



**AUSTRALIAN ATOMIC ENERGY COMMISSION
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LUCAS HEIGHTS RESEARCH LABORATORIES

**RESULTS OF PIPE BEND ANALYSIS
PART VI: STRESS DISTRIBUTIONS IN FLANGED PIPE ELBOWS
FROM OUT-OF-PLANE BENDING**

by

J.F. WHATHAM

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ABSTRACT

Graphs of outside surface stress distributions are presented, and numerical values of stresses on inside and outside surfaces tabulated for a wide range of flange-ended pipe elbows subjected to a pure out-of-plane bending moment applied at one flange and pure torsion at the other; calculations are based on linear thin shell theory.

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ANALYTICAL SOLUTION; BENDING; EXPERIMENTAL DATA; FLANGES; PIPES; STRESS ANALYSIS; STRESSES

CONTENTS

1. INTRODUCTION	1
2. STRESS DERIVATION	1
3. ELBOW CONFIGURATION AND RESULTS	3
4. REFERENCES	4
Figure 1 Pipe bend configuration	5
Figure 2 Pipe middle surface	6
Figure 3 Element of pipe middle surface	7
Appendix A Stresses in flanged pipe elbows from out-of-plane bending	9

1. INTRODUCTION

The objective of this report is to present the surface stress distributions for a range of flanged elbows under out-of-plane bending, to assist pipework design engineers and to provide analytic solutions for checking numerical solution methods. Wall thicknesses vary from one to ten per cent of the pipe radius with bend radii two, three and five times the pipe radius.

Stresses were calculated by the thin shell theory of Novozhilov [1970] and details of the analysis have been published [Whatham 1982, 1983]. The assumptions were that:

- (i) the pipe wall is thin ($t/r < 0.3$),
- (ii) normal stresses through the wall are negligible,
- (iii) normals through the wall remain normal to it and unchanged in length, and
- (iv) the flanges are infinitely stiff.

2. STRESS DERIVATION

The flanged pipe elbow configuration is shown in Figure 1, and a segment of a curved pipe middle surface, an imaginary surface mid-way between the inner and outer surfaces, is shown in Figure 2 with one end flanged. An element of the middle surface in Figure 3 is supposed to have forces T_θ , T_η , $T_{\theta\eta}$, $T_{\eta\theta}$, N_θ , N_η and moments M_θ , M_η , $M_{\eta\theta}$, $M_{\theta\eta}$ per unit length acting on its edges and the solution was obtained by thin shell theory in terms of these forces and moments; the stresses presented in this report were then derived as follows:

$$\text{Hoop stress: } \sigma_{\theta\theta} = T_\theta/t + 12zM_\theta/t^3 ,$$

$$\text{Axial stress: } \sigma_{\eta\eta} = T_\eta/t + 12zM_\eta/t^3 , \tag{1}$$

$$\text{Shear stress: } \sigma_{\eta\theta} = S/t + z(12H/t^3 - S/rt) ,$$

where $S = T_{\theta\eta} - M_{\eta\theta}/r_\eta = T_{\eta\theta} - M_{\theta\eta}/r$, and $H = M_{\theta\eta} = M_{\eta\theta}$.

These stresses were close to those derived from beam theory when considering a straight pipe subjected to bending or torsion; if a moment M is applied to a straight pipe, Novozhilov's theory [see Whatham 1981] gives

$$\begin{aligned} T_\eta &= \frac{12M \cos \theta}{(12+\gamma)\pi r^2}, \\ M_\eta &= \frac{\gamma M \cos \theta}{(12+\gamma)\pi r}, \\ T_\theta &= M_\theta = S = H = 0, \end{aligned} \quad (2)$$

where $\gamma = (t/r)^2$.

Substituting in Equations (1), the axial stress distribution approximates that from beam theory, which is

$$\sigma_{\eta\eta} = \frac{M(r+z)\cos \theta}{\pi r^3 t(1+\gamma/4)}. \quad (3)$$

If torque T is applied to a straight pipe, Novozhilov's theory gives

$$\begin{aligned} S &= \frac{3T}{2(3+\gamma)\pi r^2}, \\ H &= \frac{\gamma T}{4(3+\gamma)\pi r}, \\ T_\eta &= M_\eta = T_\theta = M_\theta = 0. \end{aligned} \quad (4)$$

Substituting in Equations (1), the shear stress distribution approximates that from beam theory, which is

$$\sigma_{\eta\theta} = \frac{T(r+z)}{2\pi r^3 t(1+\gamma/4)}. \quad (5)$$

Equations (1) assume that the strains are linearly distributed through the pipe wall; this is not true for curved shells and the stresses $\sigma'_{\theta\theta}$, $\sigma'_{\eta\eta}$, $\sigma'_{\eta\theta}$ derived by the following equations are theoretically more accurate, even though the results do not agree with beam theory in the case of straight pipes:

$$\begin{aligned}
\sigma'_{\theta\theta} &= \sigma_{\theta\theta} - z(A+\nu B)/(1-\nu^2) \quad , \\
\sigma'_{\eta\eta} &= \sigma_{\eta\eta} - z(B+\nu A)/(1-\nu^2) \quad , \\
\sigma'_{\eta\theta} &= \sigma_{\eta\theta} - \frac{z}{2r} \left[(r/(r+z)+r/(r_\eta+z))\sigma_{\eta\theta} - (r_\eta-r)\bar{\sigma}_{\eta\theta}/(r_\eta+z) \right] \quad .
\end{aligned} \tag{6}$$

where

$$\begin{aligned}
r_\eta &= r + R/\cos \theta \quad , \\
A &= (\sigma_{\theta\theta} - \nu\sigma_{\eta\eta})/(r+z) \quad , \\
B &= (\sigma_{\eta\eta} - \nu\sigma_{\theta\theta})/(r_\eta+z) \quad , \quad \text{and} \\
\bar{\sigma}_{\eta\theta} &= \frac{1}{2}\sigma_{\eta\theta}(\text{inside}) + \frac{1}{2}\sigma_{\eta\theta}(\text{outside}).
\end{aligned}$$

3. ELBOW CONFIGURATION AND RESULTS

Stresses were calculated for one side of the bend in Figure 1 ($\theta = 0$ to 180°), those for negative θ having the same magnitude but with the hoop and axial stress signs changed; note that a pure out-of-plane bending moment acting on one flange of a 90° bend produces a reaction of pure torsion at the other flange. Hoop and axial stresses on the outside surface are plotted in Appendix A, together with the stresses at $\phi = 90^\circ$ on theoretically unflanged or unflanged pipe bends. The latter stresses vary as $\sin\phi$ and the maxima and minima are given by the floating numbers; note that the shear stresses on unflanged pipe bends with this loading vary as $\cos\phi$.

The two graphs for each pipe bend are accompanied by tabulated stresses from which the graphs were constructed. In addition, since shear stresses and inside surface stresses are also given and a linear variation through the wall is assumed, the complete stress state in each pipe bend is provided.

A computer program package BENDPAC, written in FORTRAN IV and ASSEMBLER for an IBM3031 computer and designed to calculate the stresses in and the flexibility of flanged pipe elbows under in-plane or out-of-plane loading, is available from the Australian Atomic Energy Commission, the Risley Nuclear Power Development Establishment, Cheshire, UK, or the National Energy Software Center, Argonne National Laboratory, USA.

4. ACKNOWLEDGEMENT

The author acknowledges the advice and encouragement of Professor J.J. Thompson of the School of Nuclear Engineering, University of New South Wales.

5. REFERENCES

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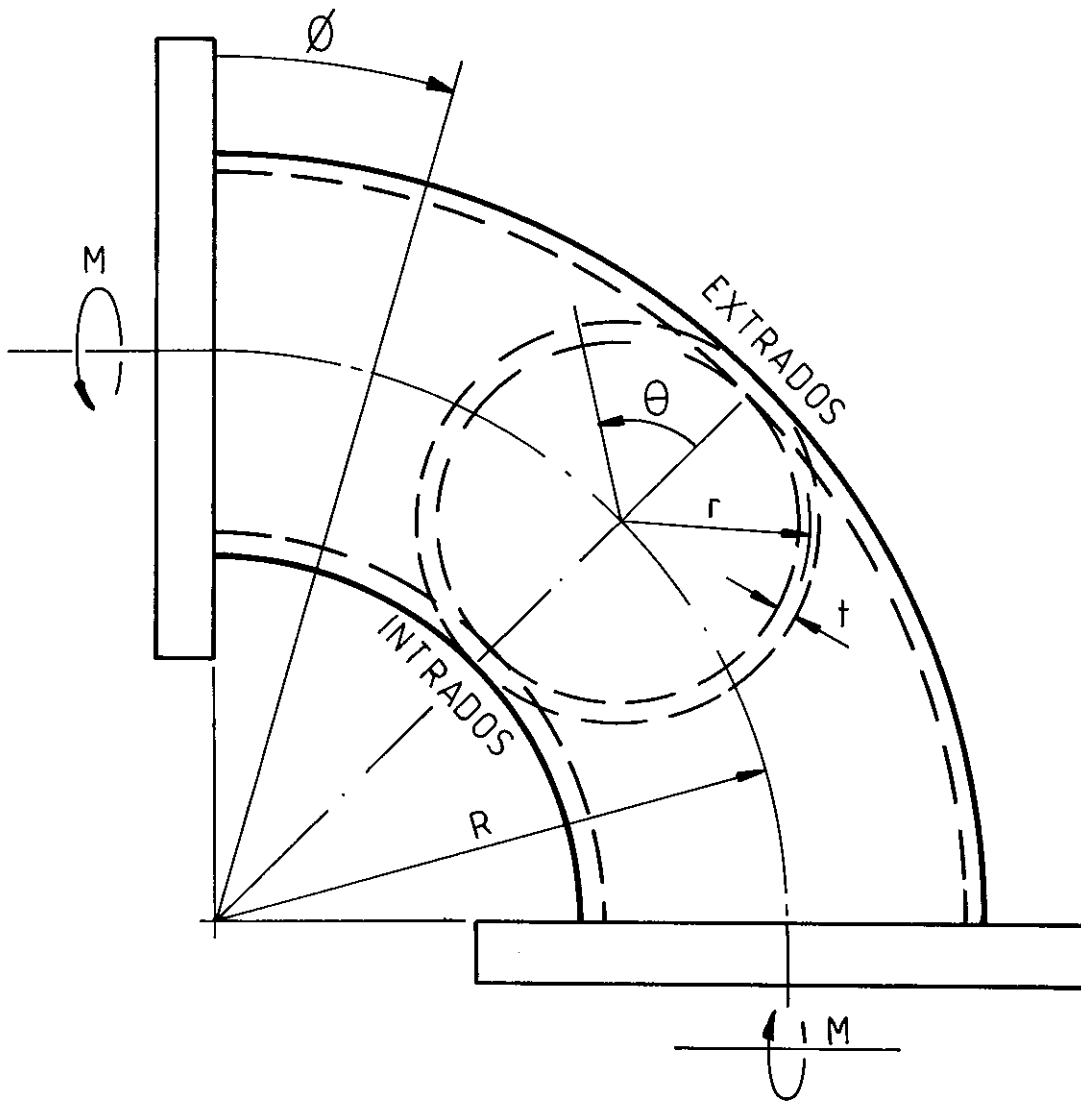


FIGURE 1. PIPE BEND CONFIGURATION

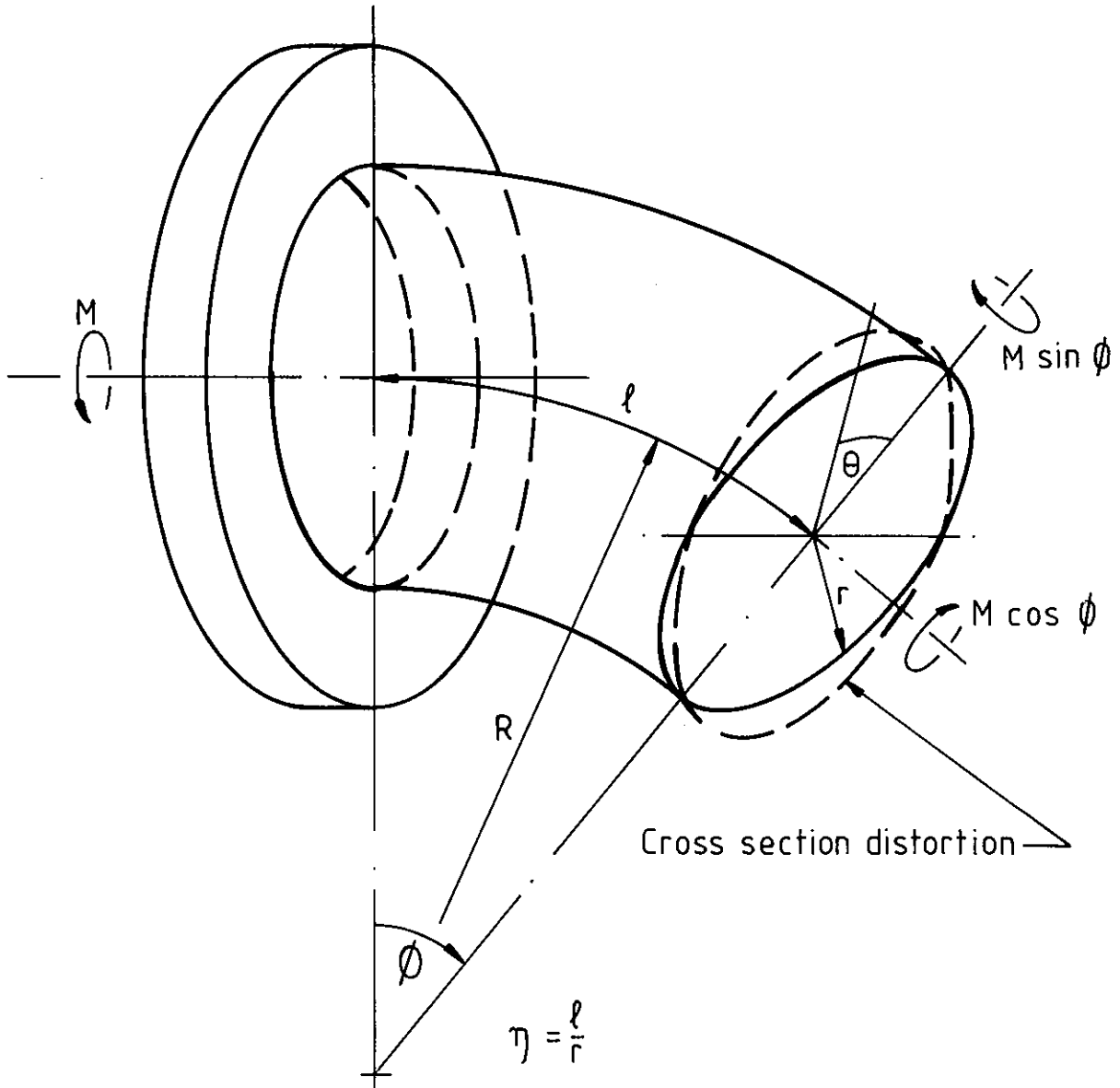


FIGURE 2. PIPE MIDDLE SURFACE

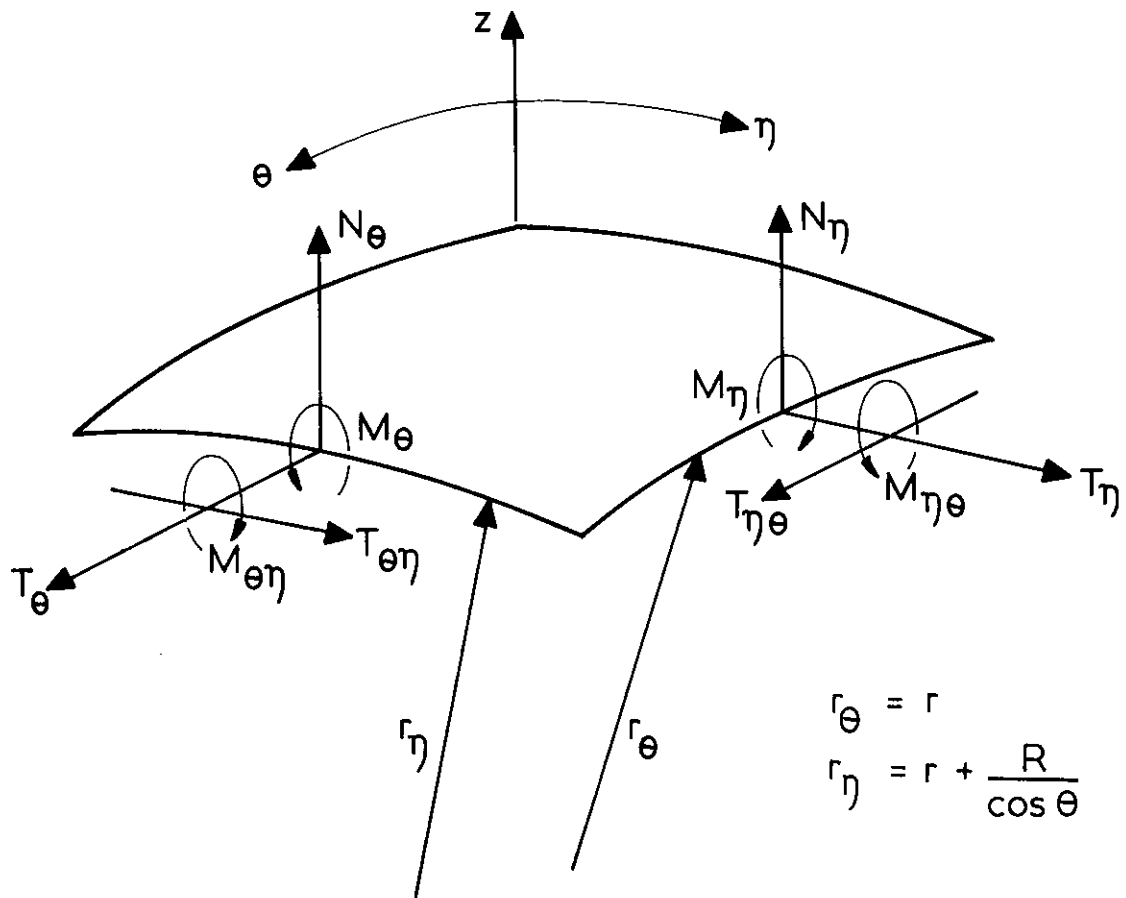


FIGURE 3. ELEMENT OF PIPE MIDDLE SURFACE

APPENDIX A STRESSES IN FLANGED PIPE ELBOWS FROM OUT-OF-PLANE BENDING

Parameters of pipe elbows considered:

$$R/r = 2, 3, 5$$

$$t/r = 0.01, 0.02, 0.05, 0.1$$

$$\nu = 0.3$$

$$\text{Stress factor (S)} = \text{stress} \cdot \pi r^2 t / M$$

For unflanged pipe bends:

$$\begin{array}{l} \left. \begin{array}{l} \times \sin \\ \times \cos \end{array} \right\} = \text{multiply stress factors by} \left. \begin{array}{l} \sin \phi \\ \cos \phi \end{array} \right\} \\ \text{UF} = \text{unflanged pipe bend.} \end{array}$$

$$\text{Diameter expansion factor} = \text{diameter expansion} \cdot \pi r E t / M$$

