

ADDENDUM B TO BAW-2346P, REV. 0
ANO-1 PLANT SPECIFIC MSLB LEAK RATES
(NON-PROPRIETARY)

This addendum provides plant specific accident condition leak rates for Arkansas Nuclear One, Unit 1 (ANO-1). The leak rates are intended to replace the generic bounding accident leak rates. These plant specific leak rates are based on the thermal and structural response of the steam generators associated with the plant specific main steam line break (MSLB) thermal hydraulic analysis results. Although the results of this appendix are based on leak testing and methodology developed as part of a Babcock and Wilcox Owners Group (B&WOG) proprietary program, the actual results of this Appendix are specific to ANO-1 and therefore are not considered B&WOG proprietary.

B.1 METHOD OF ANALYSIS

The method of analysis used for determining plant specific leak rates is identical to that outlined in Topical Report BAW-2346P. The ANO-1 MSLB loads are determined and applied to define the tube-to-tubesheet bore Δ dilations. The tube-to-tubesheet bore Δ dilations are used with the results from the mockup leak tests to determine the leak rates as a function of tubesheet radius.

The ANO-1 plant specific tube loads and associated Δ dilations as a function of tubesheet radius are summarized in Table B-1 for the intact steam generator and in Table B-2 for the broken steam generator. The tube leakage is addressed in Section B.2.

TABLE B-1					
ANO-1 MSLB Δ DILATION versus TUBESHEET RADIUS (intact steam generator, unplugged tube case)					
T/S RADIUS (in)	Δ DILATION (mils)				TUBE LOAD (lbs)
	UPPER T/S		LOWER T/S		
	RAD	CIRC	RAD	CIRC	
3	-0.65	-0.61	-0.73	-0.67	193
4	-0.76	-0.63	-0.81	-0.71	193
5	-0.78	-0.66	-0.81	-0.73	193
6	-0.79	-0.68	-0.82	-0.75	193
7	-0.79	-0.70	-0.81	-0.76	194
8	-0.79	-0.71	-0.81	-0.76	196
9	-0.78	-0.72	-0.80	-0.77	198
10	-0.77	-0.72	-0.80	-0.77	201
11	-0.76	-0.73	-0.79	-0.77	205
12	-0.75	-0.73	-0.78	-0.77	209
13	-0.73	-0.73	-0.77	-0.77	214
14	-0.72	-0.73	-0.76	-0.77	219
15	-0.71	-0.73	-0.75	-0.77	225
16	-0.70	-0.73	-0.74	-0.77	231
17	-0.69	-0.73	-0.73	-0.77	237
18	-0.67	-0.72	-0.71	-0.77	244
19	-0.66	-0.72	-0.70	-0.76	251
20	-0.65	-0.72	-0.69	-0.76	258
21	-0.63	-0.71	-0.68	-0.76	266
22	-0.62	-0.71	-0.66	-0.75	274
23	-0.61	-0.71	-0.65	-0.75	283
24	-0.59	-0.70	-0.63	-0.74	291
25	-0.58	-0.70	-0.62	-0.74	301
26	-0.56	-0.69	-0.60	-0.73	310
27	-0.55	-0.69	-0.59	-0.73	319
28	-0.53	-0.68	-0.57	-0.72	329
29	-0.51	-0.68	-0.56	-0.72	340
30	-0.50	-0.67	-0.54	-0.71	350
31	-0.48	-0.66	-0.52	-0.71	360
32	-0.46	-0.66	-0.51	-0.70	371

TABLE B-1

ANO-1 MSLB Δ DILATION versus TUBESHEET RADIUS
(intact steam generator, unplugged tube case)

