



Department of Energy
Washington, D.C. 20545

Docket No. 50-537
HQ:S:83:239

APR 11 1983

Dr. J. Nelson Grace, Director
CRBR Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Grace:

CELL LINER DESIGN VALIDATION PROGRAM - SQUARE PENETRATION ANALYSIS

Reference: Letter HQ:S:83:231, J. R. Longenecker to J. N. Grace,
"Cell Liner Design Validation Program," dated March 4, 1983

This letter transmits new information related to the Clinch River Breeder
Reactor Plant Cell Liner Design Validation Program promised in the reference.
Specifically enclosed is the analysis of the wall liner at square penetrations.

Any questions regarding the information provided or further submittals
can be addressed to Mr. P. Washer (FTS 626-6179) or Mr. V. Fayne
(FTS 626-6394) of the Project Office Oak Ridge staff.

Sincerely,

John R. Longenecker
Acting Director, Office of
Breeder Demonstration Projects
Office of Nuclear Energy

Enclosure

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ATTACHMENT I

(1 sheet of 12)

CELL LINER
WALL LINER AT SQUARE PENETRATIONS

Analyses of the wall liner near a square penetration were considered based on the mathematical model of Figure A-1.

The following ANSYS elements were used in the model: STIF 48 for the plate, STIF 20 and STIF 8 for the studs and STIF 52 for the interface between the plate and the concrete. The maximum liner temperature is 670°F.

Table A-1 shows the maximum strains and Figure A-2 shows the calculated buckling pattern in terms of the displacement contours. The maximum equivalent von Mises strains are:

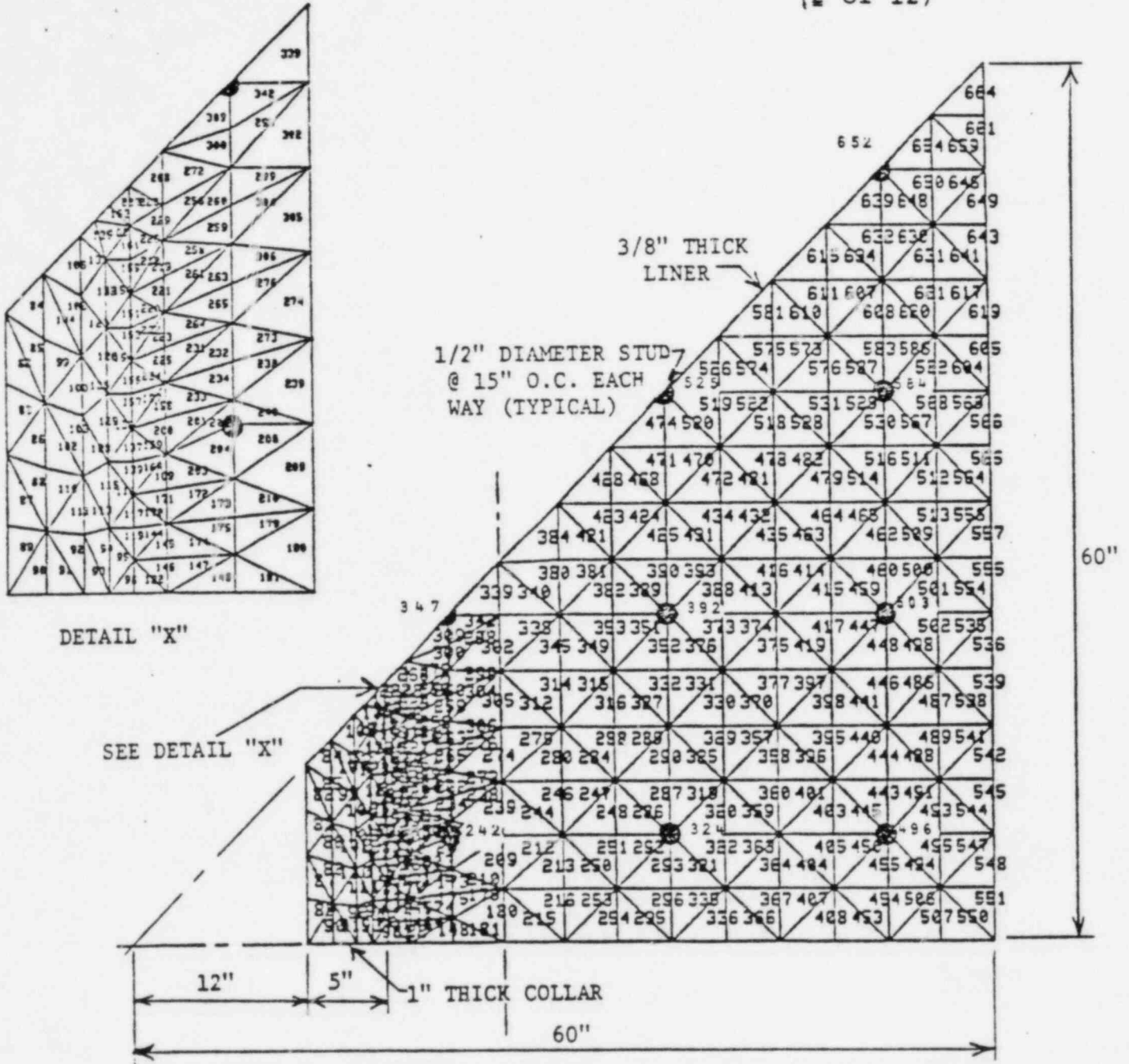
Plate - .016 (in/in) (Membrane); 0.033 (in/in) (Membrane plus Bending)