$$E = \text{Young's modulus}$$

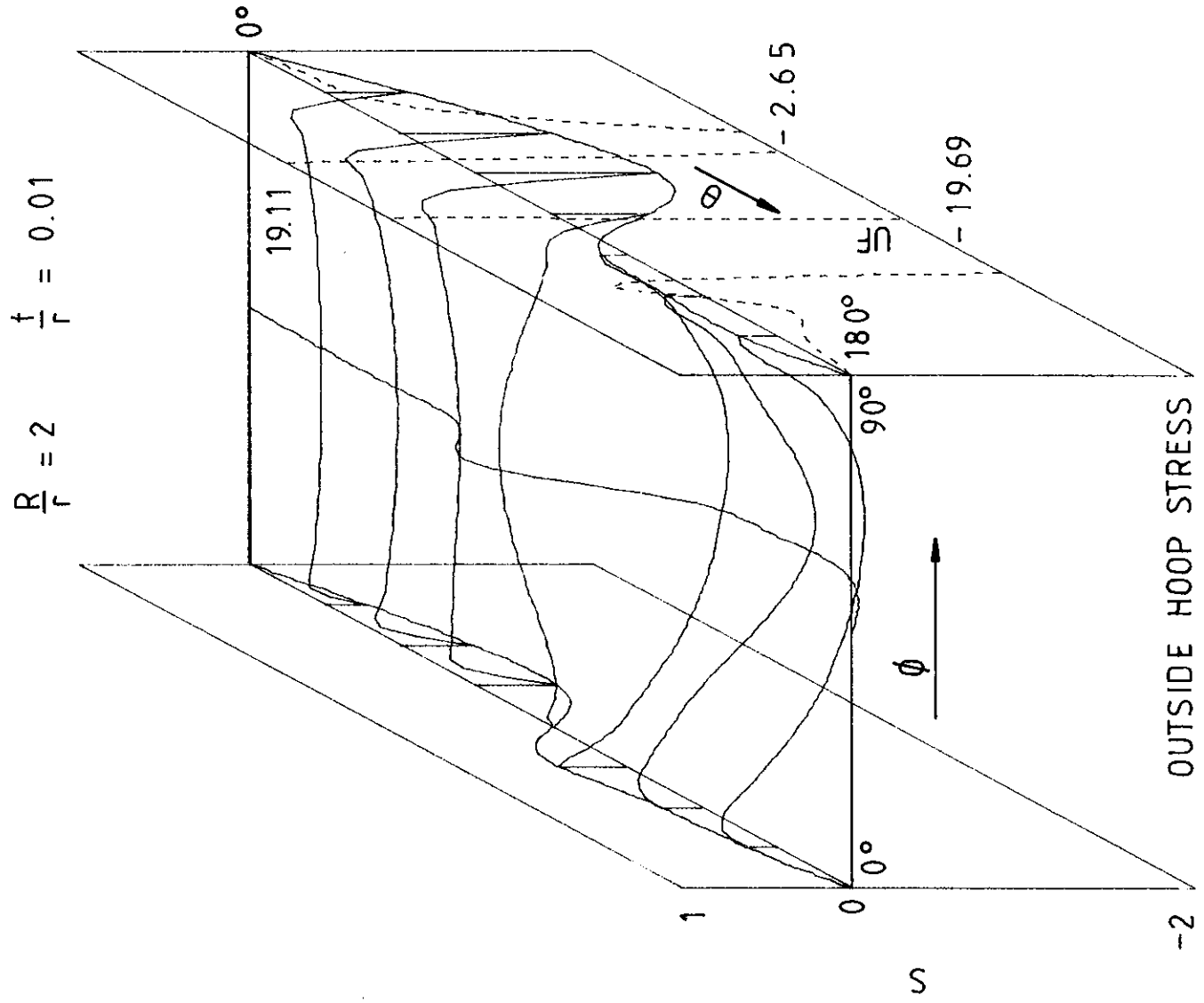


FIGURE A1

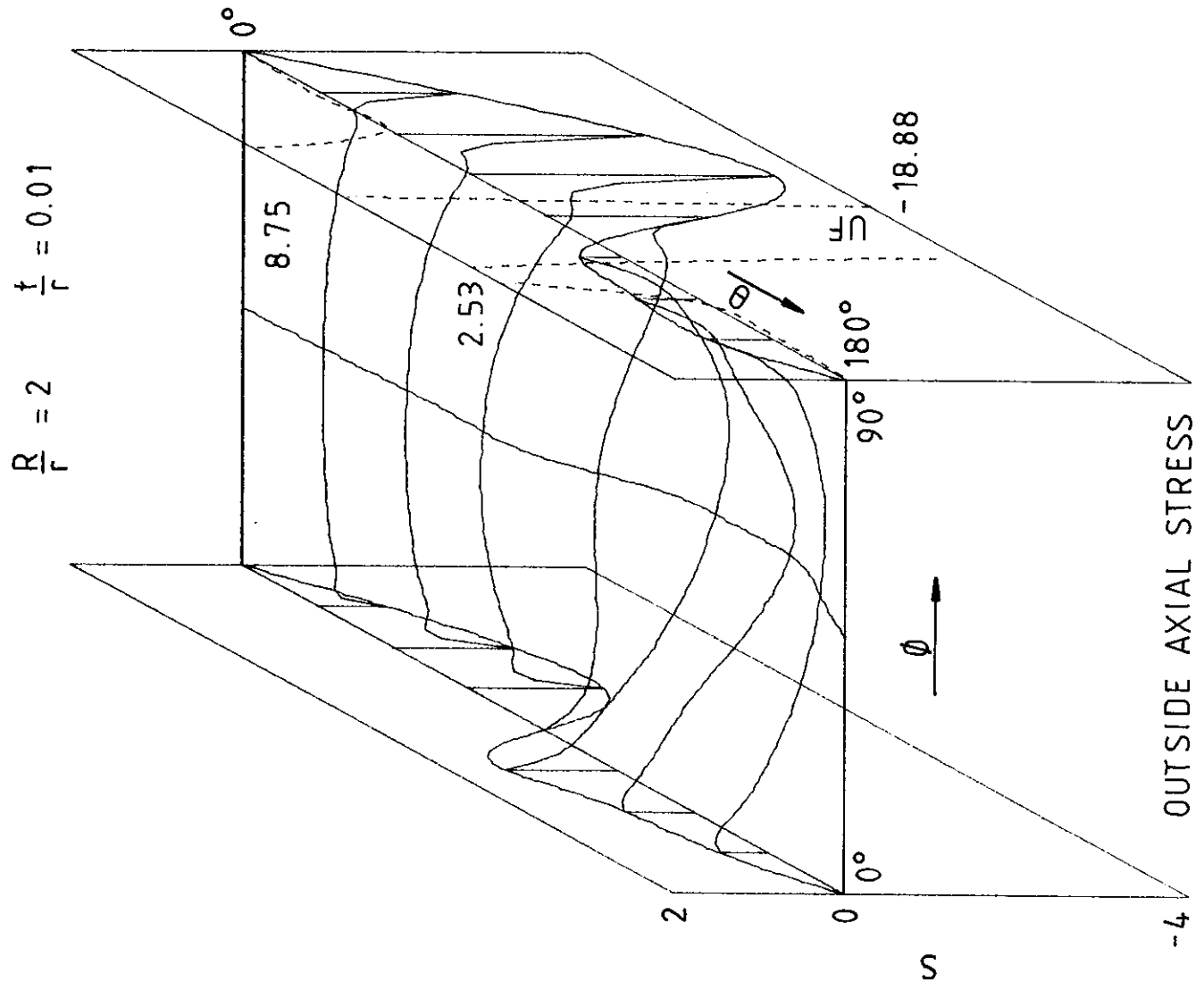


FIGURE A2

TABLE A1

R/r = 2.0 t/r = 0.01

OUTSIDE HOOP STRESS FACTORS													
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Unflanged x sin 0.0
22.5	-0.2411	0.0663	0.0426	0.0290	0.0217	0.0189	0.0200	0.0254	0.0360	0.0542	0.0840	0.1336	-0.4784
45.0	-0.4295	0.1081	0.0631	0.0362	0.0206	0.0142	0.0162	0.0269	0.0480	0.0830	0.1376	0.2269	-0.8717
67.5	-0.4803	0.1456	0.1340	0.1215	0.1056	0.0938	0.0918	0.1031	0.1284	0.1655	0.2087	0.2732	-1.0640
90.0	-0.0122	-0.0269	0.0302	0.1145	0.1975	0.2610	0.2952	0.2945	0.2561	0.1826	0.0875	0.0220	-0.5747
112.5	0.3962	0.0352	-0.1455	-0.3105	-0.4329	-0.5140	-0.5667	-0.5966	-0.5932	-0.5341	-0.4052	-0.2169	0.1469
135.0	0.2399	0.3242	0.1585	-0.0432	-0.2808	-0.4994	-0.6393	-0.6657	-0.5826	-0.4299	-0.2667	-0.0849	0.2109
157.5	0.1694	0.2726	0.0358	-0.1587	-0.3021	-0.4023	-0.4699	-0.5109	-0.5173	-0.4713	-0.3598	-0.1122	0.2243
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE AXIAL STRESS FACTORS													
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Unflanged x sin 0.0
22.5	-0.8038	-0.2010	-0.1269	-0.0870	-0.0663	-0.0590	-0.0630	-0.0789	-0.1101	-0.1636	-0.2525	-0.4081	-1.5945
45.0	-1.4316	-0.3980	-0.2695	-0.1961	-0.1574	-0.1449	-0.1557	-0.1912	-0.2578	-0.3677	-0.5419	-0.8256	-2.9057
67.5	-1.6010	-0.5243	-0.3562	-0.2384	-0.1702	-0.1469	-0.1660	-0.2300	-0.3475	-0.5334	-0.8067	-1.1818	-3.5468
90.0	-0.0406	-0.5163	-0.6184	-0.6301	-0.6081	-0.6001	-0.6370	-0.7351	-0.8953	-1.0990	-1.3013	-1.4116	-1.9158
112.5	1.3206	0.3361	-0.0730	-0.4461	-0.7372	-0.9587	-1.1249	-1.2371	-1.2765	-1.2064	-0.9858	-0.6329	0.4897
135.0	0.7998	0.5623	0.2467	-0.1229	-0.5288	-0.8850	-1.1144	-1.1717	-1.0561	-0.8104	-0.5133	-0.2492	0.7029
157.5	0.5645	0.3694	0.0335	-0.1996	-0.3784	-0.5050	-0.5899	-0.6387	-0.6430	-0.5820	-0.4514	-0.2196	0.7476
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OUTSIDE SHEAR STRESS FACTORS													
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0
0.0	-0.0978	-0.1423	-0.1944	-0.2279	-0.2515	-0.2704	-0.2887	-0.3100	-0.3388	-0.3810	-0.4460	-0.5504	-0.5023
22.5	-0.1832	-0.1990	-0.2327	-0.2554	-0.2720	-0.2856	-0.2989	-0.3145	-0.3352	-0.3650	-0.4094	-0.4781	-0.5417
45.0	-0.4378	-0.3814	-0.3608	-0.3486	-0.3409	-0.3353	-0.3302	-0.3244	-0.3163	-0.3036	-0.2815	-0.2434	-0.1257
67.5	-0.8408	-0.7351	-0.6341	-0.5569	-0.4944	-0.4395	-0.3847	-0.3223	-0.2432	-0.1363	0.0124	0.2206	0.4845
90.0	-1.0537	-1.0166	-0.9294	-0.8334	-0.7242	-0.5982	-0.4525	-0.2845	-0.0918	0.1289	0.3818	0.6744	0.9226
112.5	-0.7820	-0.9221	-0.9671	-0.9209	-0.8110	-0.6535	-0.4592	-0.2373	0.0016	0.2427	0.4621	0.6148	0.6258
135.0	-0.5517	-0.5958	-0.6626	-0.6870	-0.6464	-0.5452	-0.4010	-0.2388	-0.0869	0.0279	0.0885	0.0928	0.0988
157.5	-0.1749	-0.1403	-0.1083	-0.1087	-0.1403	-0.1971	-0.2714	-0.3569	-0.4461	-0.5279	-0.5910	-0.6223	-0.6361
180.0	0.1063	0.1514	0.2189	0.2219	0.1474	0.0009	-0.2004	-0.4268	-0.6452	-0.8292	-0.9606	-1.0166	-1.0807

DIAMETER EXPANSION FACTORS													
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0
45.0	0.0	1.268	2.607	4.161	5.760	7.097	7.859	7.859	7.106	5.787	4.173	2.426	0.0
													Unflanged x sin 374.297

TABLE A2

R/r = 2.0 t/r = 0.01

Theta	Phi=0.0	INSIDE HOOP STRESS FACTORS										Unflanged	
		30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	0.0473	0.0209	0.0191	0.0206	0.0254	0.0347	0.0507	0.0777	0.1291	0.0835	0.0835	0.0255	
45.0	0.0725	0.0598	0.0589	0.0624	0.0706	0.0852	0.1089	0.1474	0.2250	0.1233	0.1233	1.6232	
67.5	0.0532	-0.0282	-0.0207	-0.0109	-0.0014	0.0095	0.0280	0.0645	0.1542	0.0750	0.0750	-7.1961	
90.0	-0.0830	-0.2343	-0.3052	-0.3433	-0.3433	-0.3016	-0.2187	-0.1081	0.0090	-0.1782	-0.1782	-10.5240	
112.5	0.0416	0.1358	0.1439	0.1719	0.1520	0.1347	0.0752	0.0079	-0.0302	-0.2394	-0.2394	17.4862	
135.0	0.1896	0.2279	0.0268	-0.1550	-0.3604	-0.4170	-0.4636	-0.4861	-0.1066	-0.1749	-0.1749	0.7329	
157.5	0.1158	0.2414	0.1137	-0.0716	-0.2709	-0.4502	-0.5630	-0.5813	-0.0439	-0.1986	-0.1986	0.7945	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	INSIDE AXIAL STRESS FACTORS										Unflanged	
		30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	0.1577	-0.1981	-0.1302	-0.0657	-0.0821	-0.1140	-0.1685	-0.2590	-0.4026	0.2784	0.2784	0.0837	
45.0	0.2417	-0.3924	-0.2695	-0.1930	-0.1392	-0.1502	-0.1870	-0.2549	-0.8179	0.4112	0.4112	0.8400	
67.5	0.1772	-0.5473	-0.4043	-0.2993	-0.2339	-0.2094	-0.2277	-0.2933	-0.4141	-0.6011	-0.6011	3.4320	
90.0	-0.2766	-0.3745	-0.5389	-0.6223	-0.6745	-0.7246	-0.7931	-0.8903	-1.0141	-1.1483	-1.1483	-12.8991	
112.5	0.1388	0.3677	0.0287	-0.2313	-0.4517	-0.6355	-0.7796	-0.8773	-0.9194	-0.8926	-0.7774	8.4890	
135.0	0.6319	0.3988	0.1156	-0.2036	-0.4792	-0.6932	-0.8381	-0.9073	-0.8885	-0.7696	-0.5443	1.5605	
157.5	0.3859	0.2043	0.1125	-0.0864	-0.2959	-0.4776	-0.5927	-0.6172	-0.5538	-0.4289	-0.2597	0.8044	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	INSIDE SHEAR STRESS FACTORS										Unflanged	
		30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	90.0	x cos	
0.0	-0.0968	-0.1285	-0.1823	-0.2179	-0.2435	-0.2645	-0.2850	-0.3089	-0.3404	-0.3859	-0.4551	-0.0743	
22.5	-0.1814	-0.1845	-0.2195	-0.2443	-0.2631	-0.2792	-0.2951	-0.3136	-0.3375	-0.3710	-0.4199	-0.5048	
45.0	-0.4334	-0.3617	-0.3418	-0.3326	-0.3287	-0.3270	-0.3262	-0.3250	-0.3221	-0.3149	-0.2985	-0.1245	
67.5	-0.8324	-0.7025	-0.5904	-0.5139	-0.4599	-0.4174	-0.3774	-0.3312	-0.2686	-0.1763	-0.0351	0.1790	
90.0	-1.0432	-1.1509	-1.0272	-0.8883	-0.7463	-0.6039	-0.4541	-0.2838	-0.0780	0.1749	0.4780	0.9134	
112.5	-0.7742	-0.9040	-1.0347	-1.0506	-0.9535	-0.7591	-0.4935	-0.1889	0.1174	0.3843	0.5719	0.6196	
135.0	-0.5462	-0.5957	-0.6415	-0.6430	-0.6024	-0.5147	-0.3895	-0.2495	-0.1201	-0.0174	0.0586	0.1054	
157.5	-0.1732	-0.1110	-0.0584	-0.0328	-0.0506	-0.1239	-0.2435	-0.3817	-0.5050	-0.5922	-0.6414	-0.6666	
180.0	0.1053	0.2581	0.3211	0.2756	0.1593	0.0002	-0.1845	-0.3897	-0.6117	-0.8354	-1.0328	-1.0699	

Theta	Phi=0.0	DIAMETER EXPANSION FACTORS										Unflanged	
		30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	90.0	x sin	
0.0	0.0	-1.268	-2.607	-4.161	-5.760	-7.097	-7.859	-7.859	-7.106	-5.787	-2.426	0.0	
135.0	0.0	-1.268	-2.607	-4.161	-5.760	-7.097	-7.859	-7.859	-7.106	-5.787	-2.426	0.0	

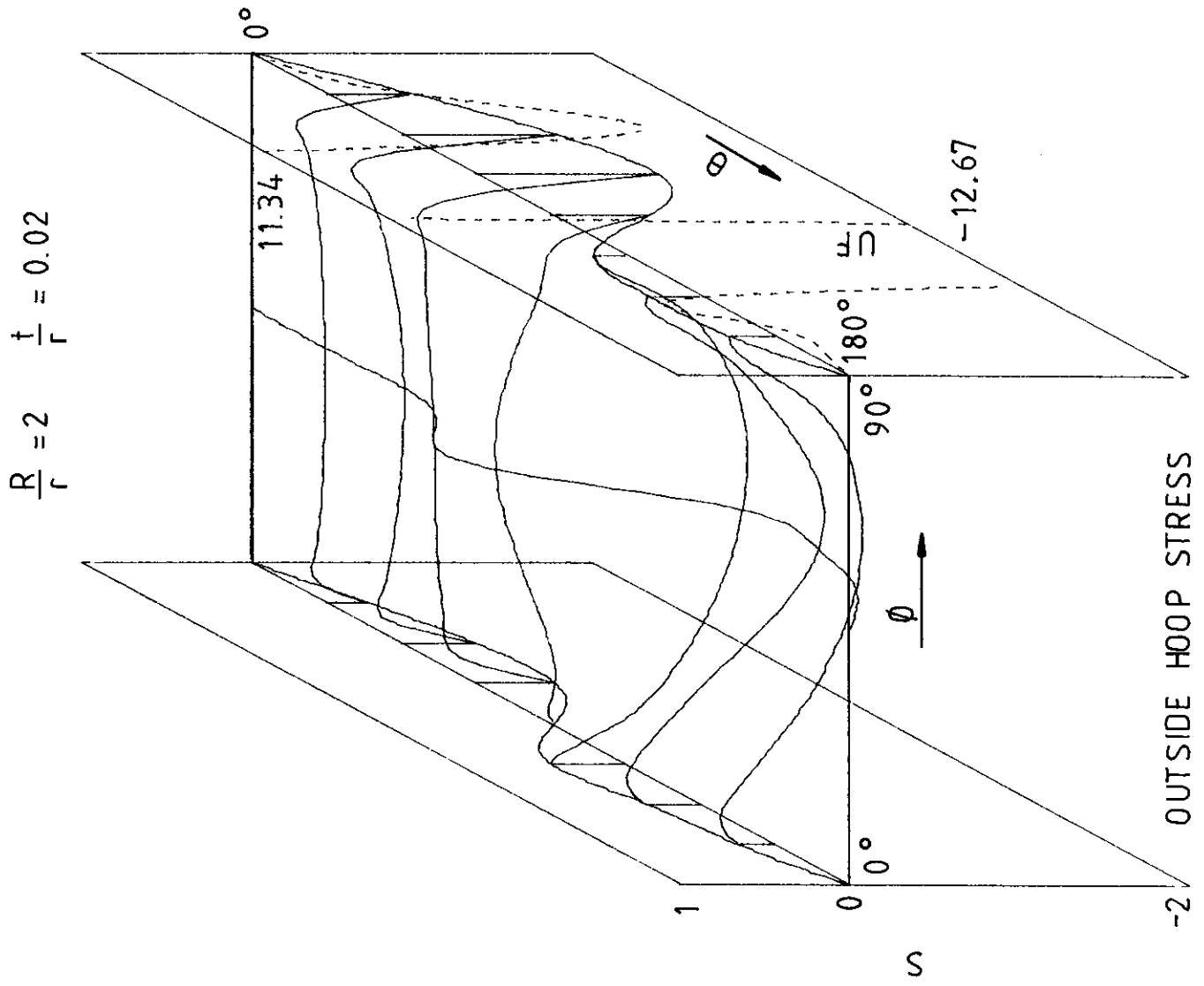
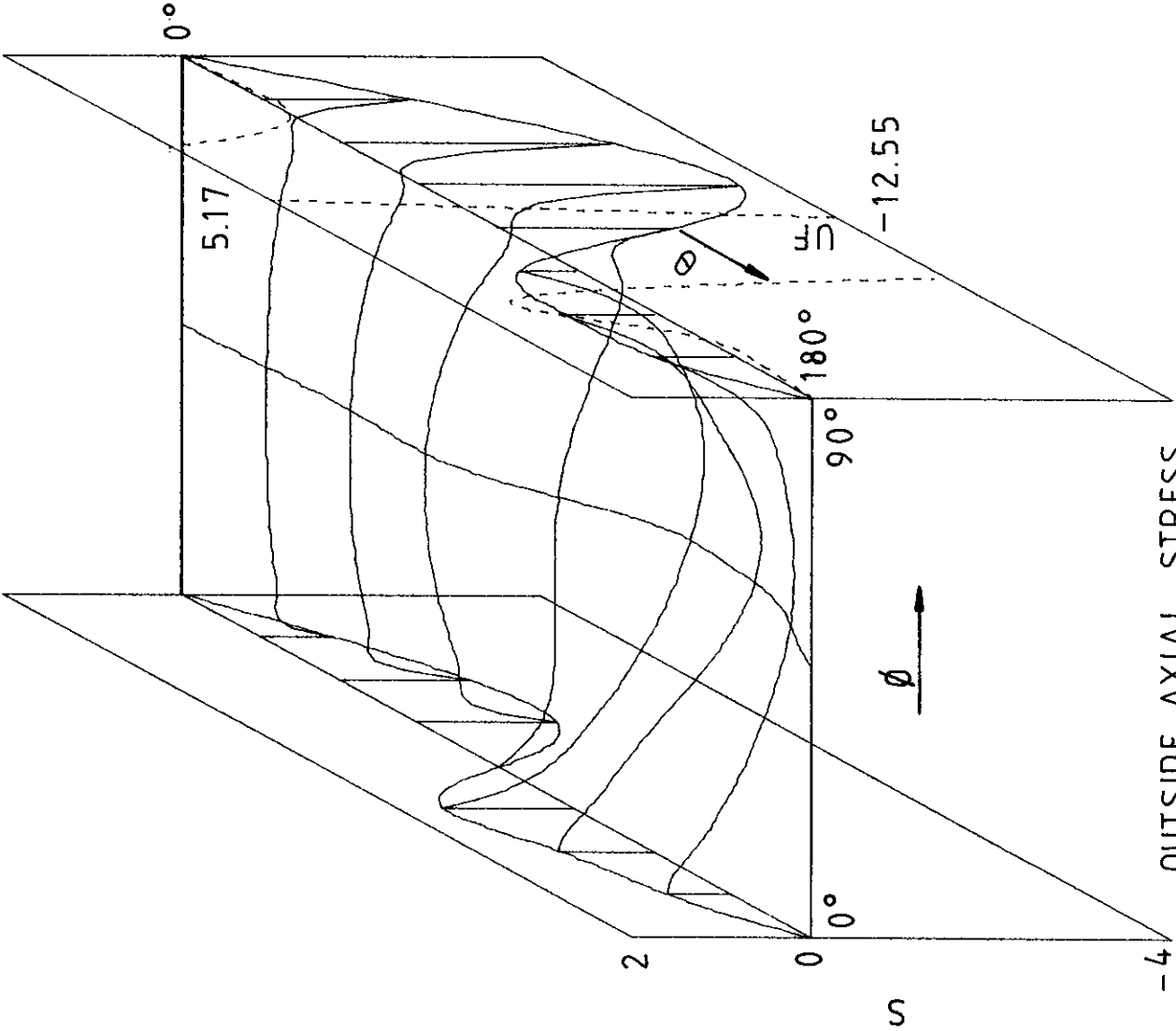


FIGURE A3

$$\frac{R}{r} = 2 \quad \frac{t}{r} = 0.02$$



OUTSIDE AXIAL STRESS
FIGURE A4

TABLE A3

R/r = 2.0 t/r = 0.02

Theta	Phi=0.0	OUTSIDE HOOP STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.2472	0.0760	0.0375	0.0225	0.0140	0.0108	0.0119	0.0177	0.0292	0.0489	0.0800	0.1574	-0.4941	-0.4231
45.0	-0.4450	0.1344	0.0618	0.0259	0.0003	-0.0138	-0.0156	-0.0040	0.0231	0.0686	0.1334	0.2789	-0.9063	-1.3965
67.5	-0.4690	0.1802	0.2028	0.2263	0.2366	0.2416	0.2483	0.2603	0.2771	0.2935	0.3004	0.3459	-1.0745	7.2402
90.0	-0.0192	-0.0257	0.0130	0.1055	0.2013	0.2790	0.3215	0.3189	0.2699	0.1828	0.0786	0.0209	-0.5822	5.0188
112.5	0.4414	0.0211	-0.2403	-0.4110	-0.5432	-0.6358	-0.6953	-0.7233	-0.7107	-0.6429	-0.5115	-0.2335	0.1866	-12.4339
135.0	0.3156	0.3853	0.1778	-0.0663	-0.3271	-0.5559	-0.7019	-0.7352	-0.6560	-0.4973	-0.2992	0.0125	0.3107	-0.3627
157.5	0.2141	0.2831	0.0773	-0.1202	-0.2776	-0.3986	-0.4799	-0.5172	-0.5083	-0.4513	-0.3178	-0.0161	0.2708	-0.1386
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE AXIAL STRESS FACTORS												Unflanged
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.8241	-0.1786	-0.1250	-0.0874	-0.0685	-0.0622	-0.0665	-0.0822	-0.1124	-0.1640	-0.2506	-0.3698	-1.6469	-0.0683
45.0	-1.4832	-0.3323	-0.2387	-0.1613	-0.1227	-0.1111	-0.1225	-0.1577	-0.2231	-0.3319	-0.5108	-0.7158	-3.0209	1.2836
67.5	-1.5634	-0.4671	-0.3373	-0.2013	-0.1147	-0.0755	-0.0850	-0.1481	-0.2739	-0.4750	-0.7739	-1.0456	-3.5816	5.1079
90.0	-0.0641	-0.5222	-0.6408	-0.6616	-0.6537	-0.6555	-0.6974	-0.7951	-0.9489	-1.1394	-1.3331	-1.3608	-1.9408	-8.2386
112.5	1.4713	0.2410	-0.2065	-0.5750	-0.8778	-1.1132	-1.2890	-1.4023	-1.4358	-1.3601	-1.1586	-0.7528	0.6221	-6.8733
135.0	1.0521	0.7014	0.3067	-0.1061	-0.5322	-0.8938	-1.1275	-1.1964	-1.0923	-0.8470	-0.5453	-0.1386	1.0356	1.3404
157.5	0.7138	0.4264	0.0803	-0.1668	-0.3712	-0.5361	-0.6459	-0.6897	-0.6668	-0.5901	-0.4678	-0.1362	0.9028	-0.1306
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE SHEAR STRESS FACTORS												Unflanged
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	
0.0	-0.1273	-0.1516	-0.2035	-0.2349	-0.2567	-0.2740	-0.2905	-0.3100	-0.3367	-0.3766	-0.4387	-0.5443	-0.5924	-0.5015
22.5	-0.2086	-0.2082	-0.2414	-0.2621	-0.2770	-0.2890	-0.3006	-0.3144	-0.3332	-0.3608	-0.4024	-0.4713	-0.4684	-0.5371
45.0	-0.4541	-0.4018	-0.3763	-0.3607	-0.3494	-0.3404	-0.3321	-0.3230	-0.3111	-0.2937	-0.2668	-0.2204	-0.0975	-0.8059
67.5	-0.8189	-0.7422	-0.6512	-0.5788	-0.5150	-0.4538	-0.3894	-0.3161	-0.2271	-0.1137	0.0341	0.2431	0.4651	-1.2764
90.0	-1.0008	-0.9513	-0.8899	-0.8054	-0.7065	-0.5884	-0.4488	-0.2875	-0.1044	0.1026	0.3385	0.5971	0.8358	0.2366
112.5	-0.7963	-0.8920	-0.9041	-0.8500	-0.7476	-0.6115	-0.4479	-0.2603	-0.0525	0.1682	0.3824	0.5405	0.6026	1.1056
135.0	-0.5418	-0.6039	-0.6573	-0.6755	-0.6308	-0.5327	-0.3984	-0.2471	-0.1004	0.0167	0.0772	0.0838	0.0701	-0.5605
157.5	-0.1846	-0.1626	-0.1438	-0.1577	-0.1938	-0.2382	-0.2863	-0.3418	-0.4091	-0.4853	-0.5528	-0.5799	-0.6127	-1.1977
180.0	0.0584	0.0658	0.1279	0.1514	0.1005	-0.0276	-0.2149	-0.4276	-0.6272	-0.7829	-0.8728	-0.8957	-0.9976	-1.5064