T/S RADIUS (in)	Δ DILATION (mils)				TUBE LOAD (lbs)
	UPPER T/S		LOWER T/S		
	RAD	CIRC	RAD	CIRC	
33	-0.45	-0.65	-0.49	-0.69	382
34	-0.43	-0.65	-0.47	-0.69	393
35	-0.41	-0.64	-0.45	-0.68	405
36	-0.40	-0.63	-0.44	-0.67	416
37	-0.38	-0.63	-0.42	-0.67	428
38	-0.37	-0.62	-0.40	-0.66	439
39	-0.35	-0.61	-0.39	-0.65	451
40	-0.34	-0.61	-0.37	-0.65	463
41	-0.33	-0.60	-0.35	-0.64	476
42	-0.32	-0.59	-0.34	-0.63	488
43	-0.31	-0.59	-0.32	-0.63	500
44	-0.30	-0.58	-0.31	-0.62	513
45	-0.29	-0.57	-0.30	-0.61	526
46	-0.29	-0.57	-0.29	-0.61	539
47	-0.28	-0.56	-0.27	-0.60	552
48	-0.28	-0.56	-0.26	-0.59	566
49	-0.27	-0.55	-0.25	-0.58	580
50	-0.26	-0.54	-0.23	-0.58	595
51	-0.25	-0.54	-0.22	-0.57	610
52	-0.23	-0.53	-0.19	-0.56	627
53	-0.20	-0.53	-0.15	-0.56	645
54	-0.15	-0.52	-0.10	-0.55	664
55	-0.05	-0.51	0.00	-0.54	686
56	0.20	-0.50	0.23	-0.53	712
57	0.69	-0.49	0.67	-0.51	743
57.72	0.67	-0.52	0.60	-0.52	743

NOTE: Tube loads are the loads associated with the listed dilations.

TABLE B-2

**ANO-1 MSLB Δ DILATION versus TUBESHEET RADIUS
(broken steam generator, unplugged tube case)**

T/S RADIUS (in)	Δ DILATION (mils)				TUBE LOAD (lbs)
	UPPER T/S		LOWER T/S		
	RAD	CIRC	RAD	CIRC	
3	-0.80	-0.71	-0.94	-0.79	74
4	-0.89	-0.75	-1.03	-0.86	74
5	-0.89	-0.78	-1.00	-0.89	75
6	-0.89	-0.80	-0.99	-0.91	76
7	-0.89	-0.81	-0.99	-0.92	78
8	-0.88	-0.82	-0.98	-0.93	81
9	-0.87	-0.83	-0.97	-0.93	84
10	-0.87	-0.83	-0.97	-0.94	88
11	-0.86	-0.84	-0.96	-0.94	92
12	-0.85	-0.84	-0.95	-0.94	97
13	-0.84	-0.84	-0.94	-0.94	102
14	-0.82	-0.84	-0.93	-0.94	108
15	-0.81	-0.84	-0.92	-0.94	114
16	-0.80	-0.83	-0.91	-0.94	121
17	-0.79	-0.83	-0.89	-0.94	128
18	-0.78	-0.83	-0.88	-0.93	135
19	-0.76	-0.83	-0.87	-0.93	143
20	-0.75	-0.82	-0.86	-0.93	151
21	-0.73	-0.82	-0.84	-0.92	160
22	-0.72	-0.81	-0.83	-0.92	169
23	-0.71	-0.81	-0.81	-0.91	178
24	-0.69	-0.81	-0.80	-0.91	188
25	-0.67	-0.80	-0.78	-0.91	198
26	-0.66	-0.80	-0.77	-0.90	208
27	-0.64	-0.79	-0.75	-0.90	219
28	-0.62	-0.78	-0.73	-0.89	230
29	-0.61	-0.78	-0.71	-0.88	241
30	-0.59	-0.77	-0.70	-0.88	253
31	-0.57	-0.77	-0.68	-0.87	265
32	-0.55	-0.76	-0.66	-0.87	277