Stud - .057 (in/in) (Membrane); 0.142 (in/in) (Membrane plus Bending)

The strain allowables in accordance with the liner design criteria are .105 (in/in) for the membrane strain and 0.141 (in/in) for the membrane plus bending strain.

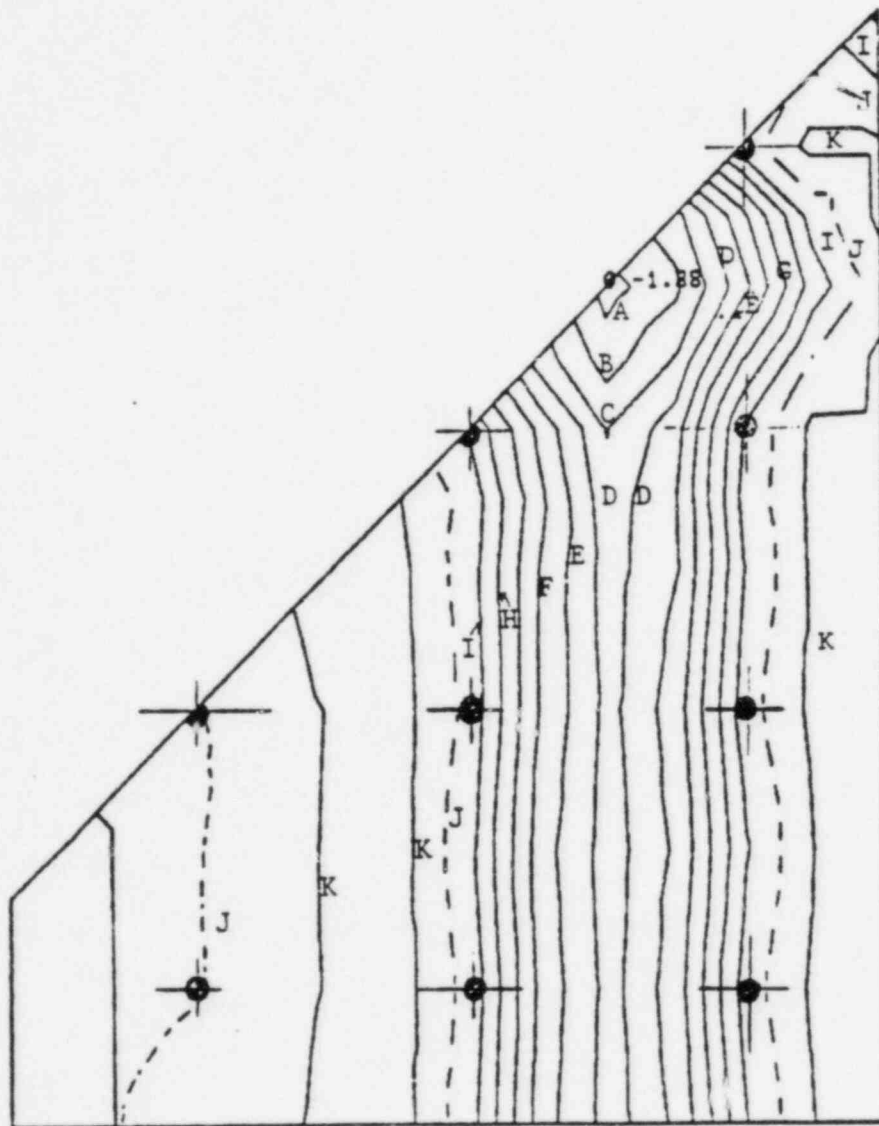
Liner strains are well below the allowables by a factor of 4.3.

