575.	47.21	3	2	2	25	26	1.00
27	1.0600	0.0	2250.00	3575.	47.21	3	2	2	26	27	1.00
28	1.0600	0.0	2250.00	3575.	47.21	9	2	2	27	28	0.0
29	0.0900	0.0	2250.00	3600.	47.21	12	2	2	28	29	0.0
30	0.2964	0.0	2250.00	3600.	47.21	3	2	2	29	30	0.0
31	0.6827	0.0	2250.00	3600.	47.21	6	2	2	30	31	0.0
32	0.0500	0.0	2250.00	3650.	47.21	4	2	2	31	32	0.0
33	0.0900	0.0	2250.00	3650.	47.21	2	2	9	32	33	0.0
34	0.0900	0.0	2250.00	3650.	47.21	5	9	2	33	34	0.21
35	0.0900	0.0	2250.00	3675.	47.21	7	2	9	34	35	0.0
36	0.0900	0.0	2250.00	3700.	47.21	6	9	9	35	36	0.0
37	0.0900	0.0	2250.00	3416.	47.21	4	2	1	36	37	0.0
38	0.3941	0.0	2250.00	3500.	47.21	9	3	9	7	38	0.
39	0.3941	0.0	2250.00	3550.	47.21	10	9	2	38	39	0.21
40	0.3941	0.0	2250.00	3575.	47.21	7	2	3	39	40	0.0
41	0.6827	0.0	2250.00	3416.	47.21	4	4	5	43	44	0.0
42	0.9500	0.0	2250.00	3416.	47.21	7	5	5	44	45	0.0
43	0.9500	0.0	2250.00	3416.	47.21	7	5	5	45	46	0.0
44	0.9500	0.0	2250.00	3416.	47.21	7	5	5	44	47	0.0
45	0.9500	0.0	2250.00	3416.	47.21	7	5	5	47	46	0.0
46	0.6827	0.0	2250.00	3416.	47.21	4	5	4	46	227	0.0
47	0.0782	0.0	2250.00	3416.	47.21	3	4	9	43	48	0.0
48	0.0782	0.0	2250.00	3416.	47.21	3	9	2	48	49	0.0
49	0.0392	0.0	2250.00	3416.	47.21	5	2	1	49	50	0.0
50	0.0782	0.0	2250.00	3416.	47.21	3	3	9	51	52	0.0
51	0.0782	0.0	2250.00	3416.	47.21	3	9	2	52	53	0.0
52	0.0392	0.0	2250.00	3416.	47.21	5	2	1	53	54	0.0
53	0.0782	0.0	2250.00	3416.	47.21	3	3	9	55	56	0.0
54	0.0782	0.0	2250.00	3416.	47.21	3	9	2	56	57	0.0
55	0.0392	0.0	2250.00	3416.	47.21	5	2	1	57	58	0.0