DIAMETER EXPANSION FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged
45.0	0.0	1.308	2.729	4.303	5.807	7.005	7.683	7.710	7.071	5.867	4.258	2.400	0.0	192.735

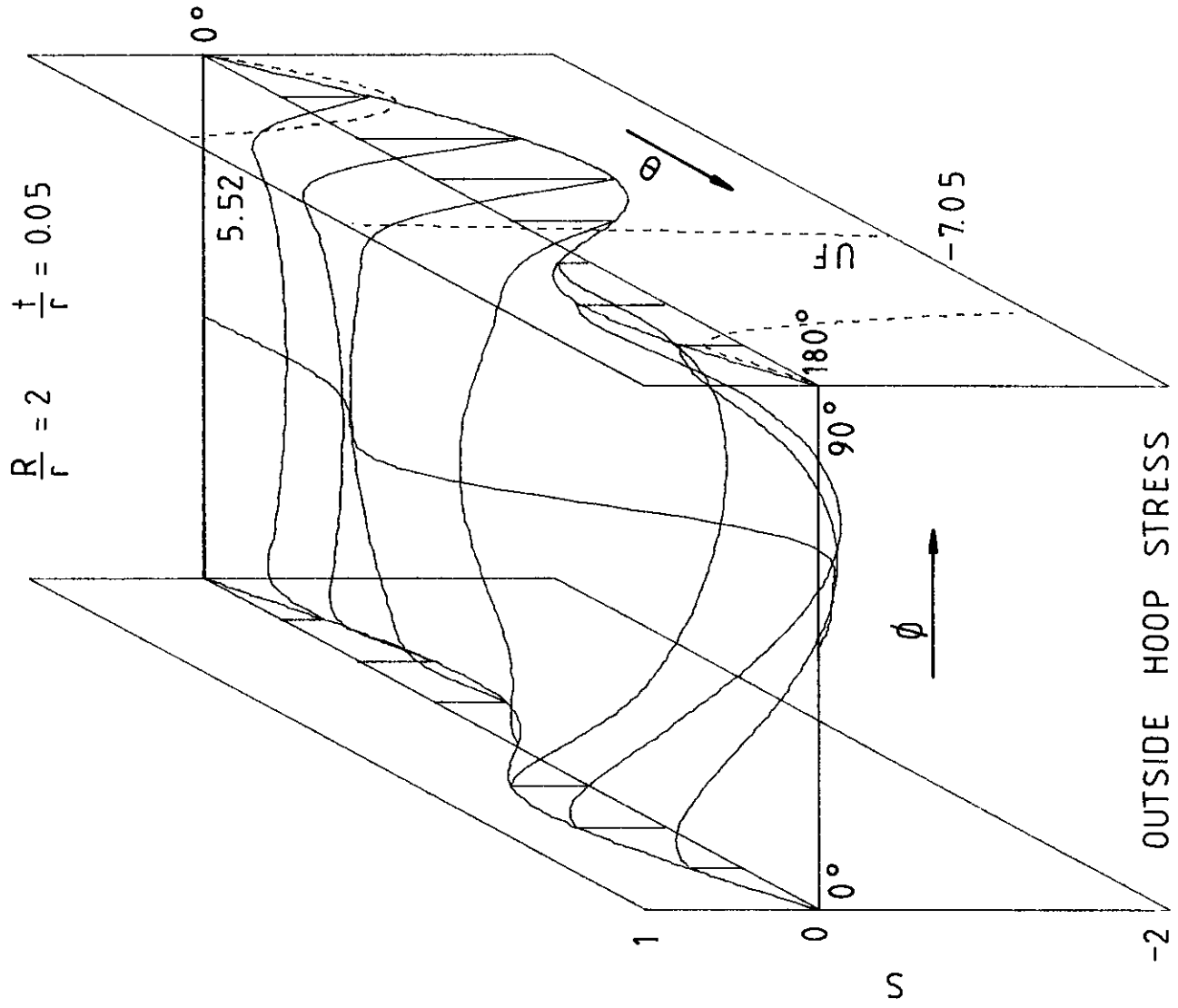
TABLE A4

R/r = 2.0 t/r = 0.02														
INSIDE HOOP STRESS FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0593	0.0633	0.0406	0.0316	0.0272	0.0260	0.0276	0.0320	0.0404	0.0547	0.0783	0.1304	0.1046	0.3471
45.0	0.0994	0.0892	0.0718	0.0703	0.0758	0.0835	0.0912	0.0985	0.1067	0.1193	0.1440	0.1994	0.1683	1.1333
67.5	0.0759	-0.0166	-0.0986	-0.1543	-0.1820	-0.1915	-0.1905	-0.1821	-0.1631	-0.1241	-0.0484	0.0514	0.1222	-8.5820
90.0	-0.0830	0.0737	-0.0205	-0.1355	-0.2535	-0.3479	-0.3995	-0.3974	-0.3390	-0.2332	-0.0985	0.0074	-0.1611	-6.1803
112.5	-0.0486	0.2222	0.2422	0.2948	0.3199	0.3197	0.3074	0.2891	0.2598	0.2044	0.1224	0.0761	-0.3384	14.1262
135.0	0.1345	0.1830	-0.0010	-0.1341	-0.1991	-0.2310	-0.2618	-0.3064	-0.3551	-0.3740	-0.2984	-0.0691	-0.2598	1.4920
157.5	0.0511	0.2126	0.1315	-0.0474	-0.2456	-0.4185	-0.5260	-0.5444	-0.4766	-0.3468	-0.1740	-0.0002	-0.2635	0.7584
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.1978	-0.2094	-0.1273	-0.0888	-0.0691	-0.0627	-0.0675	-0.0840	-0.1156	-0.1696	-0.2587	-0.4321	0.3487	0.0789
45.0	0.3312	-0.4158	-0.2442	-0.1630	-0.1176	-0.1015	-0.1115	-0.1491	-0.2209	-0.3400	-0.5242	-0.8868	0.5609	1.6529
67.5	0.2529	-0.5762	-0.4147	-0.3281	-0.2685	-0.2450	-0.2632	-0.3297	-0.4513	-0.6353	-0.8803	-1.3315	0.4075	0.2832
90.0	-0.2766	-0.3319	-0.4933	-0.6041	-0.6860	-0.7626	-0.8452	-0.9393	-1.0428	-1.1453	-1.2171	-1.3147	-0.5368	-7.5311
112.5	-0.1619	0.3196	0.0281	-0.2259	-0.4332	-0.6076	-0.7454	-0.8401	-0.8839	-0.8659	-0.7484	-0.5526	-1.1279	4.3033
135.0	0.4484	0.3198	0.1119	-0.1489	-0.3652	-0.5307	-0.6483	-0.7155	-0.7228	-0.6481	-0.4521	-0.2710	-0.8658	2.7382
157.5	0.1702	0.1231	0.0913	-0.0650	-0.2473	-0.4022	-0.5002	-0.5250	-0.4750	-0.3566	-0.1942	-0.1909	-0.8783	0.7277
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x cos
0.0	-0.1248	-0.1246	-0.1799	-0.2153	-0.2409	-0.2622	-0.2832	-0.3076	-0.3398	-0.3861	-0.4563	-0.5696	-0.5807	-0.0756
22.5	-0.2045	-0.1770	-0.2155	-0.2406	-0.2599	-0.2766	-0.2932	-0.3125	-0.3375	-0.3723	-0.4225	-0.5027	-0.4591	-0.0681
45.0	-0.4451	-0.3469	-0.3307	-0.3220	-0.3199	-0.3209	-0.3233	-0.3257	-0.3265	-0.3230	-0.3088	-0.2851	-0.0956	-0.0411
67.5	-0.8026	-0.7195	-0.5974	-0.5156	-0.4580	-0.4146	-0.3757	-0.3310	-0.2686	-0.1738	-0.0266	0.1950	0.4559	-0.7768
90.0	-0.9809	-1.1575	-1.0372	-0.9058	-0.7664	-0.6195	-0.4596	-0.2774	-0.0624	0.1936	0.4935	0.8435	0.8193	-2.2646
112.5	-0.7806	-0.9370	-1.0653	-1.0656	-0.9584	-0.7613	-0.4973	-0.1948	0.1138	0.3921	0.6040	0.7084	0.5906	-0.5737
135.0	-0.5311	-0.5366	-0.6089	-0.6350	-0.6038	-0.5170	-0.3887	-0.2443	-0.1124	-0.0136	0.0432	0.0501	0.0688	0.0864
157.5	-0.1810	-0.1015	-0.0340	-0.0095	-0.0363	-0.1157	-0.2355	-0.3734	-0.5029	-0.6022	-0.6635	-0.6804	-0.6006	-0.1750
180.0	0.0573	0.2255	0.3088	0.2875	0.1885	0.0307	-0.1698	-0.3951	-0.6265	-0.8460	-1.0319	-1.1214	-0.9778	-0.2184

DIAMETER EXPANSION FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
135.0	0.0	-1.308	-2.729	-4.303	-5.807	-7.005	-7.683	-7.710	-7.071	-5.867	-4.258	-2.400	0.0	-192.735



OUTSIDE HOOP STRESS

FIGURE A5

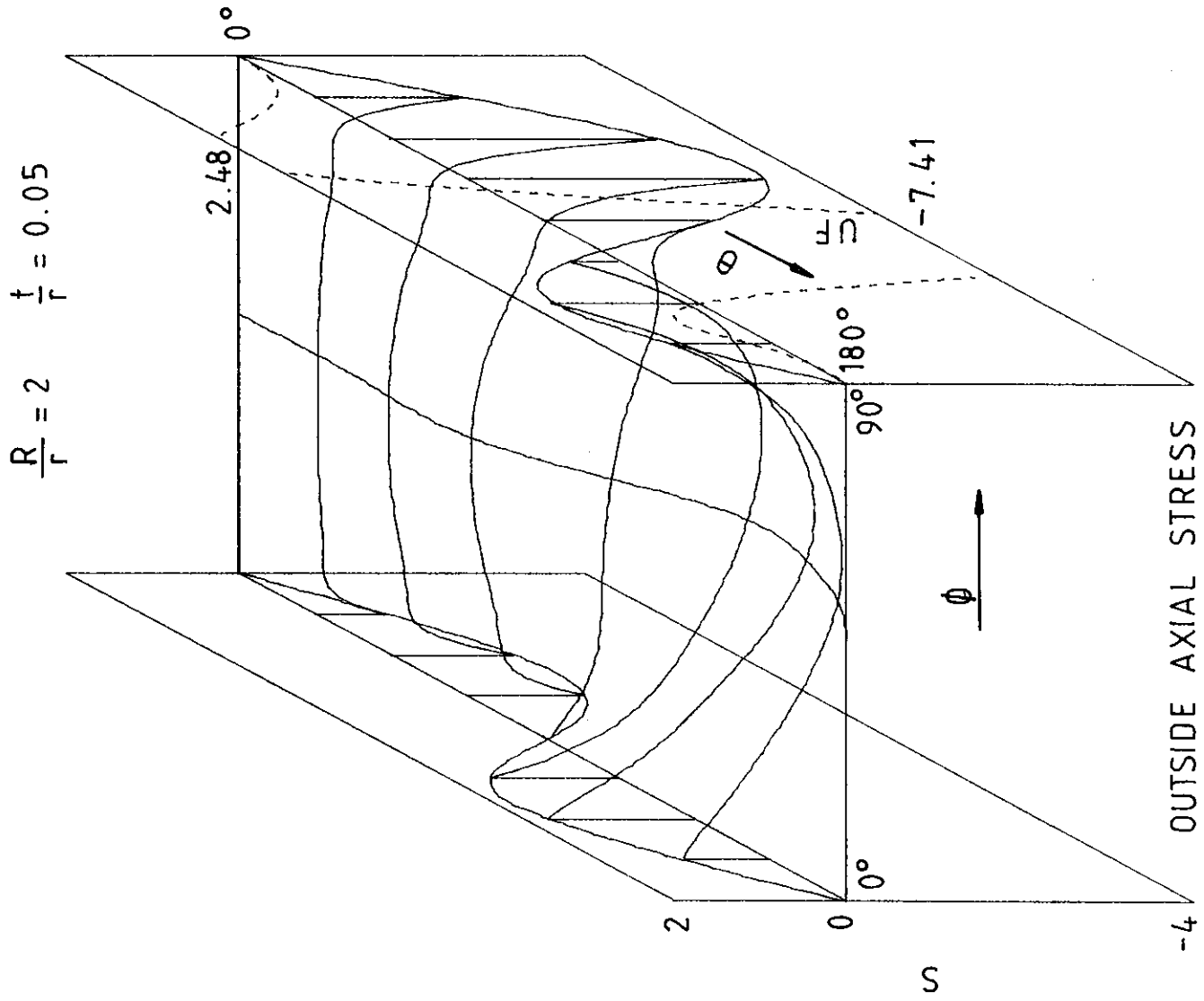


TABLE A5

R/r = 2.0 $\tau/r = 0.05$

Theta	Phi=0.0	OUTSIDE HOOP STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.2490	0.0670	0.0356	0.0012	-0.0193	-0.0319	-0.0353	-0.0282	-0.0093	0.0223	0.0825	0.1487	-0.5135	-0.6238
45.0	-0.4333	0.1250	0.1416	0.1123	0.0956	0.0854	0.0859	0.1000	0.1286	0.1705	0.2503	0.2601	-0.9262	0.9396
67.5	-0.4120	0.1143	0.2519	0.3231	0.3880	0.4363	0.4677	0.4816	0.4750	0.4470	0.4230	0.2259	-1.0356	5.0996
90.0	-0.0362	-0.0024	0.0086	0.0840	0.1771	0.2516	0.2911	0.2867	0.2361	0.1513	0.0742	-0.0554	-0.5929	2.1334
112.5	0.4439	0.0995	-0.2583	-0.4663	-0.6009	-0.6975	-0.7624	-0.7942	-0.7874	-0.7225	-0.5415	-0.1657	0.1655	-6.6493
135.0	0.5106	0.4228	0.0733	-0.2724	-0.5722	-0.8101	-0.9620	-1.0086	-0.9425	-0.7550	-0.4102	0.1185	0.4950	-3.3757
157.5	0.3002	0.3577	0.1836	-0.0382	-0.2429	-0.4069	-0.5137	-0.5513	-0.5135	-0.3905	-0.1605	0.1636	0.3484	0.2045
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE AXIAL STRESS FACTORS												Unflanged x sin
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.8301	-0.0987	-0.0881	-0.0544	-0.0367	-0.0324	-0.0374	-0.0519	-0.0791	-0.1290	-0.2087	-0.2258	-1.7117	0.4115
45.0	-1.4442	-0.2211	-0.1536	-0.0628	-0.0031	0.0232	0.0209	-0.0120	-0.0828	-0.2100	-0.3917	-0.4981	-3.0873	1.9898
67.5	-1.3735	-0.4178	-0.3333	-0.2095	-0.1106	-0.0586	-0.0591	-0.1199	-0.2509	-0.4661	-0.7293	-0.9256	-3.4520	1.5867
90.0	-0.1208	-0.4555	-0.6481	-0.6948	-0.7146	-0.7469	-0.8069	-0.9040	-1.0414	-1.2120	-1.3419	-1.2881	-1.9762	-4.9780
112.5	1.4795	0.2027	-0.4061	-0.7779	-1.0745	-1.3181	-1.5035	-1.6229	-1.6675	-1.6220	-1.4138	-0.8072	0.5515	-6.3998
135.0	1.7021	0.9051	0.2628	-0.2447	-0.6899	-1.0559	-1.3015	-1.3979	-1.3392	-1.1332	-0.7395	0.0706	1.6501	-0.2702
157.5	1.0008	0.6532	0.2622	-0.0769	-0.3784	-0.6270	-0.7876	-0.8376	-0.7814	-0.6352	-0.3678	0.1744	1.1614	0.3056
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE SHEAR STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos	
0.0	-0.1942	-0.1986	-0.2253	-0.2530	-0.2697	-0.2825	-0.2950	-0.3102	-0.3321	-0.3657	-0.4252	-0.4879	-0.4886	-0.5022	
22.5	-0.2688	-0.2651	-0.2714	-0.2865	-0.2947	-0.3004	-0.3060	-0.3134	-0.3247	-0.3436	-0.3795	-0.3977	-0.3736	-0.5921	
45.0	-0.4812	-0.4590	-0.4249	-0.4045	-0.3845	-0.3635	-0.3411	-0.3162	-0.2878	-0.2555	-0.2168	-0.1295	-0.0442	-0.8515	
67.5	-0.7553	-0.6958	-0.6548	-0.5986	-0.5387	-0.4717	-0.3954	-0.3081	-0.2078	-0.0922	0.0490	0.2145	0.3945	-0.8903	
90.0	-0.9023	-0.8053	-0.7886	-0.7303	-0.6507	-0.5523	-0.4352	-0.2991	-0.1438	0.0307	0.2237	0.3859	0.6647	0.0071	
112.5	-0.7964	-0.7864	-0.7594	-0.7104	-0.6359	-0.5409	-0.4280	-0.2963	-0.1455	0.0204	0.1874	0.3264	0.5155	0.7478	
135.0	-0.5492	-0.6325	-0.6276	-0.6059	-0.5587	-0.4846	-0.3901	-0.2829	-0.1731	-0.0734	0.0069	0.0671	0.0432	-0.2596	
157.5	-0.2290	-0.2752	-0.2825	-0.2904	-0.3022	-0.3117	-0.3189	-0.3293	-0.3485	-0.3752	-0.3985	-0.4206	-0.5356	-1.2487	
180.0	-0.0347	-0.0860	-0.0705	-0.0632	-0.0950	-0.1671	-0.2692	-0.3870	-0.5022	-0.5921	-0.6397	-0.6737	-0.8404	-1.5163	

DIAMETER EXPANSION FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
45.0	0.0	1.158	2.653	4.135	5.460	6.468	7.035	7.080	6.567	5.508	3.980	2.011	0.0	78.887

TABLE A6

R/r = 2.0 t/r = 0.05														
INSIDE HOOP STRESS FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0805	0.0022	0.0423	0.0460	0.0560	0.0655	0.0722	0.0755	0.0755	0.0754	0.0885	0.0195	0.1429	0.5407
45.0	0.1343	-0.0512	-0.0230	-0.0432	-0.0440	-0.0381	-0.0319	-0.0275	-0.0233	-0.0098	0.0343	-0.0585	0.2362	-1.3483
67.5	0.0985	-0.0896	-0.1698	-0.2945	-0.3841	-0.4422	-0.4702	-0.4655	-0.4237	-0.3327	-0.1826	-0.1744	0.1786	-6.1898
90.0	-0.0647	0.0908	0.0204	-0.1235	-0.2584	-0.3636	-0.4209	-0.4178	-0.3515	-0.2240	-0.0581	-0.0430	-0.1205	-2.9106
112.5	-0.1663	0.2605	0.3439	0.3836	0.4130	0.4260	0.4245	0.4108	0.3827	0.3417	0.2893	0.1357	-0.4473	7.6378
135.0	-0.0710	0.1601	0.1407	0.1321	0.1658	0.2036	0.2113	0.1740	0.0999	0.0276	0.0100	-0.0059	-0.4862	4.6581
157.5	-0.0441	0.1091	0.0546	-0.0669	-0.1806	-0.2671	-0.3247	-0.3506	-0.3343	-0.2591	-0.1282	-0.0475	-0.3525	0.4339
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE AXIAL STRESS FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.2683	-0.2372	-0.0995	-0.0530	-0.0293	-0.0195	-0.0228	-0.0398	-0.0746	-0.1321	-0.2314	-0.5258	0.4763	0.6278
45.0	0.4477	-0.4438	-0.2291	-0.1375	-0.0875	-0.0648	-0.0715	-0.1109	-0.1896	-0.3133	-0.5234	-1.0262	0.7872	0.9977
67.5	0.3285	-0.5207	-0.4150	-0.3708	-0.3543	-0.3583	-0.3914	-0.4593	-0.5663	-0.7107	-0.9418	-1.3661	0.5954	-1.2823
90.0	-0.2156	-0.2915	-0.3936	-0.5351	-0.6582	-0.7636	-0.8604	-0.9501	-1.0278	-1.0817	-1.1412	-1.2506	-0.4015	-3.5224
112.5	-0.5543	0.0727	0.0140	-0.0205	-0.3980	-0.5543	-0.6761	-0.7606	-0.7951	-0.7609	-0.6843	-0.7711	-1.4909	1.1265
135.0	-0.2368	0.0671	0.1290	0.0244	-0.0993	-0.1999	-0.2773	-0.3301	-0.3446	-0.3080	-0.2843	-0.5702	-1.6206	3.3502
157.5	-0.1469	-0.0854	-0.0196	-0.0415	-0.0979	-0.1510	-0.1894	-0.2080	-0.1993	-0.1697	-0.1927	-0.4655	-1.1750	0.9204
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