Stud strains are at the maximum allowable for combined membrane plus bending, however this is acceptable because the large strains experienced by stud do not adversely influence the liner integrity.



347	242	525	392	324	652	584	503	496	} ELEMENT NUMBERS FOR STUDS
386	281	579	437	368	663	623	560	552	
429	317	614	484	410	667	644	600	596	
476	355	636	533	457	671	657	627	625	

FIGURE A-1 WALL LINER AT SQUARE PENETRATION MATHEMATICAL MODEL



CONTOUR VALUES
(INCHES)*

- A=-1.8
- B=-1.6
- C=-1.4
- D=-1.2
- E=-1
- F=-.8
- G=-.6
- H=-.4
- I=-.2
- J=0
- K=.2

* Negative value indicates displacement away from concrete.

FIGURE A-2 WALL LINER AT SQUARE PENETRATIONS
DISPLACEMENT CONTOURS

TABLE A-1
WALL LINER AT SQUARE PENETRATION

ELEMENT -----	M -	M+B ---	
122	0.001378	0.001556	LINER
144	0.001063	0.001243	LINER
145	0.000875	0.001131	LINER
146	0.000935	0.001354	LINER
147	0.000900	0.001394	LINER
148	0.000613	0.001153	LINER
168	0.000939	0.001448	LINER
169	0.000890	0.001430	LINER
170	0.000964	0.001249	LINER
171	0.000876	0.001237	LINER
172	0.000726	0.001304	LINER
173	0.000591	0.000979	LINER
174	0.000798	0.001210	LINER
175	0.000601	0.001125	LINER
179	0.000585	0.001034	LINER
180	0.000528	0.001050	LINER
181	0.000625	0.001173	LINER
197	0.001052	0.001640	LINER
198	0.000939	0.001233	LINER
199	0.001033	0.001545	LINER
200	0.000957	0.001420	LINER
201	0.000726	0.002015	LINER
202	0.000597	0.001418	LINER
203	0.000705	0.001417	LINER
204	0.000637	0.001652	LINER
208	0.000523	0.001438	LINER
209	0.000496	0.001194	LINER
210	0.000542	0.001027	LINER
212	0.000491	0.000751	LINER
213	0.000532	0.000739	LINER
215	0.000538	0.001101	LINER
216	0.000544	0.000904	LINER
218	0.000872	0.001956	LINER
219	0.000681	0.001488	LINER
220	0.000817	0.001539	LINER

TABLE A-1
WALL LINER AT SQUARE PENETRATION

<u>ELEMENT</u>	<u>M</u>	<u>M + B</u>	
221	0.000811	0.001644	LINER
222	0.001096	0.001839	LINER
223	0.000899	0.001238	LINER
224	0.000990	0.001277	LINER
225	0.000953	0.001328	LINER
226	0.000703	0.001741	LINER
227	0.000477	0.001175	LINER
228	0.000562	0.001766	LINER
229	0.000746	0.002168	LINER
231	0.000716	0.001438	LINER
232	0.000568	0.001180	LINER
233	0.000699	0.001496	LINER
234	0.000559	0.001333	LINER
238	0.000468	0.001173	LINER
239	0.000490	0.001630	LINER
240	0.000530	0.001522	LINER
242	0.005539	0.011177	STUD-TOP
242	0.001031	0.001760	STUD-BOTTOM
244	0.000443	0.000627	LINER
246	0.000484	0.000731	LINER
247	0.001059	0.004321	LINER
248	0.000907	0.003789	LINER
250	0.000885	0.003750	LINER
251	0.000917	0.003817	LINER
253	0.000887	0.004040	LINER
254	0.000893	0.004156	LINER
256	0.000397	0.001552	LINER
258	0.000469	0.001486	LINER
259	0.000535	0.001639	LINER
260	0.000481	0.001582	LINER
261	0.000594	0.001533	LINER
263	0.000566	0.001476	LINER
264	0.000664	0.001438	LINER
265	0.000610	0.001513	LINER
268	0.000454	0.001631	LINER
272	0.000455	0.001997	LINER
273	0.000465	0.001188	LINER
274	0.000449	0.001147	LINER
276	0.000411	0.000942	LINER
279	0.000371	0.000593	LINER