56	0.0782	0.0	2250.00	3416.	47.21	3	4	9	227	59	0.0
57	0.0782	0.0	2250.00	3416.	47.21	3	9	2	59	60	0.0
58	0.0392	0.0	2250.00	3416.	47.21	5	2	1	60	61	0.0
59	0.6979	0.0	2250.00	3416.	47.21	4	5	1	44	62	0.0
60	0.6979	0.0	2250.00	3416.	47.21	4	5	1	47	63	0.0
61	0.6979	0.0	2250.00	3416.	47.21	4	5	1	45	64	0.0
62	0.6979	0.0	2250.00	3416.	47.21	4	5	1	46	65	0.0
63	0.6827	0.0	2250.00	3416.	47.21	4	5	3	47	51	0.0
64	0.6827	0.0	2250.00	3416.	47.21	4	5	3	45	55	0.0
65	0.0782	0.0	2250.00	3416.	47.21	10	4	9	43	66	0.0
66	0.0782	0.0	2250.00	3416.	47.21	10	9	9	66	67	0.0
67	0.0782	0.0	2250.00	3416.	47.21	10	9	9	67	68	0.0
68	0.0782	0.0	2250.00	3416.	47.21	10	9	9	68	69	0.0
69	0.0782	0.0	2250.00	3416.	47.21	7	9	9	69	70	0.0
70	0.0782	0.0	2250.00	3416.	47.21	9	9	9	70	71	0.0
71	0.0782	0.0	2250.00	3416.	47.21	5	9	5	71	90	0.0
72	0.0782	0.0	2250.00	3416.	47.21	10	3	9	55	72	0.0
73	0.0782	0.0	2250.00	3416.	47.21	10	9	9	72	73	0.0
74	0.0782	0.0	2250.00	3416.	47.21	10	9	9	73	74	0.0
75	0.0782	0.0	2250.00	3416.	47.21	10	9	9	74	75	0.0
76	0.0782	0.0	2250.00	3416.	47.21	7	9	9	75	76	0.0
77	0.0782	0.0	2250.00	3416.	47.21	9	9	9	76	77	0.0
78	0.0782	0.0	2250.00	3416.	47.21	5	9	5	77	90	0.0
79	0.0782	0.0	2250.00	3416.	47.21	10	4	9	227	78	0.0
80	0.0782	0.0	2250.00	3416.	47.21	10	9	9	78	79	0.0
81	0.0782	0.0	2250.00	3416.	47.21	10	9	9	79	80	0.0
82	0.0782	0.0	2250.00	3416.	47.21	10	9	9	80	81	0.0
83	0.0782	0.0	2250.00	3416.	47.21	7	9	9	81	82	0.0
84	0.0782	0.0	2250.00	3416.	47.21	9	9	9	82	83	0.0
85	0.0782	0.0	2250.00	3416.	47.21	5	9	5	83	90	0.0
86	0.0782	0.0	2250.00	3416.	47.21	10	3	9	51	84	0.0
87	0.0782	0.0	2250.00	3416.	47.21	10	9	9	84	85	0.0
88	0.0782	0.0	2250.00	3416.	47.21	10	9	9	85	86	0.0
89	0.0782	0.0	2250.00	3416.	47.21	10	9	9	86	87	0.0
90	0.0782	0.0	2250.00	3416.	47.21	7	9	9	87	88	0.0
91	0.0782	0.0	2250.00	3416.	47.21	9	9	9	88	89	0.0
92	0.0782	0.0	2250.00	3416.	47.21	5	9	5	89	90	0.0
93	0.4108	0.0	2250.00	3416.	47.21	10	5	9	44	91	0.0
94	0.4108	0.0	2250.00	3416.	47.21	9	9	2	91	92	0.0