TABLE B-2

**ANO-1 MSLB Δ DILATION versus TUBESHEET RADIUS
(broken steam generator, unplugged tube case)**

T/S RADIUS (n)	Δ DILATION (mils)				TUBE LOAD (lbs)
	UPPER T/S		LOWER T/S		
	RAD	CIRC	RAD	CIRC	
33	-0.53	-0.75	-0.64	-0.86	289
34	-0.52	-0.75	-0.62	-0.85	301
35	-0.50	-0.74	-0.60	-0.85	314
36	-0.48	-0.73	-0.58	-0.84	327
37	-0.46	-0.73	-0.56	-0.83	340
38	-0.44	-0.72	-0.54	-0.82	353
39	-0.43	-0.71	-0.52	-0.82	366
40	-0.41	-0.70	-0.49	-0.81	380
41	-0.39	-0.70	-0.47	-0.80	393
42	-0.38	-0.69	-0.45	-0.79	407
43	-0.36	-0.68	-0.43	-0.78	421
44	-0.35	-0.67	-0.41	-0.78	435
45	-0.33	-0.67	-0.39	-0.77	449
46	-0.32	-0.66	-0.37	-0.76	464
47	-0.31	-0.65	-0.35	-0.75	479
48	-0.30	-0.65	-0.33	-0.74	493
49	-0.28	-0.64	-0.30	-0.73	509
50	-0.27	-0.63	-0.28	-0.72	525
51	-0.25	-0.62	-0.25	-0.72	541
52	-0.23	-0.62	-0.21	-0.71	558
53	-0.19	-0.61	-0.17	-0.70	576
54	-0.13	-0.60	-0.11	-0.69	596
55	-0.04	-0.59	-0.02	-0.67	617
56	0.20	-0.58	0.18	-0.66	641
57	0.64	-0.56	0.55	-0.65	670
57.72	0.58	-0.58	0.45	-0.64	670

NOTE: Tube loads are the loads associated with the listed dilations.

B.2 ANO-1 MSLB LEAK RATE VS. TUBESHEET RADIUS

The Δ dilation versus tubesheet radius values from Tables B-1 and B-2 are used to determine the ANO-1 plant specific MSLB accident leak rate versus tubesheet radius.

The Δ dilation that resulted in the least amount of contact pressure was used to determine the leak rates as a function of tubesheet radius (i.e. the tube defect was assumed to align in the direction of the worst case Δ dilation). The smallest contact pressure, and therefore largest leakage, occurs at the largest positive Δ dilation. For the cases where both the circumferential and radial dilations are negative (compressive), the least negative Δ dilation was used. The worst case dilations from Table B-1 and Table B-2 were used to select the appropriate leak rate. Leak rates were determined based upon leak rate testing at the corresponding Δ dilation and accident condition ΔP .

A summary of the limiting Δ dilations and resulting accident leak rates for the intact steam generator is contained in Table B-3 and also in Figures B-1 and B-2. A condensed numerical summary of the leak rates is provided in Table B-4.

A summary of the limiting Δ dilations and resulting accident leak rates for the broken steam generator is contained in Table B-5 and also in Figures B-3 and B-4. A condensed numerical summary of the leak rates is provided in Table B-6.

TABLE B-3				
ANO-1 MSLB LEAK RATE versus TUBESHEET RADIUS (intact steam generator, unplugged tube case)				
tubesheet radius (in)	upper tubesheet		lower tubesheet	
	limiting Δ dilation (mils)	leak rate (gpm)	limiting Δ dilation (mils)	leak rate (gpm)
3	-0.61	7.10E-05	-0.67	7.10E-05
4	-0.63	7.10E-05	-0.71	7.10E-05
5	-0.66	7.10E-05	-0.73	7.10E-05
6	-0.68	7.10E-05	-0.75	7.10E-05
7	-0.70	7.10E-05	-0.76	7.10E-05
8	-0.71	7.10E-05	-0.76	7.10E-05
9	-0.72	7.10E-05	-0.77	7.10E-05
10	-0.72	7.10E-05	-0.77	7.10E-05
11	-0.73	7.10E-05	-0.77	7.10E-05
12	-0.73	7.10E-05	-0.77	7.10E-05
13	-0.73	7.10E-05	-0.77	7.10E-05
14	-0.72	7.10E-05	-0.76	7.10E-05
15	-0.71	7.10E-05	-0.75	7.10E-05
16	-0.70	7.10E-05	-0.74	7.10E-05
17	-0.69	7.10E-05	-0.73	7.10E-05
18	-0.67	7.10E-05	-0.71	7.10E-05
19	-0.66	7.10E-05	-0.70	7.10E-05
20	-0.65	7.10E-05	-0.69	7.10E-05
21	-0.63	7.10E-05	-0.68	7.10E-05
22	-0.62	7.10E-05	-0.66	7.10E-05
23	-0.61	7.10E-05	-0.65	7.10E-05
24	-0.59	7.10E-05	-0.63	7.10E-05
25	-0.58	7.10E-05	-0.62	7.10E-05
26	-0.56	7.10E-05	-0.60	7.10E-05
27	-0.55	7.10E-05	-0.59	7.10E-05
28	-0.53	7.10E-05	-0.57	7.10E-05
29	-0.51	7.10E-05	-0.56	7.10E-05
30	-0.50	7.10E-05	-0.54	7.10E-05