TABLE A-1
WALL LINER AT SQUARE PENETRATION

<u>ELEMENT</u>	<u>M</u>	<u>M + B</u>	
280	0.000418	0.000524	LINER
281	0.001588	0.002615	STUD-TOP
281	0.000743	0.000823	STUD-BOTTOM
284	0.001003	0.004526	LINER
286	0.001243	0.011075	LINER
287	0.002043	0.012220	LINER
288	0.001134	0.004958	LINER
289	0.002611	0.011825	LINER
290	0.002142	0.010885	LINER
292	0.001256	0.011090	LINER
293	0.001841	0.012126	LINER
295	0.002427	0.011749	LINER
296	0.001947	0.010815	LINER
298	0.000266	0.000865	LINER
299	0.000268	0.001015	LINER
300	0.000484	0.001886	LINER
302	0.000374	0.001588	LINER
304	0.000325	0.000957	LINER
305	0.000383	0.001053	LINER
306	0.000352	0.001008	LINER
309	0.000460	0.002299	LINER
312	0.000326	0.000435	LINER
314	0.000343	0.000466	LINER
315	0.001069	0.004583	LINER
316	0.001098	0.004902	LINER
317	0.000744	0.000824	STUD-TOP
317	0.001494	0.002987	STUD-BOTTOM
319	0.000588	0.001975	LINER
320	0.000894	0.002932	LINER
321	0.000640	0.002057	LINER
322	0.000989	0.003080	LINER
324	0.029992	0.109678	STUD-TOP
324	0.016468	0.027740	STUD-BOTTOM
325	0.000742	0.001866	LINER
327	0.002563	0.011751	LINER
329	0.000623	0.001170	LINER
330	0.000734	0.001306	LINER
331	0.000729	0.001675	LINER
332	0.002271	0.010999	LINER
335	0.000749	0.001724	LINER

TABLE A-1
WALL LINER AT SQUARE PENETRATION

<u>ELEMENT</u>	<u>M</u>	<u>M + B</u>	
336	0.000644	0.001020	LINER
338	0.000292	0.000702	LINER
339	0.000492	0.002080	LINER
340	0.000446	0.001349	LINER
342	0.000389	0.002091	LINER
345	0.000342	0.000784	LINER
347	0.001803	0.005633	STUD-TOP
347	0.000678	0.001044	STUD-BOTTOM
349	0.001054	0.004222	LINER
351	0.001778	0.011450	LINER
352	0.002123	0.012065	LINER
353	0.000825	0.003375	LINER
355	0.000881	0.001599	STUD-TOP
355	0.004673	0.012504	STUD-BOTTOM
357	0.001263	0.012226	LINER
358	0.001841	0.013680	LINER
359	0.002972	0.015384	LINER
360	0.002094	0.013623	LINER
363	0.002987	0.015376	LINER
364	0.002284	0.014085	LINER
366	0.001327	0.013097	LINER
367	0.001981	0.014168	LINER
368	0.019139	0.031586	STUD-TOP
368	0.016679	0.017483	STUD-BOTTOM
370	0.001051	0.012157	LINER
373	0.001250	0.003242	LINER
374	0.002840	0.013454	LINER
375	0.002575	0.012775	LINER
376	0.000612	0.001844	LINER
377	0.001957	0.012837	LINER
380	0.000430	0.001243	LINER
381	0.000453	0.002141	LINER
382	0.000737	0.003079	LINER
384	0.000418	0.001283	LINER
386	0.001001	0.001281	STUD-TOP
386	0.000599	0.000679	STUD-BOTTOM
388	0.001061	0.003086	LINER
389	0.001666	0.011242	LINER
390	0.002080	0.012113	LINER
392	0.023865	0.100340	STUD-TOP