INSIDE SHEAR STRESS FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x cos
0.0	-0.1848	-0.0982	-0.1709	-0.2061	-0.2321	-0.2545	-0.2769	-0.3032	-0.3379	-0.3867	-0.4598	-0.6171	-0.4648	-0.0397
22.5	-0.2557	-0.1506	-0.1991	-0.2250	-0.2457	-0.2653	-0.2859	-0.3099	-0.3401	-0.3794	-0.4358	-0.5501	-0.3553	-0.0356
45.0	-0.4577	-0.3478	-0.3180	-0.3067	-0.3041	-0.3082	-0.3162	-0.3254	-0.3323	-0.3319	-0.3232	-0.2921	-0.0420	-0.1897
67.5	-0.7184	-0.7432	-0.6210	-0.5373	-0.4756	-0.4258	-0.3788	-0.3249	-0.2527	-0.1484	0.0030	0.2511	0.3752	-0.8841
90.0	-0.8583	-1.1167	-1.0425	-0.9228	-0.7879	-0.6374	-0.4673	-0.2726	-0.0473	0.2134	0.5138	0.8317	0.6322	-1.6513
112.5	-0.7575	-0.9845	-1.0960	-1.0754	-0.9534	-0.7547	-0.4987	-0.2050	0.1040	0.3997	0.6415	0.7464	0.4904	-0.9664
135.0	-0.5224	-0.4961	-0.5830	-0.6353	-0.6128	-0.5232	-0.3878	-0.2335	-0.0905	0.0096	0.0411	0.0146	0.0411	0.0475
157.5	-0.2178	-0.0634	0.0240	-0.0339	-0.0122	-0.0989	-0.2148	-0.3486	-0.4876	-0.6156	-0.7035	-0.6908	-0.5095	-0.0906
180.0	-0.0330	0.1760	0.3144	0.3433	0.2661	0.0986	-0.1348	-0.4016	-0.6657	-0.8904	-1.0310	-1.0216	-0.7994	-0.2137

DIAMETER EXPANSION FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
0.0	0.0	-1.158	-2.653	-4.135	-5.460	-6.468	-7.035	-7.080	-6.567	-5.508	-3.980	-2.011	0.0	-78.887

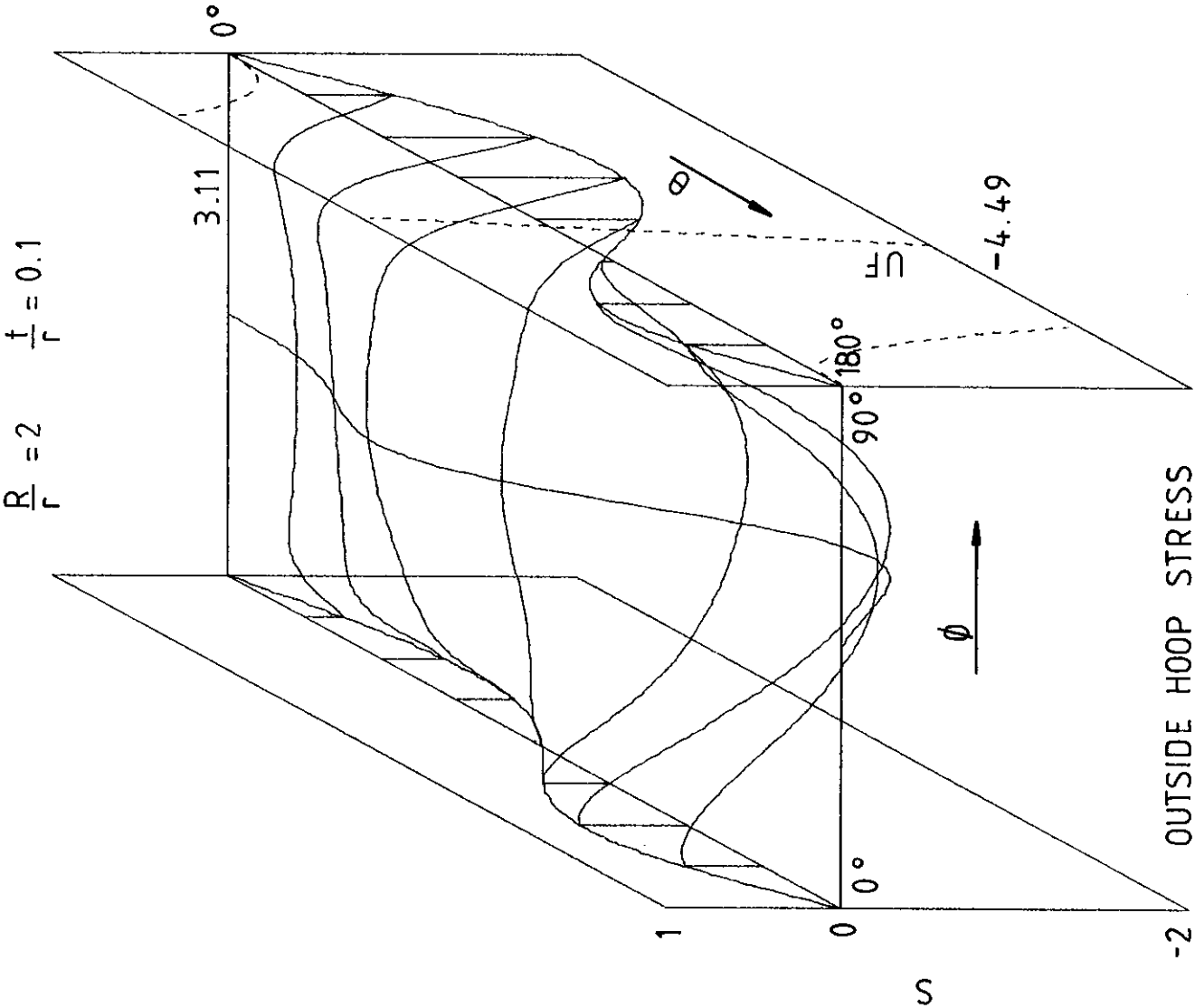


FIGURE A7

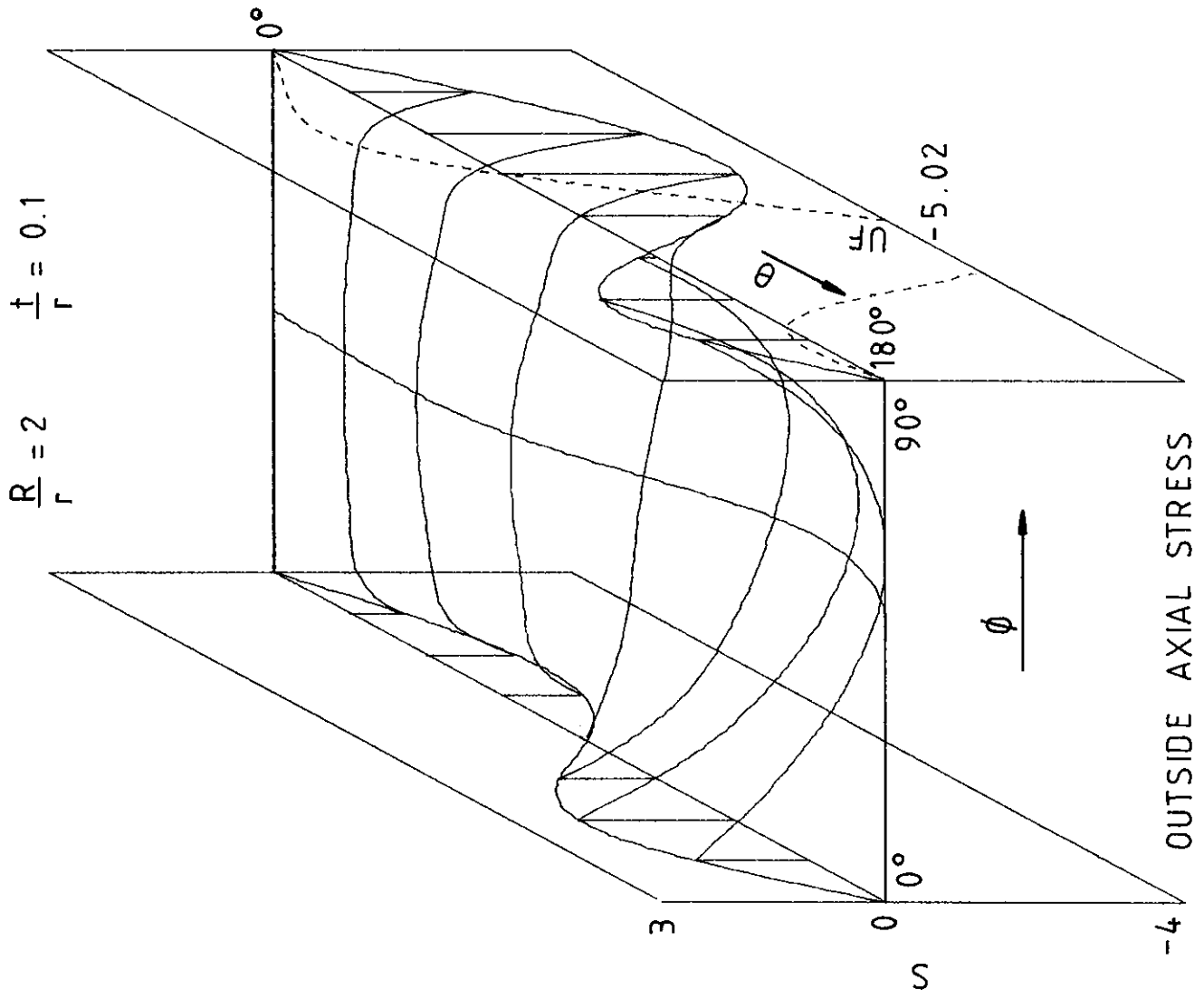


FIGURE A8

TABLE A7

R/r = 2.0 t/r = 0.1

Theta	Phi=0.0	OUTSIDE HOOP STRESS FACTORS										Unflanged	
		30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	90.0	x sin	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0	0.0567	0.0503	0.0514	0.0611	0.0810	0.1186	0.1746	0.0748	-0.5004	0.3227	0.3227	0.3227
45.0	-0.3631	0.2403	0.2596	0.2781	0.2954	0.3134	0.3428	0.3689	0.0951	-0.8701	1.7440	1.7440	1.7440
67.5	-0.3270	0.4062	0.4766	0.5211	0.5343	0.5177	0.4835	0.4028	0.0000	-0.9454	3.1096	3.1096	3.1096
90.0	-0.0407	0.0152	0.0255	0.0584	0.1138	0.1646	0.1892	0.1792	0.1404	0.0927	0.5926	0.9763	0.9763
112.5	0.3875	0.1674	-0.1559	-0.3980	-0.5601	-0.6695	-0.7421	-0.7779	-0.7609	-0.6602	-0.4447	-0.1318	-0.1318
135.0	0.6225	0.4261	0.0131	-0.3920	-0.7243	-0.9693	-1.1185	-1.1584	-1.0689	-0.8242	-0.4055	0.1400	0.5264
157.5	0.4522	0.4014	0.1733	-0.0933	-0.3324	-0.5152	-0.6258	-0.6509	-0.5780	-0.3959	-0.1076	0.2325	0.4462
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE AXIAL STRESS FACTORS										Unflanged	
		30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	90.0	x sin	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.7372	-0.0948	-0.0146	0.0677	0.0712	0.0591	-0.0282	-0.0769	-0.2197	-1.6679	0.8353	0.8353	0.8353
45.0	-1.2104	-0.2380	-0.0856	0.0645	0.1087	0.1177	0.0866	0.0065	-0.1190	-0.2420	-2.9003	1.4152	1.4152
67.5	-1.0899	-0.4033	-0.3016	-0.2368	-0.1651	-0.1241	-0.1308	-0.1946	-0.3227	-0.4977	-0.6572	-1.0041	0.1419
90.0	-0.1358	-0.3491	-0.5616	-0.6797	-0.7446	-0.8066	-0.8873	-0.9937	-1.1220	-1.2360	-1.2580	-1.9754	-3.4377
112.5	1.2915	0.2356	-0.4260	-0.8548	-1.1656	-1.4115	-1.6050	-1.7410	-1.8006	-1.7342	-1.4443	-0.8222	-4.8783
135.0	2.0750	0.9754	0.1374	-0.4804	-0.9573	-1.3251	-1.5799	-1.7041	-1.6726	-1.4390	-0.9060	0.0966	-1.8125
157.5	1.5073	0.8973	0.3357	-0.1276	-0.5029	-0.7911	-0.9782	-1.0468	-0.9819	-0.7600	-0.3284	0.4022	0.2133
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE SHEAR STRESS FACTORS										Unflanged	
		30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	90.0	x cos	x cos
0.0	-0.2788	-0.3038	-0.2834	-0.2935	-0.3006	-0.3033	-0.3053	-0.3093	-0.3189	-0.3418	-0.3740	-0.3570	-0.5818
22.5	-0.3364	-0.3556	-0.3333	-0.3337	-0.3320	-0.3257	-0.3177	-0.3099	-0.3058	-0.3107	-0.3166	-0.2561	-0.6461
45.0	-0.4913	-0.4847	-0.4662	-0.4460	-0.4211	-0.3892	-0.3514	-0.3092	-0.2650	-0.2197	-0.1610	-0.0698	-0.7599
67.5	-0.6817	-0.6143	-0.6105	-0.5783	-0.5298	-0.4674	-0.3921	-0.3063	-0.2120	-0.1074	0.0107	0.1105	-0.6625
90.0	-0.8017	-0.6696	-0.6590	-0.6273	-0.5738	-0.5024	-0.4150	-0.3134	-0.1988	-0.0707	0.0610	0.1652	-0.1240
112.5	-0.7635	-0.6654	-0.6154	-0.5739	-0.5281	-0.4742	-0.4102	-0.3339	-0.2425	-0.1347	-0.0166	0.1128	0.3756
135.0	-0.5764	-0.6121	-0.5745	-0.5304	-0.4879	-0.4434	-0.3930	-0.3339	-0.2637	-0.1812	-0.0890	0.0005	-0.1195
157.5	-0.3137	-0.4389	-0.4627	-0.4500	-0.4256	-0.3953	-0.3604	-0.3226	-0.2837	-0.2458	-0.2187	-0.2413	-1.1652
180.0	-0.1638	-0.3154	-0.3601	-0.3623	-0.3533	-0.3434	-0.3351	-0.3290	-0.3243	-0.3215	-0.3324	-0.4049	-1.5872

Theta	Phi=0.0	DIAMETER EXPANSION FACTORS										Unflanged	
		30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	90.0	x sin	x sin
45.0	0.0	4.319	5.127	5.579	5.611	5.189	4.322	3.044	1.354	0.0	0.0	36.739	36.739

TABLE A8

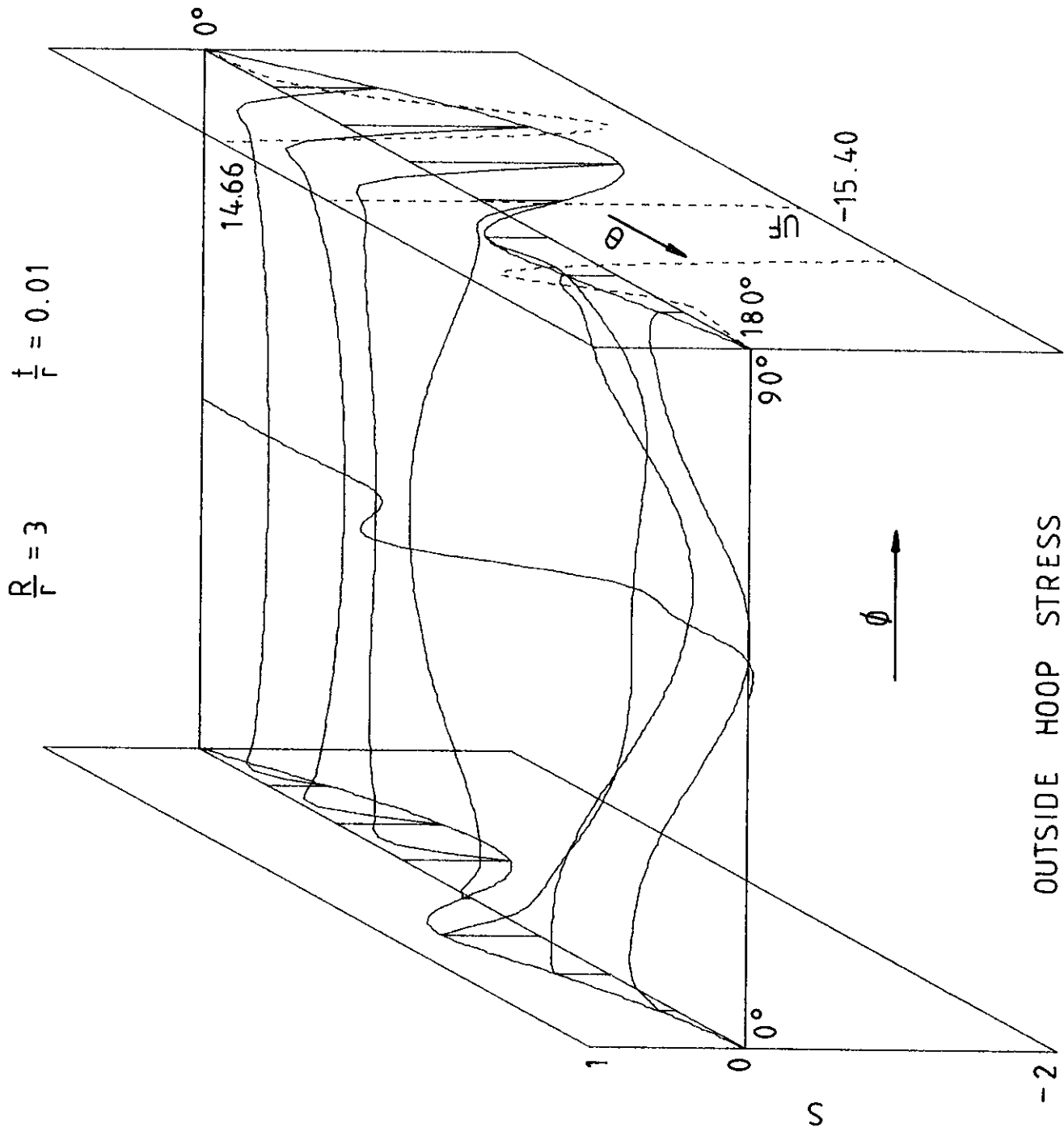
R/r = 2.0 t/r = 0.1

Theta	Phi=0.0	INSIDE HOOP STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0887	-0.0683	-0.0412	-0.0366	-0.0336	-0.0283	-0.0251	-0.0258	-0.0278	-0.0256	-0.0374	-0.1292	0.1677	-0.4459
45.0	0.1394	-0.1225	-0.1377	-0.1858	-0.2279	-0.2537	-0.2672	-0.2692	-0.2531	-0.2102	-0.1745	-0.2512	0.2645	-2.1875
67.5	0.1046	-0.0910	-0.1775	-0.3190	-0.4493	-0.5414	-0.5896	-0.5881	-0.5273	-0.4035	-0.2716	-0.2630	0.2015	-3.9364
90.0	-0.0401	0.0687	0.0440	-0.0784	-0.2103	-0.3095	-0.3589	-0.3483	-0.2717	-0.1406	-0.0294	-0.0822	-0.0783	-1.5186
112.5	-0.2177	0.1868	0.3410	0.3985	0.4266	0.4453	0.4574	0.4627	0.4601	0.4374	0.3438	0.0737	-0.4604	4.2175
135.0	-0.2874	0.1020	0.2690	0.3826	0.4874	0.5708	0.6094	0.5899	0.5157	0.4003	0.2418	-0.0315	-0.6528	4.9145
157.5	-0.2128	0.0050	0.0586	0.0633	0.0668	0.0714	0.0651	0.0425	0.0125	-0.0098	-0.0291	-0.1196	-0.4798	1.4382
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	INSIDE AXIAL STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	0.2957	-0.1833	-0.1089	-0.0410	-0.0102	0.0033	0.0019	-0.0164	-0.0539	-0.1239	-0.2841	-0.4832	0.5590	0.4515	
45.0	0.4648	-0.3165	-0.2493	-0.1612	-0.1259	-0.1172	-0.1318	-0.1732	-0.2452	-0.3721	-0.6392	-0.8894	0.8818	0.1310	
67.5	0.3486	-0.3408	-0.3733	-0.3625	-0.3880	-0.4290	-0.4815	-0.5477	-0.6308	-0.7586	-0.9993	-1.1089	0.6717	-1.2383	
90.0	-0.1335	-0.2482	-0.3202	-0.4295	-0.5580	-0.6767	-0.7760	-0.8534	-0.9098	-0.9683	-1.0720	-1.0762	-0.2612	-1.8553	
112.5	-0.7257	-0.1910	-0.0807	-0.1677	-0.3078	-0.4378	-0.5368	-0.5981	-0.6230	-0.6370	-0.7104	-0.9534	-1.5346	0.3228	
135.0	-0.9580	-0.3184	0.0003	0.0877	0.0744	0.0346	-0.0034	-0.0329	-0.0619	-0.1315	-0.3533	-0.9461	-2.1761	2.3904	
157.5	-0.7093	-0.3631	-0.0979	0.0499	0.1209	0.1526	0.1627	0.1544	0.1169	0.0146	-0.2318	-0.7434	-1.5993	1.4732	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