TABLE B-3 ANO-1 MSLB LEAK RATE versus TUBESHEET RADIUS (intact steam generator, unplugged tube case)				
tubesheet radius (in)	upper tubesheet		lower tubesheet	
	limiting Δ dilation (mils)	leak rate (gpm)	limiting Δ dilation (mils)	leak rate (gpm)
31	-0.48	7.10E-05	-0.52	7.10E-05
32	-0.46	7.10E-05	-0.51	7.10E-05
33	-0.45	7.10E-05	-0.49	7.10E-05
34	-0.43	7.10E-05	-0.47	7.10E-05
35	-0.41	7.10E-05	-0.45	7.10E-05
36	-0.40	1.90E-04	-0.44	7.10E-05
37	-0.38	1.90E-04	-0.42	7.10E-05
38	-0.37	1.90E-04	-0.40	7.10E-05
39	-0.35	1.90E-04	-0.39	1.90E-04
40	-0.34	1.90E-04	-0.37	1.90E-04
41	-0.33	1.90E-04	-0.35	1.90E-04
42	-0.32	1.90E-04	-0.34	1.90E-04
43	-0.31	1.90E-04	-0.32	1.90E-04
44	-0.30	1.90E-04	-0.31	1.90E-04
45	-0.29	1.90E-04	-0.30	1.90E-04
46	-0.29	1.90E-04	-0.29	1.90E-04
47	-0.28	1.90E-04	-0.27	1.90E-04
48	-0.28	1.90E-04	-0.26	1.90E-04
49	-0.27	1.90E-04	-0.25	1.90E-04
50	-0.26	1.90E-04	-0.23	1.90E-04
51	-0.25	1.90E-04	-0.22	1.90E-04
52	-0.23	1.90E-04	-0.19	3.83E-04
53	-0.20	1.90E-04	-0.15	3.83E-04
54	-0.15	3.83E-04	-0.10	3.83E-04
55	-0.05	3.83E-04	0.00	3.83E-04
56	0.20	8.23E-04	0.23	8.23E-04
57	0.69	1.37E-03	0.67	1.37E-03
57.72	0.67	1.37E-03	0.60	1.37E-03