95	0.3559	0.0	2250.00	3416.	47.21	4	2	2	92	93	0.0
96	0.4108	0.0	2250.00	3416.	47.21	11	2	9	93	94	0.0
97	0.4108	0.0	2250.00	3416.	47.21	11	9	2	94	95	0.0
98	0.3559	0.0	2250.00	3416.	47.21	2	2	6	95	111	0.0
99	0.4108	0.0	2250.00	3416.	47.21	10	5	9	45	96	0.0
100	0.4108	0.0	2250.00	3416.	47.21	9	9	2	96	97	0.0
101	0.3559	0.0	2250.00	3416.	47.21	4	2	2	97	98	0.0
102	0.4108	0.0	2250.00	3416.	47.21	11	2	9	98	99	0.0
103	0.4108	0.0	2250.00	3416.	47.21	11	9	2	99	100	0.0
104	0.3559	0.0	2250.00	3416.	47.21	2	2	6	100	111	0.0
105	0.4108	0.0	2250.00	3416.	47.21	10	5	9	46	101	0.0
106	0.4108	0.0	2250.00	3416.	47.21	9	9	2	101	102	0.0
107	0.3559	0.0	2250.00	3416.	47.21	4	2	2	102	103	0.0
108	0.4108	0.0	2250.00	3416.	47.21	11	2	9	103	104	0.0
109	0.4108	0.0	2250.00	3416.	47.21	11	9	2	104	105	0.0
110	0.3559	0.0	2250.00	3416.	47.21	2	2	6	105	111	0.0
111	0.4108	0.0	2250.00	3416.	47.21	10	5	9	47	106	0.0
112	0.4108	0.0	2250.00	3416.	47.21	9	9	2	106	107	0.0
113	0.3559	0.0	2250.00	3416.	47.21	4	2	2	107	108	0.0
114	0.4108	0.0	2250.00	3416.	47.21	11	2	9	108	109	0.0
115	0.4108	0.0	2250.00	3416.	47.21	11	9	2	109	110	0.0
116	0.3559	0.0	2250.00	3416.	47.21	2	2	6	110	111	0.0
117	6.5800	0.0	2250.00	3416.	47.21	7	5	6	90	111	0.0
118	6.6800	0.0	2250.00	3416.	47.21	2	6	2	111	112	0.0
119	1.6110	0.0	2250.00	3416.	47.21	2	2	4	112	113	0.0
120	4.2800	0.0	2250.00	3416.	47.21	2	4	2	113	114	9.84
121	4.2800	0.0	2250.00	3416.	47.21	2	2	2	114	115	0.0
122	1.9800	0.0	2250.00	3416.	47.21	2	2	2	115	116	6.94
123	1.9800	0.0	2250.00	3416.	47.21	2	2	2	116	117	1.98
124	1.9800	0.0	2250.00	3416.	47.36	6	2	2	117	118	1.98
125	1.9800	0.0	2250.00	3416.	47.96	5	2	2	118	119	1.98
126	1.9800	0.0	2250.00	3416.	47.21	6	2	2	119	120	1.98
127	1.9800	0.0	2250.00	3416.	47.21	2	2	2	120	121	3.24
128	1.9800	0.0	2250.00	3416.	47.21	2	2	2	121	122	0.0
129	1.2800	0.0	2250.00	3416.	47.21	2	2	2	122	123	0.0
130	2.8300	0.0	2250.00	3416.	47.21	5	2	9	123	124	0.0

131	2.8300	0.0	2250.00	3416.	47.21	5	9	9	124	125	0.0
132	2.8300	0.0	2250.00	3416.	47.21	5	9	9	125	126	0.0
133	2.8300	0.0	2250.00	3416.	47.21	6	9	9	126	127	0.0
134	2.8300	0.0	2250.00	3416.	47.21	6	9	4	127	128	0.0
135	0.2700	0.0	2250.00	3416.	47.21	5	4	9	113	129	0.0
136	0.2700	0.0	2250.00	3416.	47.21	5	9	9	129	130	0.0
137	0.2700	0.0	2250.00	3416.	47.21	10	9	9	130	131	0.0
138	0.2700	0.0	2250.00	3416.	47.21	10	9	9	131	132	0.0
139	0.2700	0.0	2250.00	3416.	47.21	10	9	9	132	133	0.0
140	0.2700	0.0	2250.00	3416.	47.21	7	9	9	133	134	0.0
141	0.2700	0.0	2250.00	3416.	47.21	4	9	4	134	135	0.0
142	0.6827	0.0	2250.00	3416.	47.21	5	4	4	128	135	0.0
143	0.2700	0.0	2250.00	3416.	47.21	5	4	9	113	159	0.0
144	0.2700	0.0	2250.00	3416.	47.21	5	9	9	159	160	0.0
145	0.2700	0.0	2250.00	3416.	47.21	10	9	9	160	161	0.0
146	0.2700	0.0	2250.00	3416.	47.21	10	9	9	161	162	0.0
147	0.2700	0.0	2250.00	3416.	47.21	10	9	9	162	163	0.0
148	0.2700	0.0	2250.00	3416.	47.21	7	9	9	163	164	0.0
149	0.2700	0.0	2250.00	3416.	47.21	4	9	4	164	226	0.0
150	0.6827	0.0	2250.00	3416.	47.21	5	4	4	128	226	0.0
151	0.2700	0.0	2250.00	3416.	47.21	8	4	1	226	137	0.0
152	0.2700	0.0	2250.00	3416.	47.21	8	4	1	135	136	0.0
153	2.8300	0.0	2250.00	3416.	47.21	2	4	9	128	138	0.0
154	2.8300	0.0	2250.00	3416.	47.21	2	9	9	138	139	0.0
155	2.8300	0.0	2250.00	3416.	47.21	3	9	6	139	140	0.0
156	2.8300	0.0	2250.00	3416.	47.21	2	6	9	140	141	0.0
157	2.8300	0.0	2250.00	3416.	47.21	2	9	1	141	142	0.0
158	0.2340	0.0	2250.00	3416.	47.21	3	6	9	140	143	0.0
159	0.2340	0.0	2250.00	3416.	47.21	3	9	2	143	144	0.0
160	0.3760	0.0	2250.00	3416.	47.21	3	2	2	144	145	0.0
161	0.0744	0.0	2250.00	3416.	47.21	2	2	3	145	146	0.0
162	0.2340	0.0	2250.00	3416.	47.21	3	6	9	140	147	0.0
163	0.2340	0.0	2250.00	3416.	47.21	3	9	2	147	148	0.0
164	0.3760	0.0	2250.00	3416.	47.21	3	2	2	148	149	0.0
165	0.0744	0.0	2250.00	3416.	47.21	2	2	3	149	150	0.0
166	0.2340	0.0	2250.00	3416.	47.21	3	6	9	140	155	0.0