TABLE A-1
WALL LINER AT SQUARE PENETRATION

<u>ELEMENT</u>	<u>M</u>	<u>M + B</u>	
392	0.011091	0.022317	STUD-BOTTOM
393	0.000662	0.002555	LINER
395	0.001099	0.012900	LINER
396	0.001707	0.013099	LINER
397	0.001864	0.014229	LINER
398	0.001315	0.013048	LINER
401	0.002047	0.012963	LINER
403	0.002647	0.013485	LINER
404	0.001970	0.012810	LINER
405	0.002614	0.013482	LINER
407	0.001707	0.012899	LINER
408	0.001348	0.012535	LINER
410	0.016994	0.017951	STUD-TOP
410	0.017301	0.019396	STUD-BOTTOM
413	0.002866	0.013424	LINER
414	0.003324	0.017475	LINER
415	0.003629	0.016136	LINER
416	0.002583	0.011016	LINER
417	0.003373	0.016260	LINER
419	0.002447	0.014264	LINER
421	0.000424	0.002140	LINER
423	0.000409	0.001773	LINER
424	0.001731	0.010390	LINER
425	0.001945	0.010811	LINER
428	0.000586	0.001507	LINER
429	0.000596	0.000709	STUD-TOP
429	0.001041	0.002505	STUD-BOTTOM
431	0.000457	0.001940	LINER
432	0.002115	0.009320	LINER
434	0.001176	0.001833	LINER
435	0.002925	0.011305	LINER
437	0.013582	0.026018	STUD-TOP
437	0.010483	0.011397	STUD-BOTTOM
440	0.000959	0.001807	LINER
441	0.001008	0.001875	LINER
443	0.001051	0.002744	LINER
444	0.001393	0.002894	LINER
445	0.001589	0.004009	LINER
446	0.001421	0.002991	LINER
447	0.002164	0.004940	LINER

TABLE A-1
WALL LINER AT SQUARE PENETRATION

<u>ELEMENT</u>	<u>M</u>	<u>M + B</u>	
448	0.001132	0.002728	LINER
450	0.001499	0.003868	LINER
453	0.000983	0.001584	LINER
454	0.001244	0.002634	LINER
455	0.000975	0.002743	LINER
457	0.016711	0.018425	STUD-TOP
457	0.019748	0.036863	STUD-BOTTOM
459	0.002297	0.005624	LINER
460	0.001194	0.003607	LINER
462	0.001350	0.003027	LINER
463	0.003632	0.017897	LINER
464	0.003552	0.020223	LINER
465	0.001752	0.002963	LINER
468	0.001603	0.010215	LINER
470	0.001162	0.003686	LINER
471	0.000861	0.007130	LINER
472	0.001501	0.002224	LINER
474	0.000561	0.012893	LINER
476	0.000495	0.001451	STUD-TOP
476	0.001811	0.013613	STUD-BOTTOM
478	0.004344	0.010005	LINER
479	0.004688	0.020623	LINER
481	0.002263	0.009052	LINER
482	0.006855	0.024241	LINER
484	0.010811	0.011893	STUD-TOP
484	0.011519	0.014224	STUD-BOTTOM
486	0.002350	0.010589	LINER
487	0.002910	0.011522	LINER
488	0.002040	0.010063	LINER
489	0.002898	0.011474	LINER
491	0.001643	0.011927	LINER
493	0.001562	0.010771	LINER
494	0.001470	0.011818	LINER
495	0.001434	0.010719	LINER
496	0.032518	0.099277	STUD-TOP
496	0.014239	0.024783	STUD-BOTTOM
498	0.002014	0.012412	LINER
500	0.002314	0.014069	LINER
501	0.001409	0.011555	LINER
502	0.001643	0.011633	LINER

TABLE A-1
WALL LINER AT SQUARE PENETRATION

<u>ELEMENT</u>	<u>M</u>	<u>M + B</u>	
503	0.030508	0.098500	STUD-TOP
503	0.013134	0.023494	STUD-BOTTOM
506	0.001772	0.009965	LINER
507	0.002533	0.011149	LINER
509	0.002407	0.011841	LINER
511	0.001826	0.011593	LINER
512	0.003091	0.013615	LINER
513	0.003165	0.013733	LINER
514	0.003050	0.003414	LINER
516	0.002118	0.002972	LINER
518	0.004643	0.009143	LINER
519	0.002417	0.011482	LINER
520	0.001868	0.009861	LINER
522	0.002955	0.007773	LINER
525	0.054115	0.132927	STUD-TOP
525	0.043697	0.050398	STUD-BOTTOM
526	0.007124	0.015596	LINER
528	0.007388	0.023391	LINER
529	0.003808	0.008908	LINER
530	0.001748	0.007335	LINER
531	0.007986	0.024587	LINER
533	0.010588	0.012635	STUD-TOP
533	0.015338	0.033197	STUD-BOTTOM
535	0.001425	0.002275	LINER
536	0.001416	0.002811	LINER
538	0.001241	0.002483	LINER
539	0.001255	0.002660	LINER
541	0.001215	0.002459	LINER
542	0.001290	0.002600	LINER
544	0.001541	0.002429	LINER
545	0.001537	0.002947	LINER
547	0.001425	0.002290	LINER
548	0.001423	0.002531	LINER
550	0.001137	0.002105	LINER
551	0.001216	0.002273	LINER
552	0.017716	0.029838	STUD-TOP
552	0.015060	0.015828	STUD-BOTTOM
554	0.001224	0.002031	LINER
555	0.001146	0.002091	LINER
556	0.001162	0.001739	LINER