FIGURE B-1
ANO-1 MSLB LEAK RATES FOR UPPER TUBESHEET OF INTACT SG

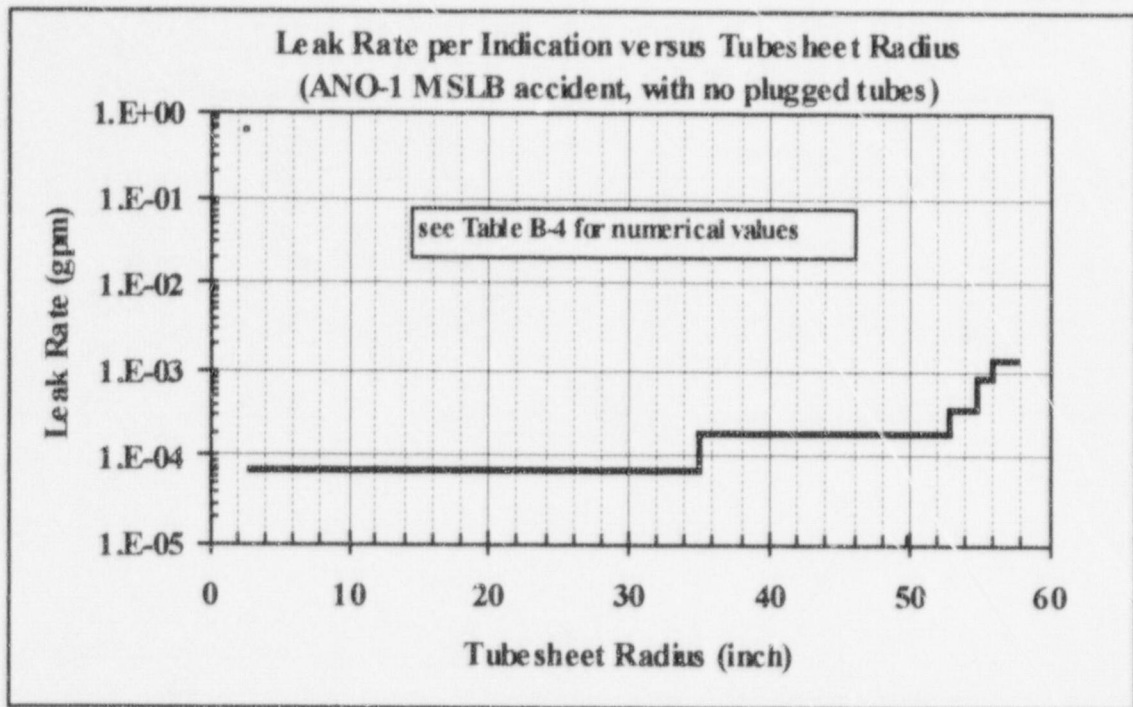


FIGURE B-2
ANO-1 MSLB LEAK RATES FOR LOWER TUBESHEET OF INTACT SG

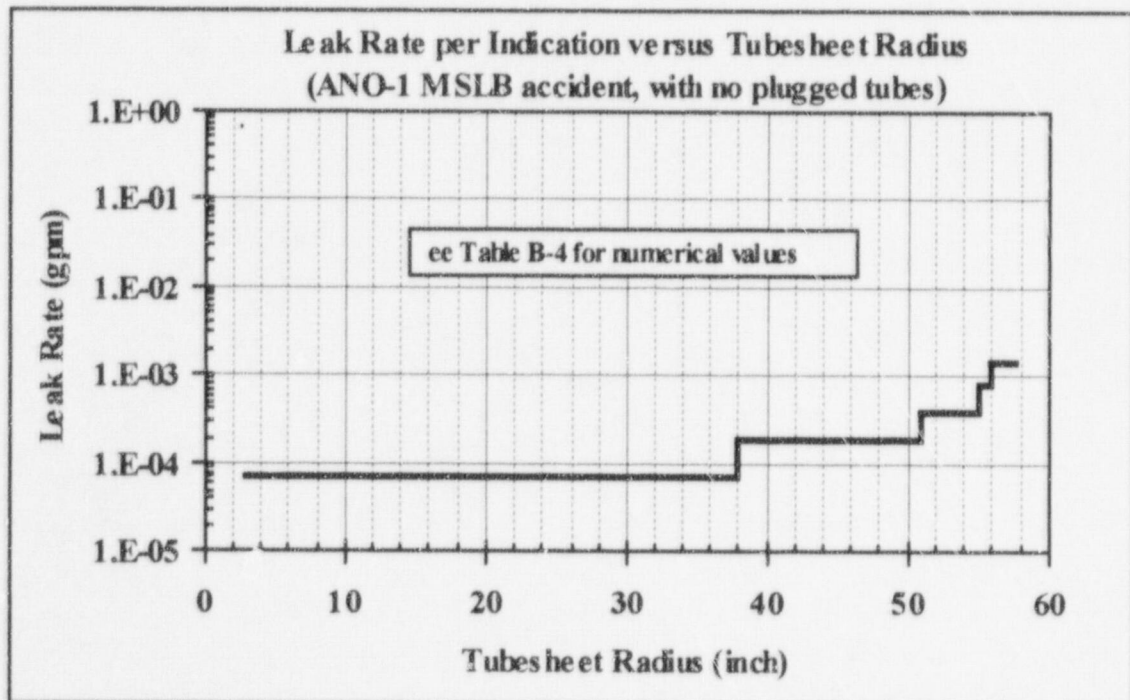


TABLE B-4 SUMMARY of 95/50 LEAK RATE vs. TUBESHEET RADIUS (intact steam generator, unplugged tube case)			
ANO-1 MSLB Accident Condition			
Upper Tubesheet		Lower Tubesheet	
Radius (inch)	Leak Rate (gpm)	Radius (inch)	Leak Rate (gpm)
> 3, ≤ 35	7.10E-5	> 3, ≤ 38	7.10E-5
> 35, ≤ 53	1.90E-4	> 38, ≤ 51	1.90E-4
> 53, ≤ 55	3.83E-4	> 51, ≤ 55	3.83E-4
> 55, ≤ 56	8.23E-4	> 55, ≤ 56	8.23E-4
> 56	1.37E-3	> 56	1.37E-3
Radius = location of tube center relative to the center of SG			

TABLE B-5				
ANO-1 MSLB LEAK RATE versus TUBESHEET RADIUS (broken steam generator, unplugged tube case)				
tubesheet radius (in)	upper tubesheet		lower tubesheet	
	limiting Δ dilation (mils)	leak rate (gpm)	limiting Δ dilation (mils)	leak rate (gpm)