167	0.2340	0.0	2250.00	3416.	47.21	3	9	2	155	156	0.0
168	0.3760	0.0	2250.00	3416.	47.21	3	2	2	156	157	0.0
169	0.0744	0.0	2250.00	3416.	47.21	2	2	3	157	158	0.0
170	0.2340	0.0	2250.00	3416.	47.21	3	6	9	140	151	0.0
171	0.2340	0.0	2250.00	3416.	47.21	3	9	2	151	152	0.0
172	0.3760	0.0	2250.00	3416.	47.21	3	2	2	152	153	0.0
173	0.0744	0.0	2250.00	3416.	47.21	2	2	3	153	154	0.0
174	0.0013	0.0	2250.00	3416.	47.21	11	3	3	146	150	0.0
175	0.0013	0.0	2250.00	3416.	47.21	11	3	3	150	158	0.0
176	0.0013	0.0	2250.00	3416.	47.21	11	3	3	158	154	0.0
177	0.0013	0.0	2250.00	3416.	47.21	11	3	3	154	146	0.0
178	0.6827	0.0	2250.00	3416.	47.21	9	4	9	135	165	0.0
179	0.6827	0.0	2250.00	3416.	47.21	9	9	2	165	166	0.50
180	0.6827	0.0	2250.00	3416.	47.21	9	2	2	166	167	0.10
181	0.6827	0.0	2250.00	3416.	47.21	5	2	3	167	168	0.0
182	0.0156	0.0	2250.00	3416.	47.21	7	3	2	168	169	0.17
183	0.0156	0.0	2250.00	3416.	47.21	10	2	2	169	170	0.17
184	0.0156	0.0	2250.00	3416.	47.21	8	2	2	170	171	0.17
185	0.0156	0.0	2250.00	3416.	47.21	6	2	2	171	172	0.17
186	0.0156	0.0	2250.00	3416.	47.21	9	2	2	172	173	0.17
187	0.0156	0.0	2250.00	3416.	47.21	14	2	2	173	174	0.17
188	0.0156	0.0	2250.00	3416.	47.21	7	2	2	174	175	0.17
189	0.0156	0.0	2250.00	3416.	47.21	7	2	7	175	176	0.0
190	0.6827	0.0	2250.00	3416.	47.21	9	3	2	168	177	0.50
191	0.6827	0.0	2250.00	3416.	47.21	13	2	2	177	178	0.10
192	0.6827	0.0	2250.00	3416.	47.21	9	2	2	178	179	0.0
193	0.8956	0.0	2250.00	3416.	47.21	4	2	2	179	180	0.10
194	0.8956	0.0	2250.00	3416.	47.21	6	2	2	180	181	0.0
195	3.4200	0.0	2250.00	3416.	47.21	9	2	6	181	182	0.0
196	0.3083	0.0	2250.00	3416.	47.21	22	6	2	182	183	4.50
197	0.3083	0.0	2250.00	3416.	47.96	16	2	2	183	184	4.50
198	0.3083	0.0	2250.00	3416.	47.21	21	2	6	184	185	0.0
199	0.3200	0.0	2250.00	3416.	47.21	22	6	2	182	186	4.20
200	0.3200	0.0	2250.00	3416.	47.96	13	2	2	186	187	4.20
201	0.3200	0.0	2250.00	3416.	47.21	21	2	6	187	185	0.0
202	0.3345	0.0	2250.00	3416.	47.21	22	6	2	182	188	4.00
203	0.3345	0.0	2250.00	3416.	47.96	9	2	2	188	189	4.00
204	0.3345	0.0	2250.00	3416.	47.21	21	2	6	185	189	0.0
205	0.3203	0.0	2250.00	3416.	47.21	22	6	2	182	190	3.70