TABLE A-1
WALL LINER AT SQUARE PENETRATION

<u>ELEMENT</u>	<u>M</u>	<u>M + B</u>	
557	0.000876	0.001724	LINER
560	0.016346	0.028365	STUD-TOP
560	0.013064	0.013822	STUD-BOTTOM
564	0.001055	0.001548	LINER
565	0.002006	0.002943	LINER
566	0.003546	0.004645	LINER
567	0.001862	0.016069	LINER
568	0.003297	0.012858	LINER
569	0.003251	0.004066	LINER
573	0.005344	0.017701	LINER
574	0.006108	0.010105	LINER
575	0.006074	0.009729	LINER
576	0.007486	0.024407	LINER
578	0.045789	0.053131	STUD-TOP
578	0.044513	0.044550	STUD-BOTTOM
581	0.003136	0.011112	LINER
582	0.006931	0.019352	LINER
583	0.006235	0.011236	LINER
584	0.056494	0.140936	STUD-TOP
584	0.034368	0.045127	STUD-BOTTOM
586	0.005140	0.012533	LINER
587	0.005925	0.010438	LINER
596	0.015627	0.016782	STUD-TOP
596	0.015225	0.015964	STUD-BOTTOM
600	0.013713	0.014945	STUD-TOP
600	0.013406	0.014696	STUD-BOTTOM
604	0.006184	0.012161	LINER
605	0.008633	0.017220	LINER
607	0.005034	0.008763	LINER
608	0.004939	0.007702	LINER
610	0.003012	0.019701	LINER
611	0.000890	0.010942	LINER
614	0.044667	0.044776	STUD-TOP
614	0.044891	0.046882	STUD-BOTTOM
615	0.000864	0.015056	LINER
617	0.012289	0.021060	LINER
619	0.012121	0.015269	LINER
620	0.003742	0.005925	LINER
621	0.010672	0.017217	LINER
623	0.038608	0.049994	STUD-TOP

TABLE A-1
WALL LINER AT SQUARE PENETRATION

<u>ELEMENT</u>	<u>M</u>	<u>M + B</u>	
623	0.036893	0.037312	STUD-BOTTOM
625	0.014978	0.015577	STUD-TOP
625	0.016865	0.024445	STUD-BOTTOM
627	0.012944	0.013956	STUD-TOP
627	0.015951	0.025738	STUD-BOTTOM
630	0.007752	0.021766	LINER
631	0.012770	0.026052	LINER
632	0.006380	0.023286	LINER
634	0.001866	0.012759	LINER
636	0.044528	0.046254	STUD-TOP
636	0.046396	0.068346	STUD-BOTTOM
639	0.005164	0.007102	LINER
641	0.015557	0.020482	LINER
643	0.014617	0.018809	LINER
644	0.037260	0.037914	STUD-TOP
644	0.037111	0.038357	STUD-BOTTOM
646	0.010676	0.021051	LINER
648	0.009782	0.010685	LINER
649	0.013779	0.033311	LINER
650	0.012236	0.027110	LINER
652	0.041820	0.142196	STUD-TOP
652	0.021258	0.035494	STUD-BOTTOM
654	0.009341	0.027222	LINER
657	0.036875	0.037990	STUD-TOP
657	0.038292	0.052200	STUD-BOTTOM
659	0.009259	0.017949	LINER
661	0.009185	0.014457	LINER
663	0.024668	0.040416	STUD-TOP
663	0.021354	0.022147	STUD-BOTTOM
664	0.006343	0.018758	LINER
667	0.022140	0.023556	STUD-TOP
667	0.021220	0.021687	STUD-BOTTOM
671	0.021021	0.021370	STUD-TOP
671	0.023272	0.030175	STUD-BOTTOM

Allowable Strains

.105 (in/in) - Membrane

.141 (in/in) - Membrane + Bending