3	-0.71	7.10E-05	-0.79	7.10E-05
4	-0.75	7.10E-05	-0.86	7.10E-05
5	-0.78	7.10E-05	-0.89	7.10E-05
6	-0.80	7.10E-05	-0.91	7.10E-05
7	-0.81	7.10E-05	-0.92	7.10E-05
8	-0.82	7.10E-05	-0.93	7.10E-05
9	-0.83	7.10E-05	-0.93	7.10E-05
10	-0.83	7.10E-05	-0.94	7.10E-05
11	-0.84	7.10E-05	-0.94	7.10E-05
12	-0.84	7.10E-05	-0.94	7.10E-05
13	-0.84	7.10E-05	-0.94	7.10E-05
14	-0.82	7.10E-05	-0.93	7.10E-05
15	-0.81	7.10E-05	-0.92	7.10E-05
16	-0.80	7.10E-05	-0.91	7.10E-05
17	-0.79	7.10E-05	-0.89	7.10E-05
18	-0.78	7.10E-05	-0.88	7.10E-05
19	-0.75	7.10E-05	-0.87	7.10E-05
20	-0.75	7.10E-05	-0.86	7.10E-05
21	-0.73	7.10E-05	-0.84	7.10E-05
22	-0.72	7.10E-05	-0.83	7.10E-05
23	-0.71	7.10E-05	-0.81	7.10E-05
24	-0.69	7.10E-05	-0.80	7.10E-05
25	-0.67	7.10E-05	-0.78	7.10E-05
26	-0.66	7.10E-05	-0.77	7.10E-05
27	-0.64	7.10E-05	-0.75	7.10E-05
28	-0.62	7.10E-05	-0.73	7.10E-05
29	-0.61	7.10E-05	-0.71	7.10E-05
30	-0.59	7.10E-05	-0.70	7.10E-05