205	0.3263	0.0	2250.00	3416.	47.96	7	2	2	190	191	3.70
207	0.3263	0.0	2250.00	3416.	47.21	21	2	6	191	185	0.0
208	0.3390	0.0	2250.00	3416.	47.21	22	6	2	182	192	3.50
209	0.3390	0.0	2250.00	3416.	47.96	4	2	2	192	193	3.50
210	0.3390	0.0	2250.00	3416.	47.21	21	2	6	193	185	0.0
211	0.3800	0.0	2250.00	3416.	47.21	8	6	2	185	194	0.0
212	0.8956	0.0	2250.00	3416.	47.21	4	2	2	194	195	0.10
213	0.8956	0.0	2250.00	3416.	47.21	5	2	2	195	196	0.0
214	0.6827	0.0	2250.00	3416.	47.21	5	2	2	196	197	0.50
215	0.6827	0.0	2250.00	3416.	47.21	7	2	2	197	198	0.17
216	0.6827	0.0	2250.00	3416.	47.21	13	2	3	198	199	0.0
217	0.6827	0.0	2250.00	3416.	47.21	7	3	2	199	200	0.17
218	0.6827	0.0	2250.00	3416.	47.21	6	2	2	200	201	0.0
219	0.3941	0.0	2250.00	3416.	47.21	8	2	11	201	202	0.0
220	0.3941	0.0	2250.00	3416.	47.21	9	11	2	202	203	0.10
221	0.3941	0.0	2250.00	3416.	47.21	12	2	2	203	204	0.0
222	0.6827	0.0	2250.00	3416.	47.21	12	2	3	204	205	0.0
223	0.6827	0.0	2250.00	3416.	47.21	7	3	2	199	206	0.17
224	0.6827	0.0	2250.00	3416.	47.21	6	2	2	206	207	0.0
225	0.3941	0.0	2250.00	3416.	47.21	8	2	11	207	208	0.0
226	0.3941	0.0	2250.00	3416.	47.21	8	11	2	208	209	0.17
227	0.3941	0.0	2250.00	3416.	47.21	6	2	3	209	205	0.0
228	0.6827	0.0	2250.00	3416.	47.21	19	3	2	205	210	0.75
229	0.6827	0.0	2250.00	3416.	47.21	18	2	3	210	211	0.0
230	0.6827	0.0	2250.00	3416.	47.21	2	3	10	211	212	0.0
231	0.6827	0.0	2250.00	3416.	47.21	2	3	3	211	213	0.0
232	0.6827	0.0	2250.00	3416.	47.21	2	3	10	213	214	0.0
233	0.6827	0.0	2250.00	3500.	47.21	5	3	4	213	43	0.0
234	0.3941	0.0	2250.00	3500.	47.21	11	3	2	5	215	0.21
235	0.3941	0.0	2250.00	3525.	47.21	11	2	9	215	216	0.0
236	0.3941	0.0	2250.00	3550.	47.21	10	9	3	216	217	0.0
237	0.3941	0.0	2250.00	3550.	47.21	10	3	2	217	218	0.21
238	0.3941	0.0	2250.00	3600.	47.21	7	2	1	218	219	0.0
239	0.3941	0.0	2250.00	3575.	47.21	10	3	2	217	220	0.21
240	0.3941	0.0	2250.00	3600.	47.21	7	2	1	220	221	0.0
241	0.3941	0.0	2250.00	3600.	47.21	10	3	2	40	222	0.21