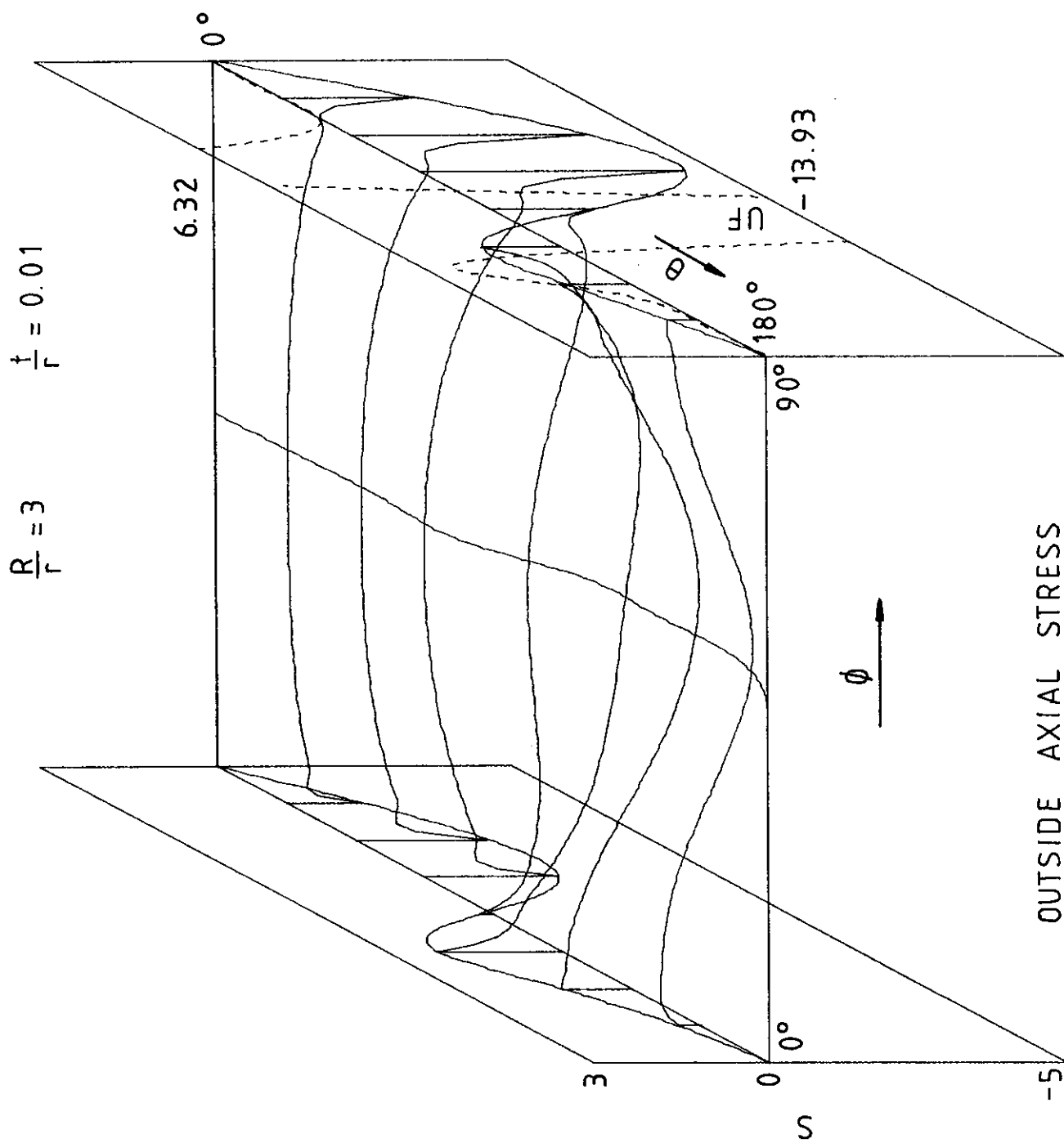
Theta	Phi=0.0	INSIDE SHEAR STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos	
0.0	-0.2523	-0.0885	-0.1402	-0.1811	-0.2087	-0.2349	-0.2640	-0.2983	-0.3404	-0.3980	-0.5001	-0.6473	-0.3230	-0.0075	
22.5	-0.3043	-0.1553	-0.1798	-0.2070	-0.2277	-0.2496	-0.2752	-0.3052	-0.3406	-0.3866	-0.4636	-0.5522	-0.2383	-0.0659	
45.0	-0.4445	-0.3680	-0.3299	-0.3148	-0.3086	-0.3089	-0.3135	-0.3187	-0.3207	-0.3183	-0.3087	-0.2445	-0.0104	-0.3136	
67.5	-0.6168	-0.7074	-0.6357	-0.5635	-0.5019	-0.4444	-0.3845	-0.3150	-0.2282	-0.1161	0.0413	0.2589	0.2688	-0.8253	
90.0	-0.7254	-1.0008	-0.9954	-0.9059	-0.7839	-0.6372	-0.4662	-0.2691	-0.0445	0.2084	0.4878	0.7122	0.4392	-1.2883	
112.5	-0.6908	-0.9578	-1.0611	-1.0351	-0.9154	-0.7258	-0.4842	-0.2072	0.0858	0.3694	0.6010	0.6728	0.3561	-1.0205	
135.0	-0.5215	-0.5398	-0.6039	-0.6332	-0.5995	-0.5067	-0.3727	-0.2212	-0.0792	0.0260	0.0726	0.0580	0.0278	-0.2154	
157.5	-0.2838	-0.0610	0.0451	0.0559	0.0060	-0.0817	-0.1951	-0.3264	-0.4656	-0.5927	-0.6677	-0.6233	-0.3848	0.0074	
180.0	-0.1482	0.1586	0.3448	0.3899	0.3107	0.1343	-0.1094	-0.3874	-0.6609	-0.8810	-0.9856	-0.9051	-0.5939	-0.1239	

		DIAMETER EXPANSION FACTORS												Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
135.0	0.0	-0.783	-2.025	-3.246	-4.319	-5.127	-5.579	-5.611	-5.189	-4.322	-3.044	-1.354	0.0	-36.739	



OUTSIDE HOOP STRESS

FIGURE A9



OUTSIDE AXIAL STRESS

FIGURE A10

TABLE A9

$$R/r = 3.0 \quad t/r = 0.01$$

Theta	Phi=0.0	OUTSIDE HOOP STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	-0.3962	0.0798	0.0473	0.0281	0.0176	0.0129	0.0129	0.0176	0.0284	0.0478	0.0812	0.1371	-0.6712	-0.1702	
45.0	-0.6878	0.1168	0.0516	0.0059	-0.0221	-0.0361	-0.0383	-0.0289	-0.0054	0.0374	0.1071	0.2101	-1.1955	-1.7189	
67.5	-0.6860	0.1911	0.2260	0.2300	0.2184	0.2047	0.1983	0.2044	0.2241	0.2531	0.2793	0.2826	-1.3472	8.7159	
90.0	0.0643	-0.0437	0.0518	0.1814	0.2941	0.3722	0.4144	0.4195	0.3787	0.2825	0.1393	0.0010	-0.5389	4.4266	
112.5	0.6354	-0.0615	-0.3240	-0.4973	-0.5623	-0.5703	-0.5776	-0.6103	-0.6513	-0.6420	-0.5106	-0.2455	0.3944	-13.4215	
135.0	0.3536	0.3626	0.2745	0.0713	-0.1725	-0.3776	-0.4983	-0.5122	-0.4095	-0.2105	0.0129	0.1623	0.3442	0.7076	
157.5	0.1150	0.3058	0.2517	0.1154	-0.0966	-0.3149	-0.4419	-0.4205	-0.2753	-0.0883	0.0674	0.1690	0.1592	-0.1053	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	OUTSIDE AXIAL STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	-1.3207	-0.3208	-0.1862	-0.1147	-0.0779	-0.0627	-0.0638	-0.0813	-0.1200	-0.1918	-0.3205	-0.5546	-2.2372	0.0396	
45.0	-2.2925	-0.6183	-0.3746	-0.2393	-0.1681	-0.1396	-0.1448	-0.1841	-0.2667	-0.4139	-0.6662	-1.1006	-3.9850	0.8418	
67.5	-2.2868	-0.7741	-0.4525	-0.2329	-0.1013	-0.0424	-0.0465	-0.1145	-0.2609	-0.5140	-0.9135	-1.5081	-4.4906	6.3149	
90.0	0.2144	-0.6722	-0.8107	-0.7738	-0.6912	-0.6360	-0.6474	-0.7464	-0.9395	-1.2094	-1.4925	-1.6467	-1.7962	-10.5093	
112.5	2.1181	0.4979	-0.1589	-0.5932	-0.8406	-0.9889	-1.1137	-1.2445	-1.3501	-1.3386	-1.0791	-0.4691	1.3147	-3.9508	
135.0	1.1787	1.0022	0.6294	0.0951	-0.4421	-0.8675	-1.1238	-1.1797	-1.0105	-0.6209	-0.0910	0.4099	1.1472	1.6324	
157.5	0.3834	0.6583	0.5287	0.2266	-0.2097	-0.6389	-0.8896	-0.8632	-0.5919	-0.2110	0.1334	0.3662	0.5308	0.1177	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	OUTSIDE SHEAR STRESS FACTORS													Unflanged x cos
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0		
0.0	-0.0277	-0.1111	-0.1910	-0.2373	-0.2658	-0.2858	-0.3033	-0.3236	-0.3528	-0.3995	-0.4784	-0.6156	-0.7575	-0.5154	
22.5	-0.1545	-0.1868	-0.2366	-0.2670	-0.2862	-0.2997	-0.3117	-0.3257	-0.3458	-0.3777	-0.4302	-0.5173	-0.5732	-0.5420	
45.0	-0.5151	-0.4241	-0.3870	-0.3665	-0.3539	-0.3447	-0.3367	-0.3279	-0.3163	-0.2984	-0.2671	-0.2080	-0.0471	-0.7079	
67.5	-0.9981	-0.8270	-0.6801	-0.5763	-0.4996	-0.4378	-0.3802	-0.3153	-0.2302	-0.1087	0.0701	0.3362	0.6908	-1.0807	
90.0	-1.0613	-1.0261	-0.9160	-0.8055	-0.6904	-0.5674	-0.4311	-0.2740	-0.0876	0.1358	0.4032	0.7231	0.9939	0.2661	
112.5	-0.5316	-0.7795	-0.8679	-0.8532	-0.7658	-0.6209	-0.4319	-0.2149	0.0119	0.2292	0.4114	0.5111	0.3992	0.4008	
135.0	-0.2695	-0.3932	-0.5534	-0.6380	-0.6273	-0.5354	-0.3890	-0.2213	-0.0699	0.0239	0.0226	-0.0817	-0.2046	-0.6680	
157.5	-0.2972	-0.2035	-0.1453	-0.1446	-0.1828	-0.2356	-0.2944	-0.3614	-0.4406	-0.5253	-0.5876	-0.5944	-0.5505	-0.9159	
180.0	-0.3577	-0.1796	-0.0020	0.1118	0.1150	-0.0094	-0.2318	-0.4897	-0.7101	-0.8347	-0.8474	-0.7719	-0.6595	-1.0295	

DIAMETER EXPANSION FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
45.0	0.0	2.242	4.992	8.542	12.169	15.065	16.626	16.522	14.711	11.514	7.640	3.939	0.0	378.281

TABLE A10

R/r = 3.0 $t/r = 0.01$

Theta	Phi=0.0	INSIDE HOOP STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0518	0.0704	0.0405	0.0255	0.0184	0.0159	0.0164	0.0200	0.0278	0.0428	0.0707	0.1231	0.0787	0.0963
45.0	0.0694	0.1189	0.0940	0.0870	0.0866	0.0887	0.0924	0.0980	0.1068	0.1217	0.1499	0.2086	0.1005	1.5154
67.5	0.0169	-0.0194	-0.1163	-0.1614	-0.1737	-0.1699	-0.1608	-0.1509	-0.1390	-0.1152	-0.0598	0.0572	0.0110	-9.7353
90.0	-0.1285	0.0459	-0.0652	-0.2114	-0.3341	-0.4174	-0.4625	-0.4691	-0.4273	-0.3239	-0.1640	-0.0019	-0.2452	-5.0099
112.5	0.0676	0.2102	0.3496	0.4271	0.4246	0.3832	0.3507	0.3512	0.3730	0.3709	0.2916	0.1348	-0.1679	14.7163
135.0	0.3027	0.1908	0.0324	-0.0605	-0.0939	-0.1058	-0.1185	-0.1393	-0.1670	-0.1796	-0.1249	0.0311	0.0907	-0.1539
157.5	0.2480	0.2351	0.1623	0.0400	-0.0876	-0.1846	-0.2425	-0.2585	-0.2188	-0.1172	0.0157	0.1260	0.1181	0.3776
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	INSIDE AXIAL STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	0.1725	-0.3238	-0.1900	-0.1177	-0.0803	-0.0649	-0.0661	-0.0841	-0.1238	-0.1971	-0.3278	-0.5610	0.2624	0.0752	
45.0	0.2315	-0.6132	-0.3666	-0.2227	-0.1452	-0.1132	-0.1174	-0.1580	-0.2448	-0.3996	-0.6626	-1.0986	0.3351	1.5993	
67.5	0.0564	-0.8022	-0.5536	-0.3640	-0.2411	-0.1818	-0.1840	-0.2523	-0.4000	-0.6490	-1.0250	-1.5399	0.0368	0.7907	
90.0	-0.4285	-0.5252	-0.7298	-0.7933	-0.8003	-0.8082	-0.8543	-0.9574	-1.1163	-1.3058	-1.4690	-1.4980	-0.8173	-10.1122	
112.5	0.2255	0.5535	0.1089	-0.2086	-0.4356	-0.6064	-0.7430	-0.8500	-0.9107	-0.8862	-0.7160	-0.3192	-0.5596	5.9333	
135.0	1.0089	0.8287	0.4431	0.0165	-0.3675	-0.6651	-0.8512	-0.9072	-0.8183	-0.5755	-0.1902	0.2804	0.3022	1.5898	
157.5	0.8267	0.5471	0.4014	0.1273	-0.2013	-0.4910	-0.6623	-0.6706	-0.5155	-0.2456	0.0519	0.2922	0.3937	0.4209	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	INSIDE SHEAR STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.0274	-0.0892	-0.1733	-0.2228	-0.2545	-0.2777	-0.2987	-0.3229	-0.3563	-0.4079	-0.4928	-0.6382	-0.7499	-0.1920
22.5	-0.1530	-0.1645	-0.2175	-0.2511	-0.2737	-0.2910	-0.3071	-0.3254	-0.3503	-0.3875	-0.4461	-0.5405	-0.5675	-0.2025
45.0	-0.5099	-0.3917	-0.3557	-0.3409	-0.3350	-0.3328	-0.3318	-0.3306	-0.3272	-0.3181	-0.2956	-0.2415	-0.0467	-0.1988
67.5	-0.9882	-0.8000	-0.6287	-0.5233	-0.4566	-0.4100	-0.3699	-0.3245	-0.2603	-0.1579	0.0128	0.2987	0.6839	-0.7607
90.0	-1.0507	-1.1912	-1.0355	-0.8627	-0.7045	-0.5642	-0.4288	-0.2757	-0.0792	0.1830	0.5192	0.9067	0.9841	-1.7926
112.5	-0.5263	-0.7760	-0.9730	-1.0049	-0.9047	-0.7142	-0.4644	-0.1769	0.1230	0.3929	0.5669	0.5720	0.3952	-0.2307
135.0	-0.2668	-0.3124	-0.4874	-0.6419	-0.6882	-0.5949	-0.3957	-0.1671	0.0033	0.0525	-0.0230	-0.1557	-0.2026	-0.1647
157.5	-0.2942	-0.1822	-0.0929	-0.0558	-0.0855	-0.1638	-0.2676	-0.3872	-0.5118	-0.6115	-0.6523	-0.6317	-0.5451	-0.3418
180.0	-0.3541	-0.1664	0.0664	0.2301	0.2575	0.1046	-0.1993	-0.5479	-0.8188	-0.9448	-0.9311	-0.8168	-0.6529	-0.3836

DIAMETER EXPANSION FACTORS														
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged
Theta	Phi=0.0	-2.242	-4.992	-8.542	-12.169	-15.065	-16.626	-16.522	-14.711	-11.514	-7.640	-3.939	0.0	x sin
135.0	0.0													-378.281

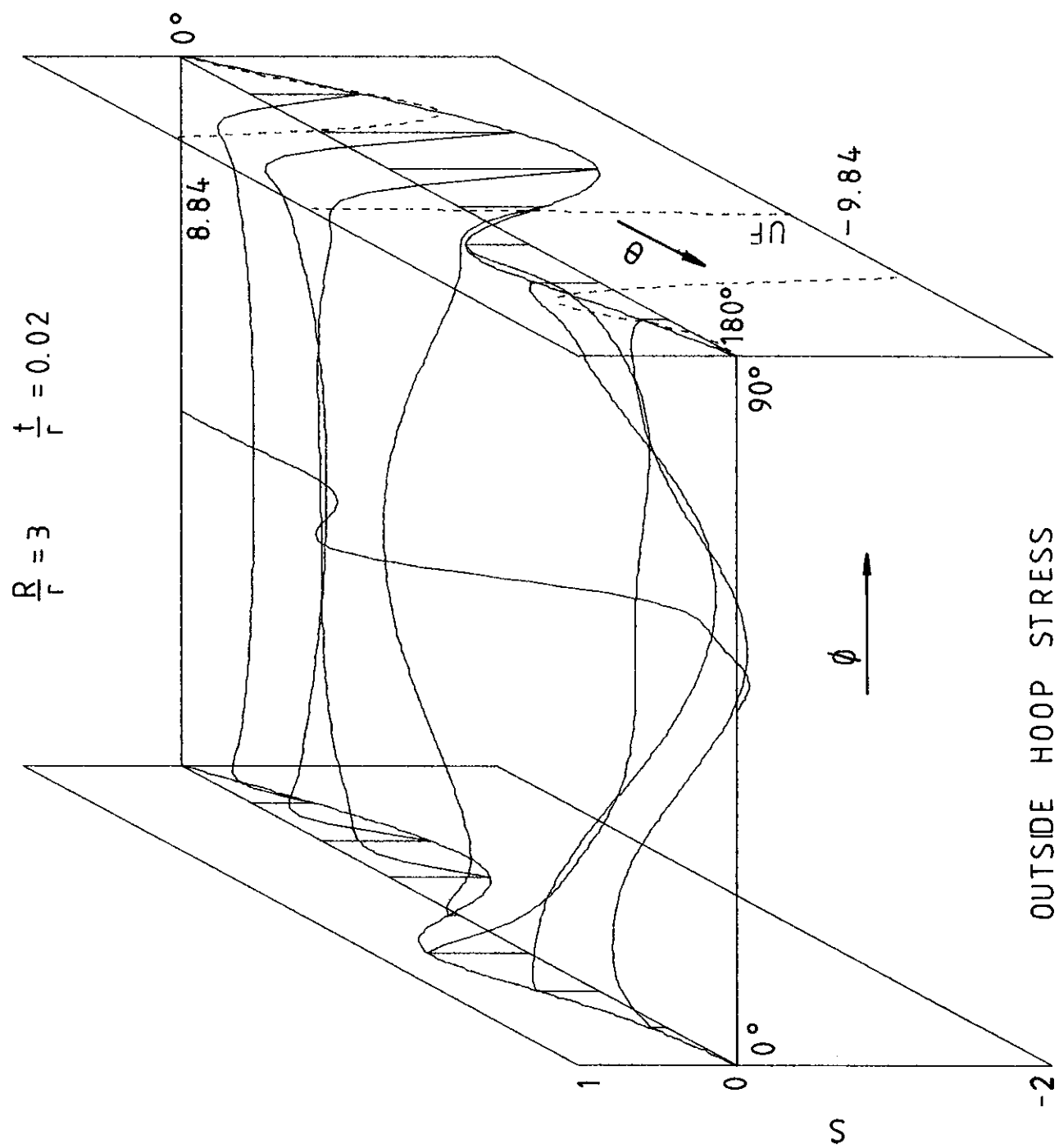
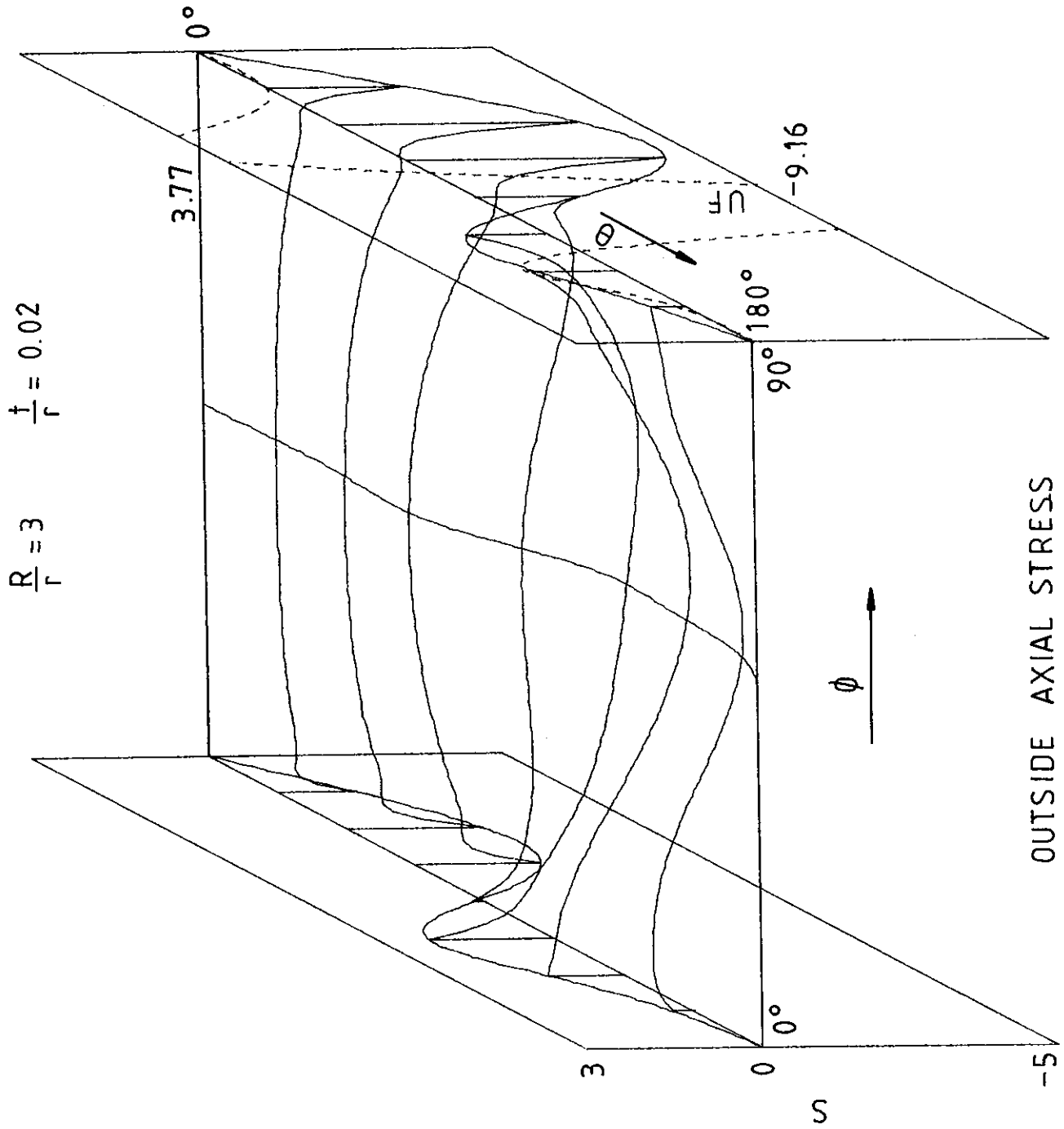