TABLE B-5 ANO-1 MSLB LEAK RATE versus TUBESHEET RADIUS (broken steam generator, unplugged tube case)				
tubesheet radius (in)	upper tubesheet		lower tubesheet	
	limiting Δ dilation (mils)	leak rate (gpm)	limiting Δ dilation (mils)	leak rate (gpm)
31	-0.57	7.10E-05	-0.68	7.10E-05
32	-0.55	7.10E-05	-0.66	7.10E-05
33	-0.53	7.10E-05	-0.64	7.10E-05
34	-0.52	7.10E-05	-0.62	7.10E-05
35	-0.50	7.10E-05	-0.60	7.10E-05
36	-0.48	7.10E-05	-0.58	7.10E-05
37	-0.46	7.10E-05	-0.56	7.10E-05
38	-0.44	7.10E-05	-0.54	7.10E-05
39	-0.43	7.10E-05	-0.52	7.10E-05
40	-0.41	7.10E-05	-0.49	7.10E-05
41	-0.39	1.90E-04	-0.47	7.10E-05
42	-0.38	1.90E-04	-0.45	7.10E-05
43	-0.36	1.90E-04	-0.43	7.10E-05
44	-0.35	1.90E-04	-0.41	7.10E-05
45	-0.33	1.90E-04	-0.39	1.90E-04
46	-0.32	1.90E-04	-0.37	1.90E-04
47	-0.31	1.90E-04	-0.35	1.90E-04
48	-0.30	1.90E-04	-0.33	1.90E-04
49	-0.28	1.90E-04	-0.30	1.90E-04
50	-0.27	1.90E-04	-0.28	1.90E-04
51	-0.25	1.90E-04	-0.25	1.90E-04
52	-0.23	1.90E-04	-0.21	1.90E-04
53	-0.19	3.83E-04	-0.17	3.83E-04
54	-0.13	3.83E-04	-0.11	3.83E-04
55	-0.04	3.83E-04	-0.02	3.83E-04
56	0.20	5.41E-04	0.18	5.41E-04
57	0.64	1.37E-03	0.55	1.37E-03
57.72	0.58	1.37E-03	0.45	1.37E-03