242	0.3941	0.0	2250.00	3600.	47.21	7	2	1	222	223	0.0
243	0.3941	0.0	2250.00	3600.	47.21	10	3	2	40	224	0.21
244	0.3941	0.0	2250.00	3600.	47.21	7	2	1	224	225	0.0

INPUT WAVEFORM IS CALCULATED INTERNALLY.

CASE NO	=	1
VALVE INPUT WAVE DURATION(SECS)V-1	=	1.00000
VALVE INPUT WAVE DURATION(SECS)V-2	=	0.00100
VALVE PASSAGE AREA(FT.SQ.)V-1	=	0.0
VALVE PASSAGE AREA(FT.SQ.)V-2	=	0.68270
DISCHARGE COEFFICIENT,CD	=	1.00000

VALVE OPENING TIME(SECS) V-1	=	1.0000000
VALVE OPENING TIME(SECS) V-2	=	0.00500
VALVE AREA OPENING DELAY(SECS)V-1	=	1.00000
VALVE AREA OPENING DELAY(SECS)V-2	=	0.0
VALVE INITIATION DELAY(SECS)V-1	=	0.0
VALVE INITIATION DELAY(SECS)V-2	=	0.0

SYSTEM ENERGY LOSS FACTORS SUPPLIED EXTERNALLY.

LOSS FACTOR	LEG DIAMETER RANGE (FT)
5.00	0 TO 10.0000

5.00 0 TO 10.0000

TIME INCREMENTS(SEC) = 0.0001000

END TIME(SECS) = 0.1010

RESULTS PRINTED AFTER EVERY 50 TIME INCREMENTS

MINIMUM FLUID VELOCITY ABOVE WHICH CHECK VALVES STAY OPEN (FT/SEC) = 0.0

PRESSURIZER PRESSURE STAYS CONSTANT.

PUMP 1 PRESENCE IGNORED.

PUMP 2 PRESENCE IGNORED.

WHAM-6 PUMP MODEL IS USED.

P(T) AND V(T) ON TAPE FOR 244 LEGS

DATA RECORDED EVERY 1 TIME STEPS

LEGS STORED ON TAPE:

1 2 3 4 5 6 7 8 9 10 11 12

13 14 15 16 17 18 19 20 21 22 23 24

25 26 27 28 29 30 31 32 33 34 35 36

37 38 39 40 41 42 43 44 45 46 47 48

49 50 51 52 53 54 55 56 57 58 59 60

61 62 63 64 65 66 67 68 69 70 71 72

73 74 75 76 77 78 79 80 81 82 83 84

85 86 87 88 89 90 91 92 93 94 95 96

97 98 99 100 101 102 103 104 105 106 107 108

109 110 111 112 113 114 115 116 117 118 119 120

121 122 123 124 125 126 127 128 129 130 131 132

133 134 135 136 137 138 139 140 141 142 143 144

145 146 147 148 149 150 151 152 153 154 155 156

157 158 159 160 161 162 163 164 165 166 167 168

169 170 171 172 173 174 175 176 177 178 179 180

181 182 183 184 185 186 187 188 189 190 191 192

193 194 195 196 197 198 199 200 201 202 203 204

205 206 207 208 209 210 211 212 213 214 215 216

217 218 219 220 221 222 223 224 225 226 227 228

229 230 231 232 233 234 235 236 237 238 239 240

241 242 243 244