FIGURE A11



OUTSIDE AXIAL STRESS

FIGURE A12

TABLE A11

$$R/r = 3.0 \quad t/r = 0.02$$

Theta	Phi=0.0	OUTSIDE HOOP STRESS FACTORS										Unflanged			
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	-0.4000	0.0757	0.0284	0.0006	-0.0154	-0.0228	-0.0237	-0.0181	-0.0046	0.0202	0.0627	0.1370	-0.6860	-0.6920	
45.0	-0.6961	0.1543	0.0832	0.0299	-0.0100	-0.0347	-0.0432	-0.0341	-0.0042	0.0504	0.1325	0.2570	-1.2273	-0.0363	
67.5	-0.6364	0.2409	0.3340	0.3953	0.4214	0.4293	0.4340	0.4431	0.4539	0.4538	0.4233	0.3733	-1.3196	7.5629	
90.0	0.0682	-0.0747	0.0141	0.1581	0.3021	0.4120	0.4723	0.4739	0.4099	0.2820	0.1157	-0.0109	-0.5310	2.4541	
112.5	0.6429	-0.1509	-0.4324	-0.6109	-0.6749	-0.6799	-0.6850	-0.7185	-0.7620	-0.7549	-0.6227	-0.3378	0.4020	-9.8090	
135.0	0.3906	0.3770	0.2307	-0.0431	-0.3406	-0.5820	-0.7238	-0.7429	-0.6273	-0.3904	-0.0969	0.1404	0.4169	-1.3379	
157.5	0.1075	0.3337	0.3238	0.1829	-0.0714	-0.3395	-0.4957	-0.4684	-0.2847	-0.0497	0.1250	0.2024	0.1735	0.2965	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	OUTSIDE AXIAL STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-1.3335	-0.3081	-0.1789	-0.1140	-0.0817	-0.0693	-0.0717	-0.0889	-0.1256	-0.1931	-0.3145	-0.5446	-2.2868	0.0152
45.0	-2.3203	-0.5579	-0.2967	-0.1522	-0.0775	-0.0485	-0.0538	-0.0927	-0.1748	-0.3238	-0.5830	-1.0363	-4.0909	1.9981
67.5	-2.1214	-0.7385	-0.4304	-0.2000	-0.0504	0.0253	0.0326	0.0319	-0.1840	-0.4508	-0.8653	-1.4506	-4.3987	3.1057
90.0	0.2273	-0.6915	-0.8351	-0.8219	-0.7510	-0.6981	-0.7095	-0.8100	-1.0029	-1.2632	-1.5220	-1.6493	-1.7701	-6.9813
112.5	2.1430	0.3234	-0.2939	-0.7362	-1.0052	-1.1761	-1.3133	-1.4424	-1.5337	-1.5052	-1.2404	-0.6761	1.3399	-5.4215
135.0	1.3021	1.0617	0.6639	0.1074	-0.4407	-0.8791	-1.1483	-1.2118	-1.0477	-0.6611	-0.1132	0.4095	1.3896	1.5641
157.5	0.3584	0.6876	0.5851	0.2773	-0.1859	-0.6387	-0.9031	-0.8793	-0.5934	-0.1820	0.1817	0.3834	0.5783	0.2618
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE SHEAR STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos	
0.0	-0.0774	-0.1297	-0.2059	-0.2485	-0.2739	-0.2908	-0.3052	-0.3223	-0.3480	-0.3909	-0.4650	-0.5979	-0.6873	-0.5112	
22.5	-0.1961	-0.2049	-0.2518	-0.2783	-0.2941	-0.3045	-0.3134	-0.3242	-0.3409	-0.3689	-0.4166	-0.5007	-0.5135	-0.5537	
45.0	-0.5358	-0.4530	-0.4139	-0.3871	-0.3679	-0.3528	-0.3392	-0.3247	-0.3064	-0.2804	-0.2403	-0.1778	-0.0131	-0.7704	
67.5	-0.9442	-0.8186	-0.6921	-0.5986	-0.5221	-0.4541	-0.3864	-0.3098	-0.2138	-0.0862	0.0886	0.3369	0.6381	-0.8647	
90.0	-0.9772	-0.9459	-0.8592	-0.7755	-0.6800	-0.5658	-0.4306	-0.2739	-0.0953	0.1077	0.3431	0.6306	0.8737	0.0796	
112.5	-0.5580	-0.7425	-0.7896	-0.7673	-0.6953	-0.5778	-0.4219	-0.2411	-0.0510	0.1366	0.3108	0.4411	0.3927	0.3675	
135.0	-0.3017	-0.4472	-0.5608	-0.5924	-0.5568	-0.4795	-0.3776	-0.2603	-0.1388	-0.0362	0.0086	-0.0443	-0.1849	-0.5865	
157.5	-0.3121	-0.2320	-0.2053	-0.2134	-0.2346	-0.2649	-0.3053	-0.3530	-0.4046	-0.4612	-0.5190	-0.5493	-0.5273	-0.9399	
180.0	-0.3513	-0.1919	-0.0521	0.0096	-0.0212	-0.1198	-0.2590	-0.4221	-0.5899	-0.7235	-0.7762	-0.7298	-0.6441	-1.0314	

DIAMETER EXPANSION FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
45.0	0.0	2.368	5.253	8.721	12.083	14.702	16.114	16.051	14.463	11.558	7.843	4.053	0.0	197.272

TABLE A12

R/r = 3.0 t/r = 0.02

Theta	Phi=0.0	INSIDE HOOP STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0710	0.0780	0.0553	0.0502	0.0492	0.0497	0.0513	0.0540	0.0589	0.0678	0.0855	0.1344	0.1091	0.6230
45.0	0.1089	0.0856	0.0489	0.0520	0.0650	0.0788	0.0894	0.0954	0.0974	0.0991	0.1124	0.1839	0.1626	-0.2434
67.5	0.0402	-0.0742	-0.2519	-0.3559	-0.4060	-0.4233	-0.4252	-0.4191	-0.3996	-0.3479	-0.2357	-0.0167	0.0627	-8.4746
90.0	-0.1418	0.0939	-0.0236	-0.1951	-0.3591	-0.4814	-0.5485	-0.5524	-0.4838	-0.3400	-0.1449	0.0447	-0.2411	-2.8933
112.5	-0.0301	0.3039	0.4839	0.5741	0.5621	0.5052	0.4637	0.4680	0.5036	0.5145	0.4305	0.2496	-0.2818	10.8135
135.0	0.2710	0.1370	0.0490	0.0662	0.1215	0.1652	0.1812	0.1657	0.1124	0.0288	-0.0351	0.0308	0.0125	1.9971
157.5	0.2408	0.1676	0.0501	-0.0637	-0.1055	-0.0938	-0.0897	-0.1285	-0.1805	-0.1761	-0.0781	0.0759	0.0846	-0.0281
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	INSIDE AXIAL STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.2367	-0.3036	-0.1749	-0.1040	-0.0681	-0.0540	-0.0563	-0.0746	-0.1140	-0.1865	-0.3162	-0.5414	0.3637	0.3491
45.0	0.3631	-0.5729	-0.3196	-0.1651	-0.0787	-0.0407	-0.0419	-0.0826	-0.1733	-0.3365	-0.6124	-1.0581	0.5420	1.7025
67.5	0.1340	-0.7690	-0.5801	-0.4254	-0.3156	-0.2583	-0.2596	-0.3280	-0.4749	-0.7140	-1.0588	-1.5205	0.2089	-1.3163
90.0	-0.4727	-0.4344	-0.6643	-0.7677	-0.8193	-0.8616	-0.9253	-1.0254	-1.1590	-1.3027	-1.4118	-1.4062	-0.8038	-6.0262
112.5	-0.1004	0.5214	0.1029	-0.1956	-0.4383	-0.6337	-0.7829	-0.8806	-0.9154	-0.8679	-0.7069	-0.3344	-0.9394	2.5050
135.0	0.9034	0.7648	0.4324	0.1041	-0.1943	-0.4361	-0.5955	-0.6522	-0.5973	-0.4300	-0.1533	0.2535	0.0417	2.8067
157.5	0.8026	0.4529	0.2910	0.0512	-0.1796	-0.3575	-0.4661	-0.4958	-0.4315	-0.2661	-0.0269	0.2208	0.2820	0.3097
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	INSIDE SHEAR STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.0759	-0.0916	-0.1726	-0.2209	-0.2520	-0.2751	-0.2962	-0.3207	-0.3545	-0.4063	-0.4914	-0.6352	-0.6737	-0.1895
22.5	-0.1922	-0.1605	-0.2124	-0.2462	-0.2694	-0.2875	-0.3044	-0.3238	-0.3500	-0.3888	-0.4493	-0.5445	-0.5033	-0.1801
45.0	-0.5252	-0.3828	-0.3435	-0.3283	-0.3242	-0.3249	-0.3275	-0.3305	-0.3318	-0.3274	-0.3079	-0.2538	-0.0129	-0.2421
67.5	-0.9255	-0.8173	-0.6406	-0.5271	-0.4546	-0.4062	-0.3676	-0.3244	-0.2602	-0.1535	0.0258	0.3186	0.6255	-0.8576
90.0	-0.9579	-1.1802	-1.0379	-0.8771	-0.7216	-0.5774	-0.4342	-0.2717	-0.0667	0.1988	0.5288	0.9060	0.8564	-1.4623
112.5	-0.5469	-0.7967	-0.9844	-1.0148	-0.9173	-0.7262	-0.4706	-0.1760	0.1282	0.4003	0.5816	0.6079	0.3849	-0.5080
135.0	-0.2957	-0.2704	-0.4742	-0.6348	-0.6807	-0.5896	-0.3953	-0.1709	-0.0008	0.0319	-0.0265	-0.1884	-0.1813	-0.0927
157.5	-0.3059	-0.1786	-0.0741	-0.0399	-0.0736	-0.1527	-0.2587	-0.3812	-0.5087	-0.6170	-0.6696	-0.6451	-0.5169	-0.3319
180.0	-0.3444	-0.1866	0.0579	0.2411	0.2770	0.1217	-0.1867	-0.5430	-0.8250	-0.9527	-0.9241	-0.7999	-0.6314	-0.3800

Theta	Phi=0.0	DIAMETER EXPANSION FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
135.0	0.0	-2.368	-5.253	-8.721	-12.083	-14.702	-16.114	-16.051	-14.463	-11.558	-7.843	-4.053	0.0	-197.272

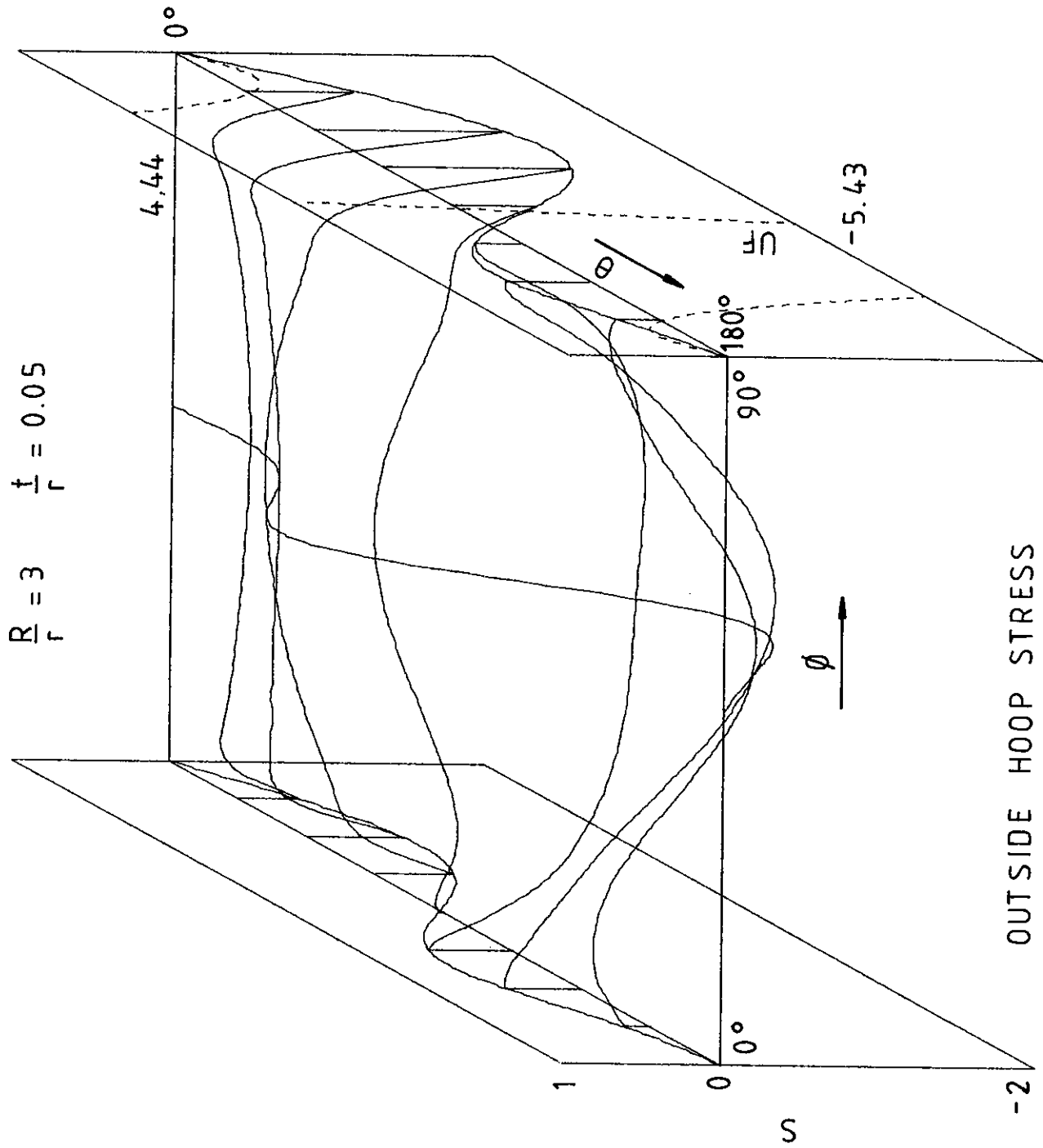
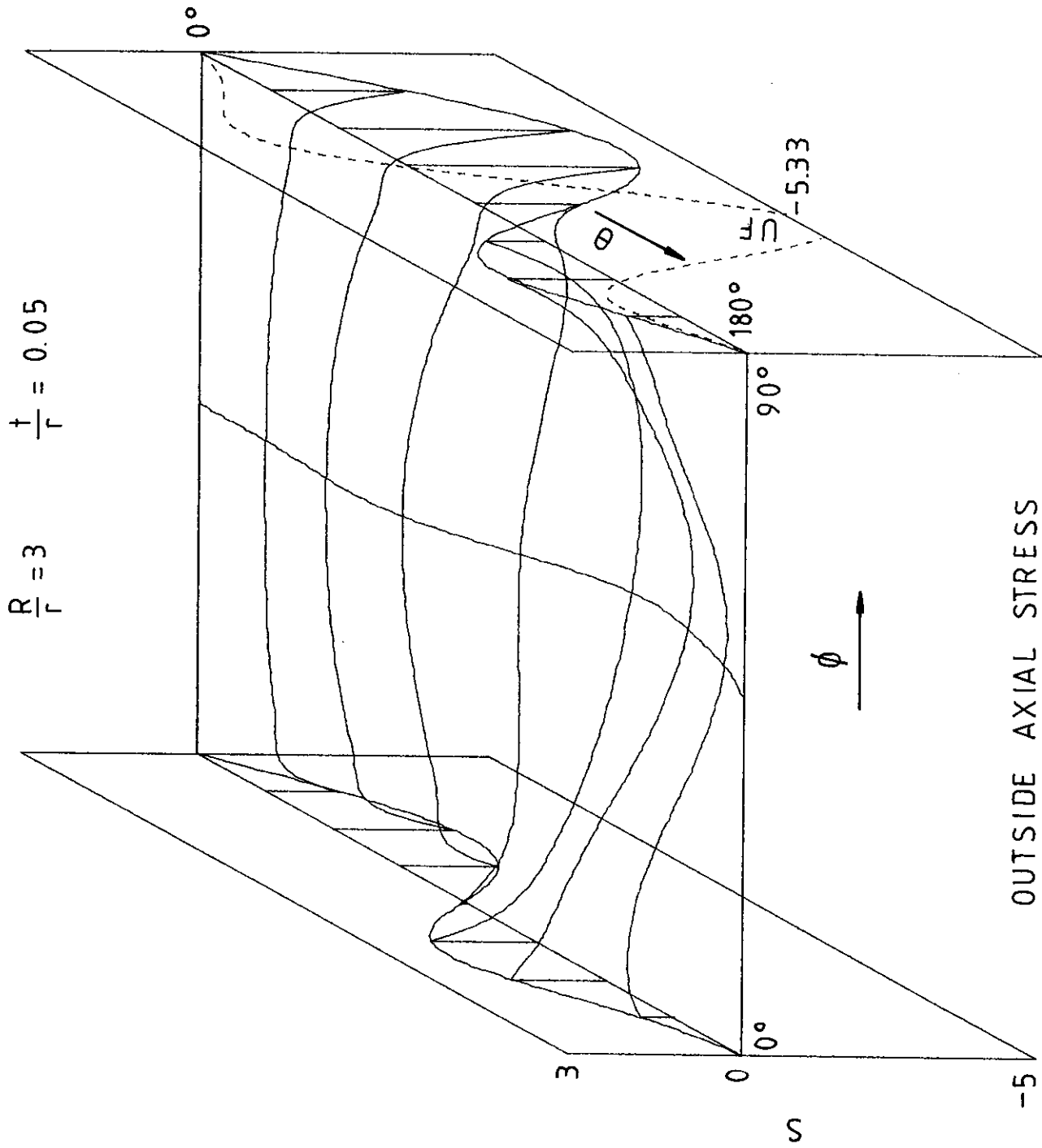


FIGURE A13



OUTSIDE AXIAL STRESS

FIGURE A14

TABLE A13

R/r = 3.0 t/r = 0.05

OUTSIDE HOOP STRESS FACTORS														Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	-0.3871	0.1158	0.0519	0.0109	-0.0230	-0.0461	-0.0559	-0.0500	-0.0264	0.0166	0.0783	0.1977	-0.6948	-0.0802	
45.0	-0.6234	0.2376	0.2348	0.2320	0.2177	0.2033	0.1988	0.2102	0.2380	0.2765	0.3158	0.3947	-1.1898	1.9281	
67.5	-0.4993	0.2117	0.3563	0.4948	0.6015	0.6751	0.7178	0.7294	0.7052	0.6365	0.5197	0.3923	-1.1928	4.4222	
90.0	0.0436	-0.0647	-0.0417	0.0935	0.2508	0.3857	0.4614	0.4571	0.3715	0.2246	0.0606	-0.0146	-0.5390	1.0233	
112.5	0.5448	-0.1100	-0.4397	-0.6065	-0.6956	-0.7358	-0.7618	-0.7899	-0.8075	-0.7768	-0.6507	-0.2914	0.2918	-5.0286	
135.0	0.4879	0.2788	-0.0112	-0.3512	-0.7061	-0.9993	-1.1739	-1.1960	-1.0571	-0.7818	-0.4274	0.0350	0.5307	-3.4837	
157.5	0.1683	0.3635	0.3266	0.1210	-0.1778	-0.4611	-0.6290	-0.6257	-0.4590	-0.2004	0.0454	0.2376	0.2723	-0.0922	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

OUTSIDE AXIAL STRESS FACTORS														Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	-1.2904	-0.1824	-0.0898	-0.0160	0.0177	0.0295	0.0267	0.0108	-0.0233	-0.0891	-0.2184	-0.3669	-2.3160	0.7824	
45.0	-2.0782	-0.3785	-0.1778	-0.0028	0.0995	0.1509	0.1598	0.1253	0.0361	-0.1315	-0.4270	-0.7502	-3.9661	1.8182	
67.5	-1.6643	-0.6241	-0.4543	-0.2507	-0.0965	-0.0008	0.0228	-0.0386	-0.1981	-0.4679	-0.8687	-1.2287	-3.9759	0.4362	
90.0	0.1452	-0.6244	-0.8087	-0.8425	-0.8096	-0.8391	-0.9379	-1.1063	-1.3174	-1.5255	-1.5133	-1.7968	-4.1297	-4.1297	
112.5	1.8161	0.1119	-0.4360	-0.8475	-1.1591	-1.3911	-1.5650	-1.6846	-1.7313	-1.6630	-1.4328	-0.8889	0.9727	-4.5894	
135.0	1.6265	0.9436	0.4856	-0.0643	-0.6140	-1.0678	-1.3582	-1.4396	-1.2934	-0.9327	-0.4269	0.2037	1.7688	-0.4152	
157.5	0.5609	0.8052	0.6565	0.2927	-0.1642	-0.5712	-0.8155	-0.8331	-0.6204	-0.2444	0.1534	0.4699	0.9076	0.7363	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

OUTSIDE SHEAR STRESS FACTORS														Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos	
0.0	-0.1901	-0.1941	-0.2510	-0.2799	-0.2945	-0.3027	-0.3094	-0.3187	-0.3354	-0.3667	-0.4250	-0.5354	-0.5314	-0.5451	
22.5	-0.2924	-0.2809	-0.3082	-0.3201	-0.3226	-0.3214	-0.3194	-0.3189	-0.3225	-0.3344	-0.3630	-0.4190	-0.3764	-0.6116	
45.0	-0.5544	-0.5088	-0.4739	-0.4446	-0.4148	-0.3838	-0.3508	-0.3147	-0.2741	-0.2275	-0.1742	-0.0977	0.0349	-0.7361	
67.5	-0.8126	-0.7340	-0.6703	-0.6114	-0.5504	-0.4795	-0.3963	-0.3008	-0.1932	-0.0707	0.0755	0.2662	0.4930	-0.6284	
90.0	-0.8354	-0.7730	-0.7366	-0.6847	-0.6208	-0.5337	-0.4220	-0.2905	-0.1450	0.0145	0.1992	0.4025	0.6515	-0.1126	
112.5	-0.6025	-0.6735	-0.6575	-0.6117	-0.5527	-0.4830	-0.4007	-0.3023	-0.1840	-0.0418	0.1231	0.2728	0.3565	0.1426	
135.0	-0.3906	-0.5407	-0.5385	-0.4994	-0.4443	-0.3980	-0.3617	-0.3198	-0.2541	-0.1606	-0.0640	-0.0033	-0.1194	-0.3942	
157.5	-0.3405	-0.3391	-0.3404	-0.3489	-0.3486	-0.3416	-0.3322	-0.3248	-0.3240	-0.3369	-0.3676	-0.3909	-0.4732	-0.9429	
180.0	-0.3460	-0.2289	-0.2123	-0.2482	-0.2926	-0.3155	-0.3181	-0.3256	-0.3674	-0.4536	-0.5538	-0.5952	-0.6025	-1.0816	

DIAMETER EXPANSION FACTORS														Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
45.0	0.0	2.124	4.763	7.656	10.379	12.499	13.669	13.674	12.463	10.164	7.082	3.598	0.0	78.281	