FIGURE B-3
ANO-1 MSLB LEAK RATES FOR UPPER TUBESHEET OF BROKEN SG

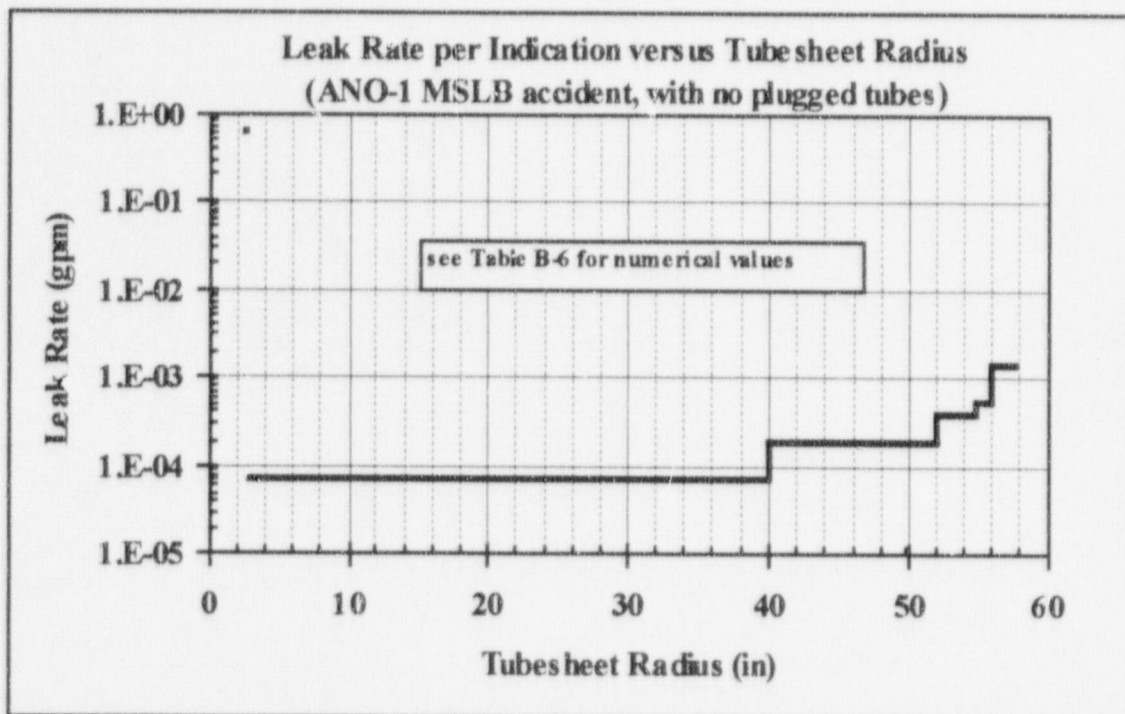


FIGURE B-4
ANO-1 MSLB LEAK RATES FOR LOWER TUBESHEET OF BROKEN SG

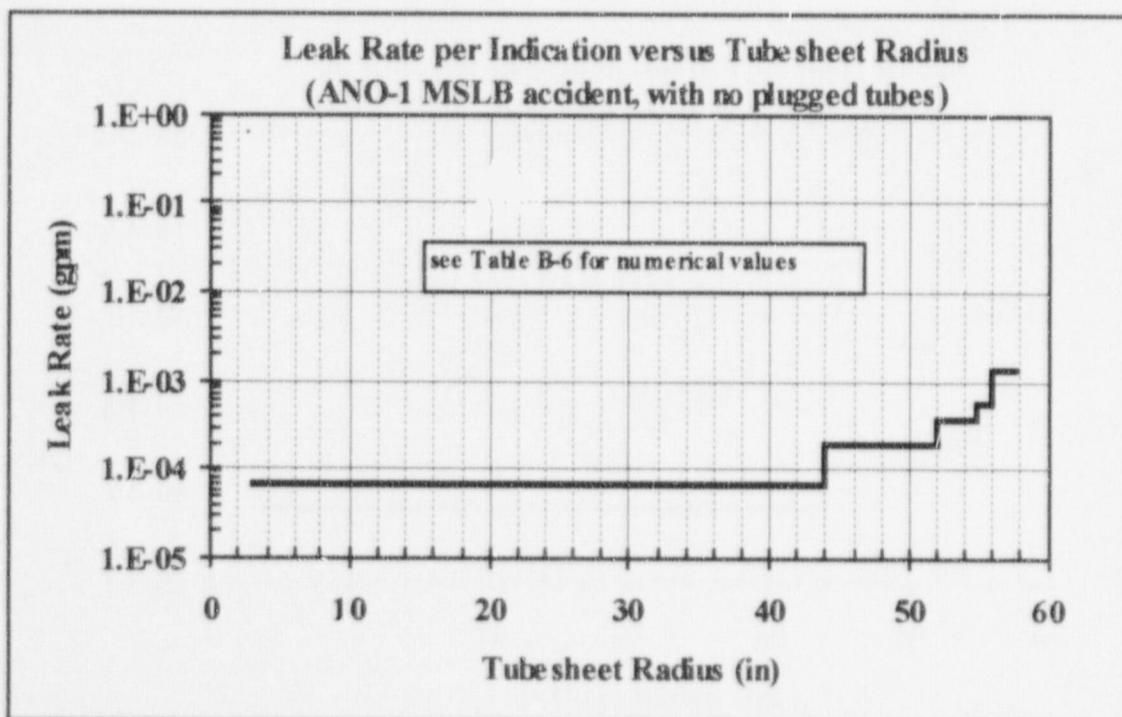


TABLE B-6
SUMMARY of 95/50 LEAK RATE vs. TUBESHEET RADIUS
(broken steam generator, unplugged tube case)

ANO-1 MSLB Accident Condition			
Upper Tubesheet		Lower Tubesheet	
Radius (inch)	Leak Rate (gpm)	Radius (inch)	Leak Rate (gpm)
> 3, ≤ 40	7.10E-5	> 3, ≤ 44	7.10E-5
> 40, ≤ 52	1.90E-4	> 44, ≤ 52	1.90E-4
> 52, ≤ 55	3.83E-4	> 52, ≤ 55	3.83E-4
> 55, ≤ 56	5.41E-4	> 55, ≤ 56	5.41E-4
> 56	1.37E-3	> 56	1.37E-3
Radius = location of tube center relative to the center of SG			