TABLE A14

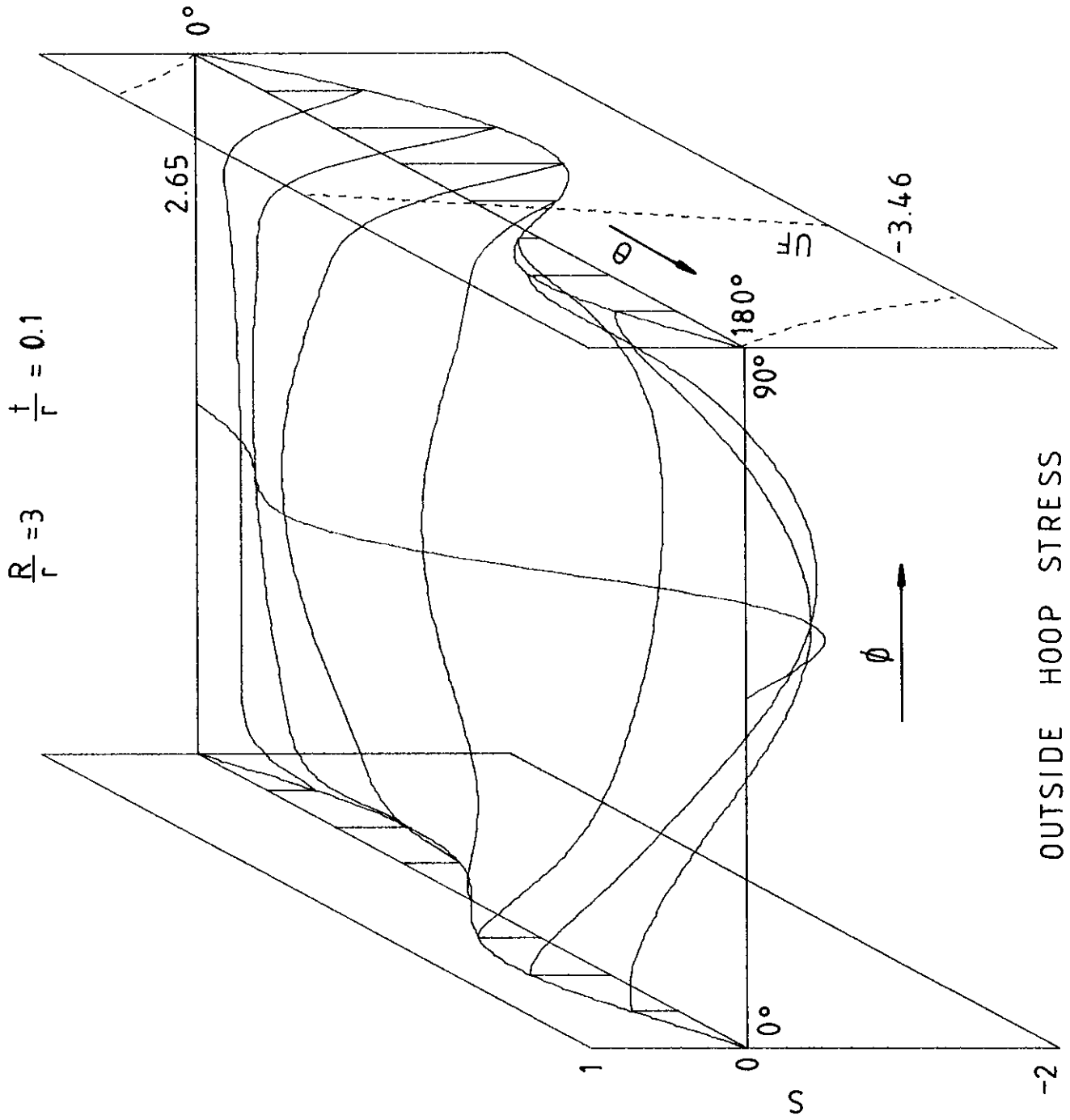
R/r = 3.0 t/r = 0.05

Theta	Phi=0.0	INSIDE HOOP STRESS FACTORS										Unflanged			
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	0.1039	0.0100	0.0143	0.0273	0.0478	0.0661	0.0776	0.0801	0.0734	0.0608	0.0546	0.0520	0.1641	-0.0109	
45.0	0.1482	-0.0714	-0.1494	-0.1932	-0.2010	-0.1941	-0.1862	-0.1835	-0.1830	-0.1714	-0.1186	-0.0394	0.2427	-2.2847	
67.5	0.0579	-0.1001	-0.3158	-0.5057	-0.6426	-0.7308	-0.7745	-0.7737	-0.7199	-0.5981	-0.3862	-0.1441	0.1200	-5.0923	
90.0	-0.1276	0.1660	0.0542	-0.1255	-0.3285	-0.4997	-0.5962	-0.5931	-0.4872	-0.3010	-0.0767	0.0839	-0.2018	-1.3145	
112.5	-0.1372	0.3716	0.5229	0.6223	0.6281	0.5895	0.5593	0.5641	0.5914	0.5911	0.5082	0.3469	-0.3957	5.6401	
135.0	0.1057	0.1753	0.2125	0.3867	0.5860	0.7476	0.8303	0.8106	0.6860	0.4777	0.2531	0.1634	-0.2243	4.1906	
157.5	0.2015	0.0290	-0.1055	-0.0917	0.0413	0.1994	0.2845	0.2446	0.0996	-0.0652	-0.1305	-0.0067	-0.0175	0.3942	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	INSIDE AXIAL STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	0.3462	-0.3024	-0.1120	-0.0303	0.0177	0.0405	0.0429	0.0246	-0.0201	-0.1041	-0.2451	-0.5836	0.5471	0.7086	
45.0	0.4939	-0.5773	-0.2933	-0.1579	-0.0682	-0.0208	-0.0151	-0.0558	-0.1523	-0.3214	-0.5811	-1.1533	0.8090	0.4770	
67.5	0.1929	-0.6706	-0.5459	-0.4883	-0.4427	-0.4244	-0.4444	-0.5125	-0.6356	-0.8185	-1.0553	-1.5302	0.4001	-1.7656	
90.0	-0.4252	-0.2983	-0.4930	-0.6461	-0.7659	-0.8716	-0.9683	-1.0579	-1.1390	-1.2057	-1.2314	-1.2932	-0.6725	-2.9510	
112.5	-0.4573	0.3571	0.0619	-0.1956	-0.4173	-0.6091	-0.7547	-0.8411	-0.8626	-0.8172	-0.6759	-0.4784	-1.3191	0.3277	
135.0	0.3522	0.5727	0.3605	0.1683	0.0162	-0.1085	-0.2054	-0.2701	-0.2935	-0.2588	-0.1215	0.0584	-0.7477	2.4311	
157.5	0.6718	0.3174	0.1680	0.0621	0.0070	-0.0206	-0.0477	-0.0871	-0.1265	-0.1301	-0.0478	0.0763	-0.0584	1.0080	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

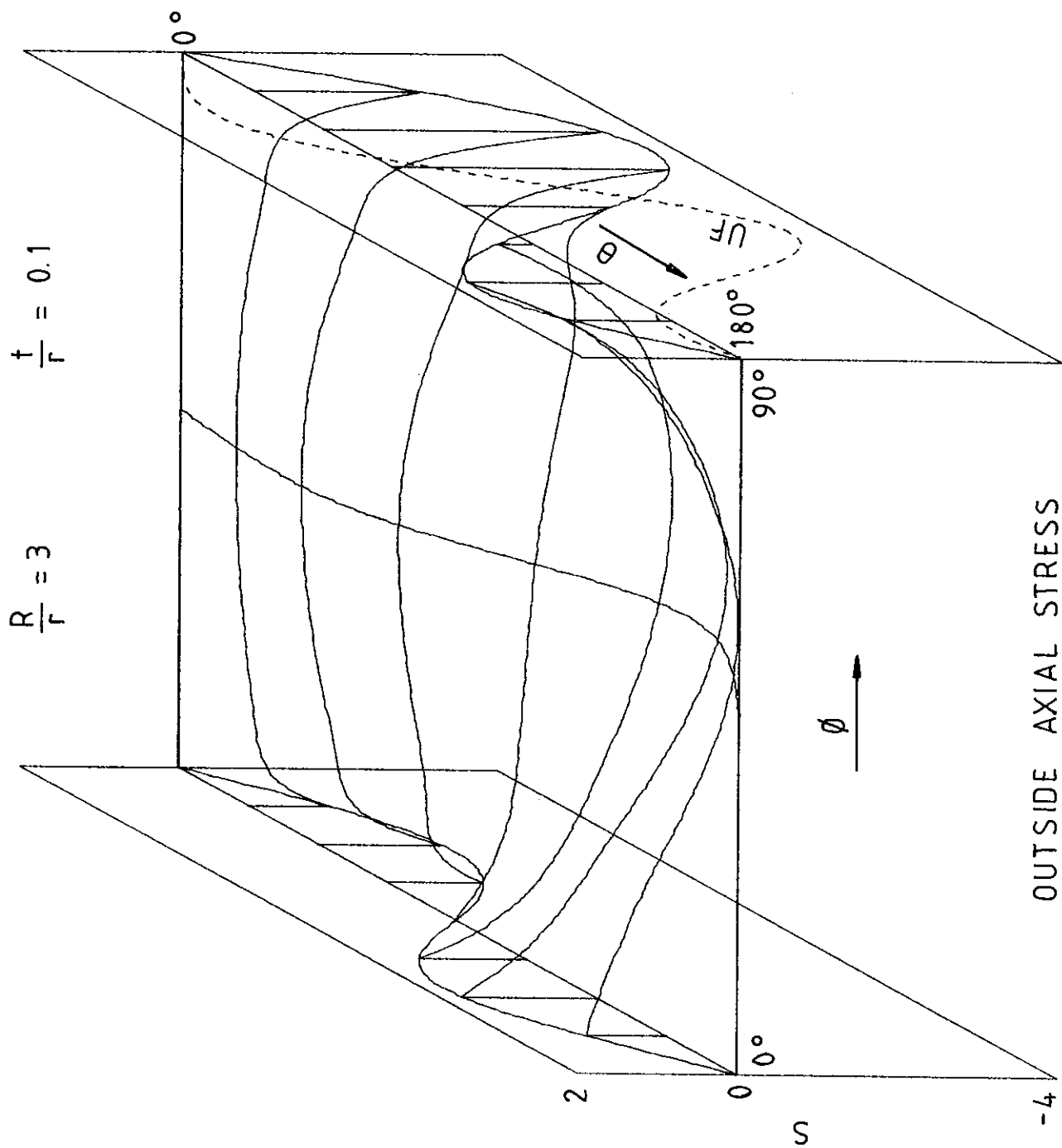
Theta	Phi=0.0	INSIDE SHEAR STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.1809	-0.0709	-0.1612	-0.2075	-0.2394	-0.2641	-0.2874	-0.3146	-0.3518	-0.4079	-0.4956	-0.6683	-0.5055	-0.1435
22.5	-0.2782	-0.1446	-0.1986	-0.2280	-0.2516	-0.2725	-0.2941	-0.3192	-0.3516	-0.3960	-0.4581	-0.5752	-0.3580	-0.1772
45.0	-0.5273	-0.4009	-0.3472	-0.3198	-0.3095	-0.3103	-0.3178	-0.3273	-0.3333	-0.3285	-0.3009	-0.2436	0.0332	-0.3760
67.5	-0.7730	-0.8298	-0.6628	-0.5530	-0.4751	-0.4180	-0.3699	-0.3163	-0.2403	-0.1223	0.0616	0.3555	0.4690	-0.8302
90.0	-0.7947	-1.1100	-1.0053	-0.8851	-0.7522	-0.6068	-0.4451	-0.2598	-0.0425	0.2139	0.5133	0.8651	0.6197	-1.1230
112.5	-0.5731	-0.8276	-0.9733	-0.9928	-0.9044	-0.7247	-0.4761	-0.1872	0.1086	0.3745	0.5714	0.6530	0.3391	-0.7053
135.0	-0.3715	-0.3064	-0.4987	-0.6187	-0.6327	-0.5468	-0.3898	-0.2061	-0.0477	0.0356	0.0083	-0.1272	-0.1136	-0.1959
157.5	-0.3239	-0.1327	-0.0489	-0.0272	-0.0575	-0.1315	-0.2379	-0.3629	-0.4900	-0.6010	-0.6776	-0.6840	-0.4501	-0.2404
180.0	-0.3292	-0.1521	0.1030	0.2566	0.2557	0.1024	-0.1622	-0.4725	-0.7515	-0.9272	-0.9573	-0.8362	-0.5731	-0.3540

DIAMETER EXPANSION FACTORS															Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin		
135.0	0.0	-2.124	-4.763	-7.656	-10.379	-12.499	-13.669	-13.674	-12.463	-10.164	-7.082	-3.598	0.0	-78.281		



OUTSIDE HOOP STRESS

FIGURE A15



OUTSIDE AXIAL STRESS

FIGURE A16

TABLE A15

R/r = 3.0 t/r = 0.1

Theta	Phi=0.0	OUTSIDE HOOP STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.3096	0.1178	0.1640	0.1644	0.1633	0.1609	0.1622	0.1703	0.1855	0.2054	0.2393	0.2042	-0.6325	0.8542
45.0	-0.4707	0.1791	0.3183	0.3841	0.4395	0.4795	0.5065	0.5213	0.5220	0.5049	0.4873	0.3197	-1.0447	2.1075
67.5	-0.3629	0.1183	0.2955	0.4451	0.5871	0.6975	0.7638	0.7772	0.7327	0.6325	0.5089	0.2275	-1.0366	2.5708
90.0	0.0086	-0.0144	-0.0282	0.0533	0.1630	0.2571	0.3103	0.3073	0.2455	0.1403	0.0466	-0.0486	-0.5547	0.4712
112.5	0.4073	0.0024	-0.3246	-0.5030	-0.6227	-0.7084	-0.7644	-0.7903	-0.7806	-0.7190	-0.5526	-0.1928	0.1266	-2.7379
135.0	0.5119	0.2090	-0.1826	-0.5376	-0.8678	-1.1386	-1.3057	-1.3391	-1.2299	-0.9860	-0.6001	-0.0153	0.5101	-3.1872
157.5	0.2990	0.2619	0.0713	-0.1806	-0.4527	-0.6889	-0.8341	-0.8544	-0.7452	-0.5296	-0.2329	0.1380	0.3894	-1.2881
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE AXIAL STRESS FACTORS												Unflanged x sin
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-1.0320	-0.1213	-0.0167	0.0717	0.1323	0.1675	0.1801	0.1682	0.1259	0.0393	-0.0986	-0.2529	-2.1084	0.8181
45.0	-1.5691	-0.3037	-0.1366	0.0225	0.1424	0.2167	0.2432	0.2143	0.1189	-0.0632	-0.3309	-0.6180	-3.4823	0.9854
67.5	-1.2095	-0.5023	-0.4272	-0.3003	-0.1909	-0.1232	-0.1106	-0.1670	-0.3044	-0.5362	-0.8330	-1.0857	-3.4554	-0.3937
90.0	0.0287	-0.4572	-0.6867	-0.7713	-0.8280	-0.8850	-0.9552	-1.0481	-1.1676	-1.3123	-1.4257	-1.3322	-1.8489	-2.7771
112.5	1.3577	0.0794	-0.4668	-0.8383	-1.1600	-1.4281	-1.6278	-1.7470	-1.7760	-1.7073	-1.4925	-0.9067	0.4221	-3.3896
135.0	1.7064	0.7476	0.1773	-0.3242	-0.8053	-1.2094	-1.4839	-1.5927	-1.5172	-1.2617	-0.8245	-0.0294	1.7003	-1.4047
157.5	0.9967	0.7546	0.4451	0.0891	-0.2819	-0.5984	-0.8043	-0.8644	-0.7641	-0.5189	-0.1609	0.3698	1.2981	0.1614
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE SHEAR STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos	
0.0	-0.3226	-0.3412	-0.3424	-0.3511	-0.3459	-0.3349	-0.3222	-0.3108	-0.3040	-0.3080	-0.3390	-0.3450	-0.3405	-0.6185	
22.5	-0.3869	-0.3955	-0.3900	-0.3897	-0.3768	-0.3571	-0.3338	-0.3098	-0.2884	-0.2749	-0.2812	-0.2590	-0.2304	-0.6404	
45.0	-0.5435	-0.5187	-0.5057	-0.4865	-0.4560	-0.4145	-0.3639	-0.3072	-0.2478	-0.1896	-0.1352	-0.0556	0.0469	-0.6494	
67.5	-0.6926	-0.6158	-0.6084	-0.5763	-0.5316	-0.4714	-0.3958	-0.3078	-0.2109	-0.1071	0.0081	0.1240	0.3387	-0.5179	
90.0	-0.7237	-0.6246	-0.6141	-0.5758	-0.5293	-0.4731	-0.4046	-0.3221	-0.2240	-0.1067	0.0346	0.1580	0.4485	-0.2264	
112.5	-0.6157	-0.5910	-0.5478	-0.4945	-0.4490	-0.4146	-0.3845	-0.3463	-0.2852	-0.1884	-0.0545	0.0740	0.2768	-0.0669	
135.0	-0.4739	-0.5562	-0.5062	-0.4518	-0.4080	-0.3808	-0.3650	-0.3466	-0.3090	-0.2407	-0.1438	-0.0473	-0.0713	-0.3595	
157.5	-0.3980	-0.4727	-0.4759	-0.4737	-0.4556	-0.4178	-0.3660	-0.3101	-0.2617	-0.2300	-0.2136	-0.2122	-0.3849	-0.8685	
180.0	-0.3809	-0.4101	-0.4482	-0.4869	-0.4919	-0.4489	-0.3705	-0.2858	-0.2284	-0.2212	-0.2568	-0.3118	-0.5082	-1.0955	

		DIAMETER EXPANSION FACTORS												Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
45.0	0.0	1.414	3.449	5.554	7.500	9.021	9.891	9.958	9.166	7.562	5.297	2.493	0.0	34.391	

TABLE A16

R/r = 3.0 t/r = 0.1

Theta	Phi=0.0	INSIDE HOOP STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.1038	-0.1043	-0.1264	-0.1543	-0.1621	-0.1615	-0.1600	-0.1609	-0.1630	-0.1578	-0.1282	-0.1497	0.1850	-0.9811
45.0	0.1402	-0.1688	-0.2739	-0.3917	-0.4703	-0.5202	-0.5466	-0.5499	-0.5257	-0.4600	-0.3308	-0.2770	0.2632	-2.4476
67.5	0.0648	-0.0918	-0.2632	-0.4823	-0.6682	-0.8071	-0.8847	-0.8887	-0.8116	-0.6464	-0.3932	-0.2439	0.1489	-3.0490
90.0	-0.0851	0.1438	0.0830	-0.0745	-0.2448	-0.3893	-0.4725	-0.4715	-0.3827	-0.2187	-0.0138	0.0299	-0.1408	-0.6645
112.5	-0.1637	0.2987	0.4435	0.5362	0.5928	0.6190	0.6297	0.6325	0.6215	0.5835	0.5031	0.2780	-0.4089	3.1348
135.0	-0.0744	0.1876	0.3320	0.5715	0.8394	1.0582	1.1768	1.1658	1.0193	0.7662	0.4801	0.2057	-0.4252	3.7918
157.5	0.0337	0.0270	0.0316	0.1758	0.3974	0.6013	0.7129	0.6922	0.5416	0.3156	0.1189	0.0267	-0.2251	1.6142
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

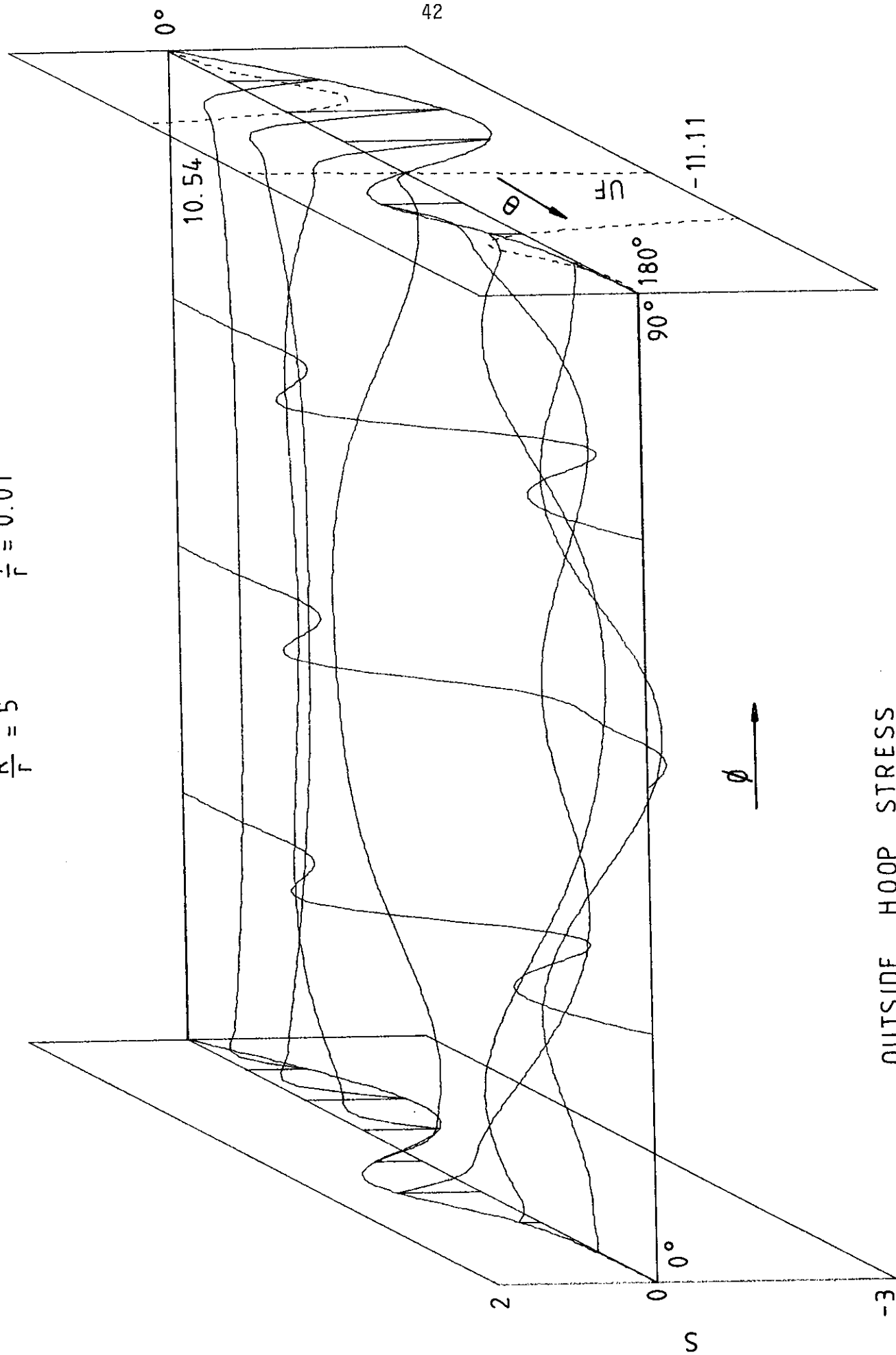
Theta	Phi=0.0	INSIDE AXIAL STRESS FACTORS												Unflanged x sin
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.3459	-0.2705	-0.1228	-0.0495	-0.0045	0.0218	0.0275	0.0091	-0.0384	-0.1209	-0.2684	-0.6007	0.6166	0.1827
45.0	0.4672	-0.4679	-0.2946	-0.2114	-0.1640	-0.1408	-0.1467	-0.1875	-0.2704	-0.4023	-0.6308	-1.1097	0.8772	-0.3178
67.5	0.2160	-0.4788	-0.4359	-0.4486	-0.4766	-0.5129	-0.5621	-0.6279	-0.7147	-0.8242	-1.0022	-1.3555	0.4963	-1.3931
90.0	-0.2838	-0.2335	-0.3380	-0.4931	-0.6330	-0.7555	-0.8600	-0.9432	-1.0026	-1.0322	-1.0599	-1.1768	-0.4694	-1.6429
112.5	-0.5455	0.1116	0.0142	-0.1788	-0.3424	-0.4789	-0.5901	-0.6710	-0.7132	-0.6998	-0.6381	-0.6986	-1.3629	-0.1249
135.0	-0.2478	0.2597	0.2498	0.1532	0.0874	0.0381	-0.0138	-0.0735	-0.1308	-0.1565	-0.1422	-0.3084	-1.4175	1.4240
157.5	0.1124	0.1648	0.1701	0.1610	0.1776	0.1994	0.2007	0.1700	0.1145	0.0612	0.0233	-0.1345	-0.7503	1.2064
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	INSIDE SHEAR STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.2919	-0.0740	-0.1473	-0.1829	-0.2103	-0.2379	-0.2689	-0.3062	-0.3532	-0.4144	-0.5062	-0.6958	-0.3081	-0.1568
22.5	-0.3501	-0.1630	-0.1988	-0.2169	-0.2336	-0.2539	-0.2790	-0.3096	-0.3465	-0.3909	-0.4529	-0.5730	-0.2084	-0.2222
45.0	-0.4917	-0.4214	-0.3703	-0.3400	-0.3232	-0.3156	-0.3135	-0.3129	-0.3089	-0.2944	-0.2639	-0.2023	0.0424	-0.4292
67.5	-0.6267	-0.7687	-0.6610	-0.5776	-0.5090	-0.4444	-0.3766	-0.2996	-0.2055	-0.0827	0.0865	0.3379	0.3064	-0.7333
90.0	-0.6548	-0.9788	-0.9344	-0.8491	-0.7418	-0.6083	-0.4474	-0.2602	-0.0476	0.1913	0.4618	0.7459	0.4058	-0.9134
112.5	-0.5570	-0.8241	-0.9207	-0.9117	-0.8236	-0.6699	-0.4636	-0.2208	0.0395	0.2939	0.5135	0.6266	0.2505	-0.7286
135.0	-0.4288	-0.4165	-0.5250	-0.5773	-0.5588	-0.4846	-0.3717	-0.2381	-0.1058	-0.0033	0.0359	-0.0077	-0.0645	-0.3556
157.5	-0.3601	-0.1221	-0.0488	-0.0435	-0.0739	-0.1344	-0.2198	-0.3227	-0.4341	-0.5449	-0.6373	-0.6384	-0.3482	-0.2103
180.0	-0.3447	-0.0470	0.1482	0.2169	0.1784	0.0507	-0.1438	-0.3773	-0.6165	-0.8223	-0.9416	-0.8710	-0.4598	-0.2328

DIAMETER EXPANSION FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged
135.0	0.0	-1.414	-3.449	-5.554	-7.500	-9.021	-9.891	-9.958	-9.166	-7.562	-5.297	-2.493	0.0	-34.391

$$\frac{R}{r} = 5 \quad \frac{t}{r} = 0.01$$

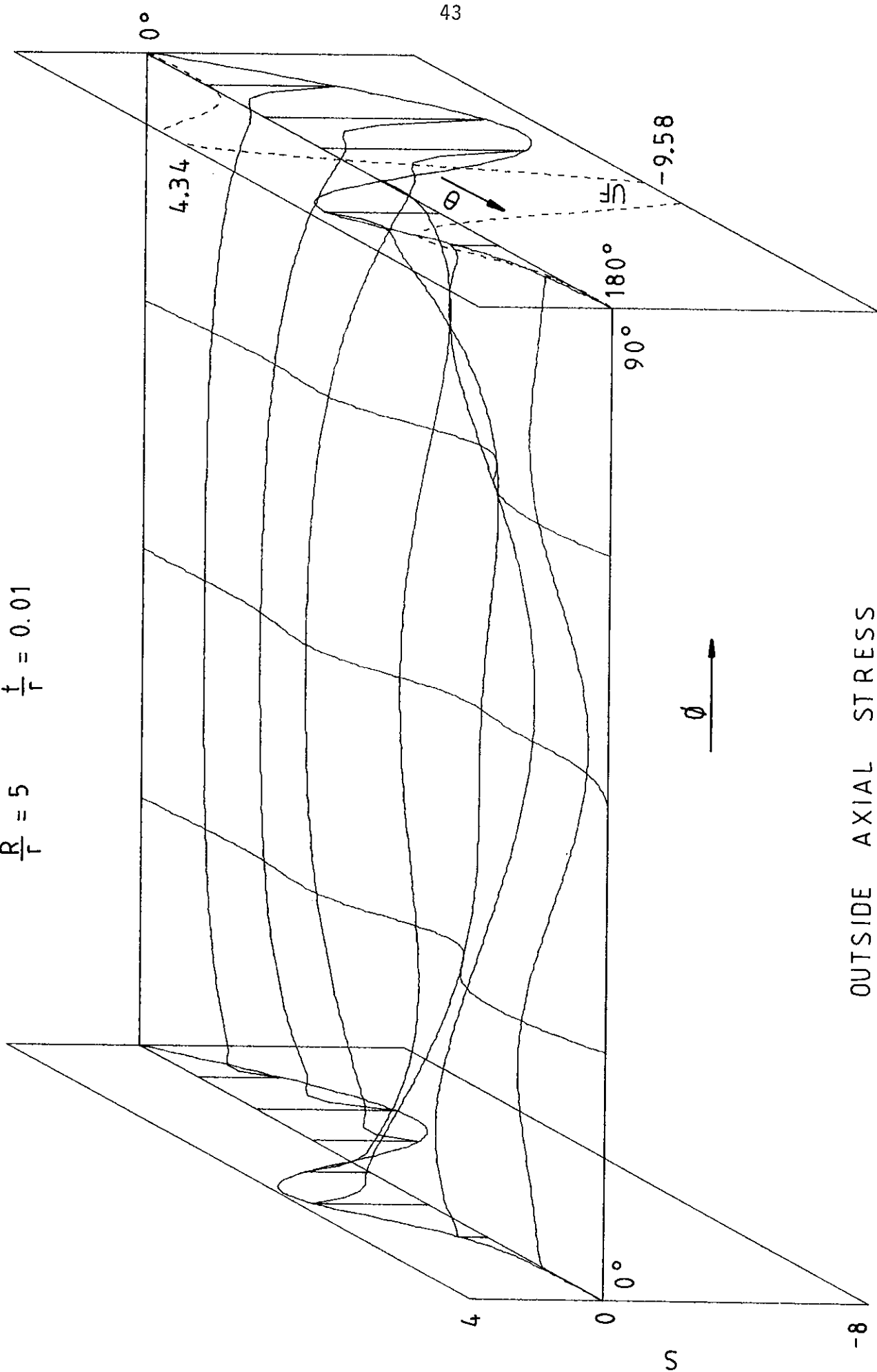
42



OUTSIDE HOOP STRESS

FIGURE A17

$$\frac{R}{r} = 5 \quad \frac{t}{r} = 0.01$$



OUTSIDE AXIAL STRESS

FIGURE A18

$$R/r = 5.0 \quad t/r = 0.01$$
[illegible][illegible]

Theta	Phi=0.0	OUTSIDE SHEAR STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	0.1144	-0.0642	-0.1995	-0.2637	-0.2940	-0.3088	-0.3184	-0.3304	-0.3538	-0.4025	-0.5029	-0.7101	-0.9786	-0.5157
22.5	-0.1048	-0.1757	-0.2562	-0.2954	-0.3132	-0.3206	-0.3244	-0.3298	-0.3432	-0.3737	-0.4374	-0.5644	-0.6727	-0.5373
45.0	-0.6958	-0.5275	-0.4479	-0.4031	-0.3762	-0.3578	-0.3421	-0.3256	-0.3048	-0.2722	-0.2144	-0.1050	0.1616	-0.6727
67.5	-1.2575	-0.9825	-0.7671	-0.6212	-0.5152	-0.4383	-0.3773	-0.3100	-0.2102	-0.0540	0.1844	0.5548	1.0724	-0.7298
90.0	-0.8758	-0.9042	-0.8361	-0.7761	-0.6882	-0.5689	-0.4161	-0.2436	-0.0519	0.1541	0.3811	0.6704	0.8929	-0.0536
112.5	-0.1189	-0.4884	-0.5935	-0.6298	-0.6365	-0.5666	-0.4027	-0.2038	-0.0443	0.0647	0.1566	0.1888	-0.1281	-0.0344
135.0	-0.2276	-0.2963	-0.4583	-0.4836	-0.4201	-0.3632	-0.3516	-0.3359	-0.2572	-0.1437	-0.1079	-0.2502	-0.3936	-0.6071
157.5	-0.5042	-0.3484	-0.3025	-0.3006	-0.2739	-0.2691	-0.3150	-0.3756	-0.4040	-0.4111	-0.4469	-0.4488	-0.3038	-0.7397
180.0	-0.5850	-0.4605	-0.2428	-0.1445	-0.2217	-0.3062	-0.3083	-0.3151	-0.4349	-0.6024	-0.6093	-0.4305	-0.2786	-0.7749

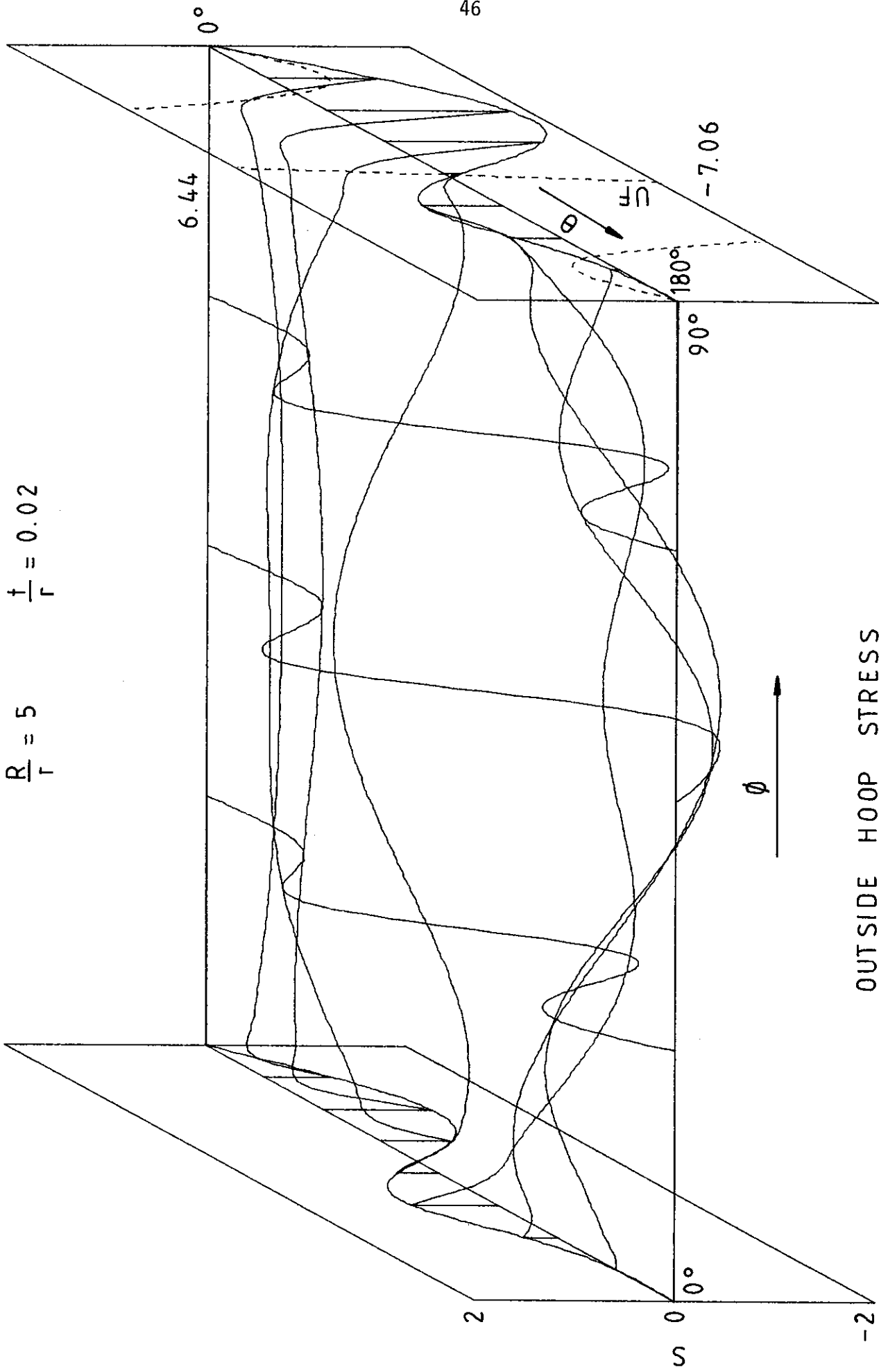
		DIAMETER EXPANSION FACTORS													
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin	
45.0	0.0	4.222	13.154	27.407	42.618	54.521	60.429	59.075	50.457	36.192	20.181	7.807	0.0	390.564	

TABLE A18

$$R/r = 5.0 \quad t/r = 0.01$$
[illegible][illegible]

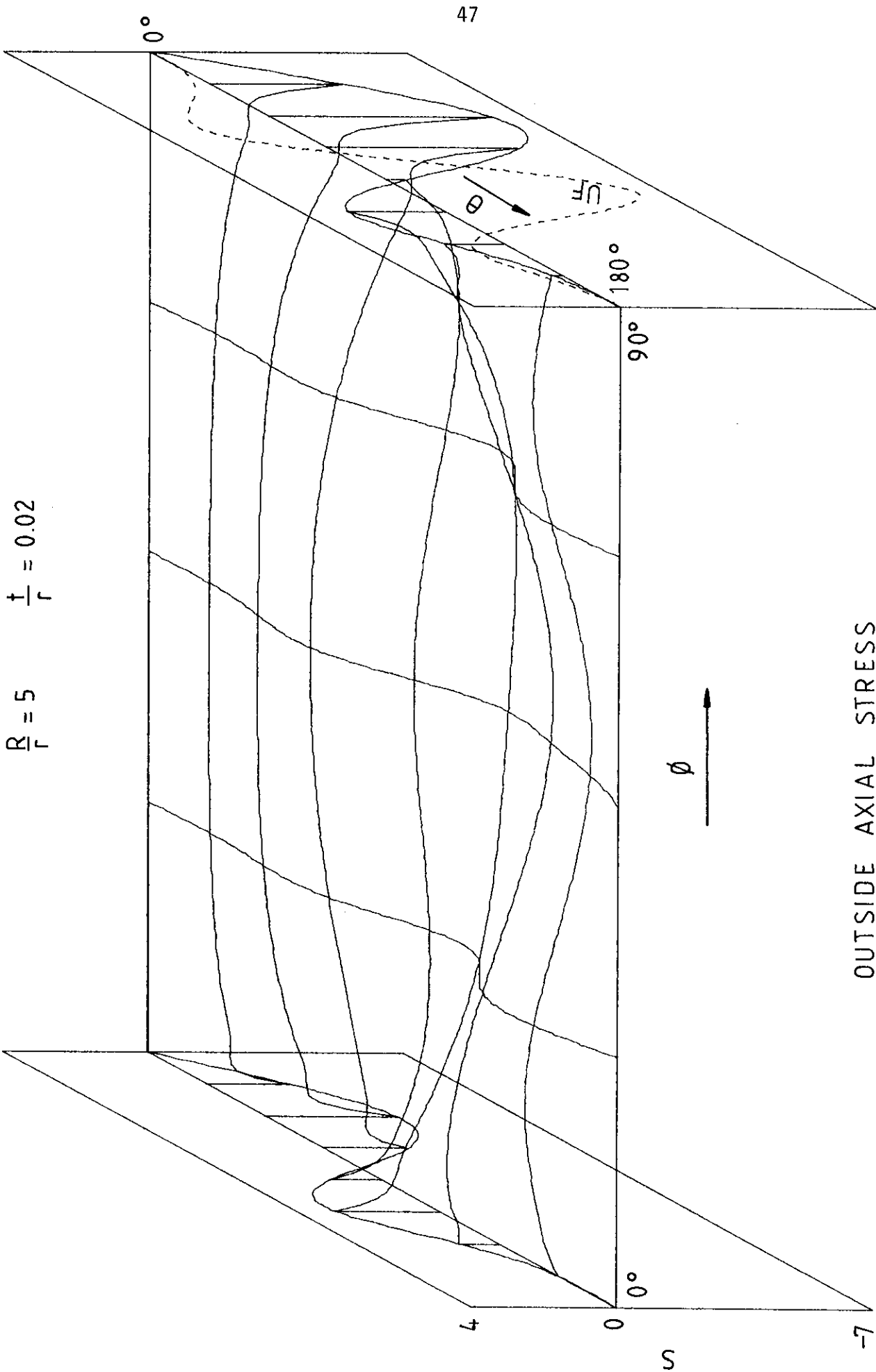
Theta	Phi=0.0	INSIDE SHEAR STRESS FACTORS												90.0	x cos	Unflanged
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5				
0.0	0.1133	-0.0221	-0.1625	-0.2323	-0.2699	-0.2933	-0.3123	-0.3343	-0.3677	-0.4262	-0.5364	-0.7552	-0.9689	-0.3002		
22.5	-0.1038	-0.1296	-0.2145	-0.2607	-0.2871	-0.3041	-0.3185	-0.3350	-0.3596	-0.4011	-0.4756	-0.6127	-0.6660	-0.3021		
45.0	-0.6889	-0.4442	-0.3686	-0.3443	-0.3378	-0.3360	-0.3347	-0.3334	-0.3311	-0.3229	-0.2923	-0.1949	0.1600	-0.3419		
67.5	-1.2450	-0.9934	-0.6931	-0.5218	-0.4326	-0.3876	-0.3582	-0.3253	-0.2679	-0.1490	0.0902	0.5358	1.0617	-0.7676		
90.0	-0.8671	-1.2462	-1.1022	-0.8766	-0.6663	-0.5129	-0.4063	-0.2891	-0.0925	0.2200	0.6322	1.0556	0.8840	-1.0978		
112.5	-0.1177	-0.4196	-0.8262	-0.9826	-0.9258	-0.7293	-0.4508	-0.1311	0.1865	0.4301	0.4842	0.2321	0.1268	-0.3967		
135.0	-0.2253	-0.0423	-0.2065	-0.5100	-0.7160	-0.6761	-0.4070	-0.0835	0.0817	-0.0140	-0.2947	-0.5296	-0.3897	-0.2756		
157.5	-0.4992	-0.3910	-0.1815	-0.0777	-0.0847	-0.1582	-0.2803	-0.4219	-0.5493	-0.6362	-0.6169	-0.4464	-0.3008	-0.4238		
180.0	-0.5791	-0.5367	-0.3410	0.0259	0.2770	0.1866	-0.2045	-0.6729	-0.9481	-0.8737	-0.5779	-0.3634	-0.2758	-0.4487		

DIAMETER EXPANSION FACTORS														
	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged
Theta														
135.0	0.0	-4.222	-13.154	-27.407	-42.618	-54.521	-60.429	-59.075	-50.457	-36.192	-20.181	-7.807	0.0	-390.564



OUTSIDE HOOP STRESS

FIGURE A19



OUTSIDE AXIAL STRESS

FIGURE A20

TABLE A19

R/r = 5.0 t/r = 0.02

Theta	Phi=0.0	OUTSIDE HOOP STRESS FACTORS										Unflanged			
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	-0.6950	0.0680	-0.0275	-0.0960	-0.1369	-0.1567	-0.1635	-0.1610	-0.1443	-0.1012	-0.0184	0.1110	-1.0929	-0.5986	
45.0	-1.0937	0.2729	0.2640	0.2034	0.1243	0.0566	0.0209	0.0285	0.0814	0.1706	0.2735	0.3517	-1.8265	1.6416	
67.5	-0.6968	0.3724	0.7345	0.9891	1.1070	1.1325	1.1348	1.1547	1.1701	1.1093	0.9006	0.5360	-1.5660	6.3268	
90.0	0.4217	-0.2789	-0.1917	0.1381	0.5395	0.8794	1.0637	1.0416	0.8155	0.4404	0.0341	-0.1982	-0.1680	0.9742	
112.5	0.8671	-0.3380	-0.9637	-1.3151	-1.3211	-1.1467	-1.0292	-1.1063	-1.3171	-1.4301	-1.1940	-0.5570	0.8022	-7.0265	
135.0	0.3313	0.4397	0.2805	-0.2041	-0.7906	-1.3005	-1.5848	-1.5540	-1.2184	-0.6721	-0.0754	0.2964	0.4877	-2.6221	
157.5	0.0005	0.3348	0.6727	0.6221	0.1083	-0.5431	-0.9270	-0.8140	-0.2714	0.3456	0.5997	0.3801	0.0867	0.4587	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	OUTSIDE AXIAL STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	-2.3167	-0.4520	-0.1941	-0.0850	-0.0425	-0.0305	-0.0351	-0.0544	-0.0956	-0.1806	-0.3623	-0.7629	-3.6431	0.4314	
45.0	-3.6456	-0.7549	-0.2077	0.0782	0.2106	0.2550	0.2525	0.2163	0.1247	-0.0829	-0.5135	-1.3530	-6.0882	2.2122	
67.5	-2.3225	-1.0113	-0.5352	-0.1232	0.1761	0.3530	0.4114	0.3466	0.1309	-0.2836	-0.9444	-1.8664	-5.2201	1.2110	
90.0	1.4055	-0.7828	-1.2414	-1.2793	-1.1105	-0.9081	-0.8264	-0.9559	-1.2800	-1.6844	-1.9844	-1.8911	-0.5601	-5.1797	
112.5	2.8903	0.6834	-0.3268	-1.0200	-1.4272	-1.6577	-1.8139	-1.9417	-2.0073	-1.8819	-1.3637	-0.2692	2.6738	-4.2810	
135.0	1.1044	1.4191	1.1116	0.4817	-0.2670	-0.9511	-1.3693	-1.3874	-1.0092	-0.3506	0.4348	1.1180	1.6257	0.8254	
157.5	0.0016	0.6689	0.9284	0.6940	0.1149	-0.4796	-0.8301	-0.7999	-0.3802	0.2541	0.7307	0.7212	0.2891	0.7280	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	OUTSIDE SHEAR STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.0234	-0.1340	-0.2436	-0.2926	-0.3125	-0.3184	-0.3193	-0.3225	-0.3363	-0.3736	-0.4575	-0.6360	-0.8082	-0.5170
22.5	-0.2115	-0.2471	-0.3040	-0.3256	-0.3308	-0.3290	-0.3251	-0.3230	-0.3271	-0.3445	-0.3889	-0.4886	-0.5381	-0.5625
45.0	-0.6848	-0.5658	-0.4975	-0.4465	-0.4054	-0.3730	-0.3467	-0.3196	-0.2835	-0.2321	-0.1597	-0.0526	0.1710	-0.6782
67.5	-1.0393	-0.8565	-0.7232	-0.6353	-0.5564	-0.4757	-0.3889	-0.2912	-0.1760	-0.0339	0.1536	0.4362	0.8373	-0.6067
90.0	-0.7779	-0.7666	-0.7045	-0.6811	-0.6448	-0.5584	-0.4172	-0.2486	-0.0859	0.0637	0.2332	0.4884	0.7234	-0.1683
112.5	-0.2734	-0.5196	-0.5414	-0.5248	-0.4982	-0.4522	-0.3825	-0.2920	-0.1869	-0.0710	0.0602	0.1789	0.0137	-0.0908
135.0	-0.2530	-0.4083	-0.4987	-0.4371	-0.3362	-0.2976	-0.3346	-0.3786	-0.3460	-0.2204	-0.0972	-0.1353	-0.3472	-0.5254
157.5	-0.4916	-0.3757	-0.3771	-0.3774	-0.3624	-0.3453	-0.3313	-0.3227	-0.3200	-0.3255	-0.3529	-0.3958	-0.3175	-0.7556
180.0	-0.5928	-0.3966	-0.2674	-0.3159	-0.4157	-0.4288	-0.3409	-0.2444	-0.2521	-0.3907	-0.5303	-0.4808	-0.2769	-0.7870

DIAMETER EXPANSION FACTORS														Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
45.0	0.0	4.736	13.014	24.206	35.871	45.362	50.348	49.480	42.875	32.042	19.477	8.271	0.0	200.304	

TABLE A20

R/r = 5.0 t/r = 0.02

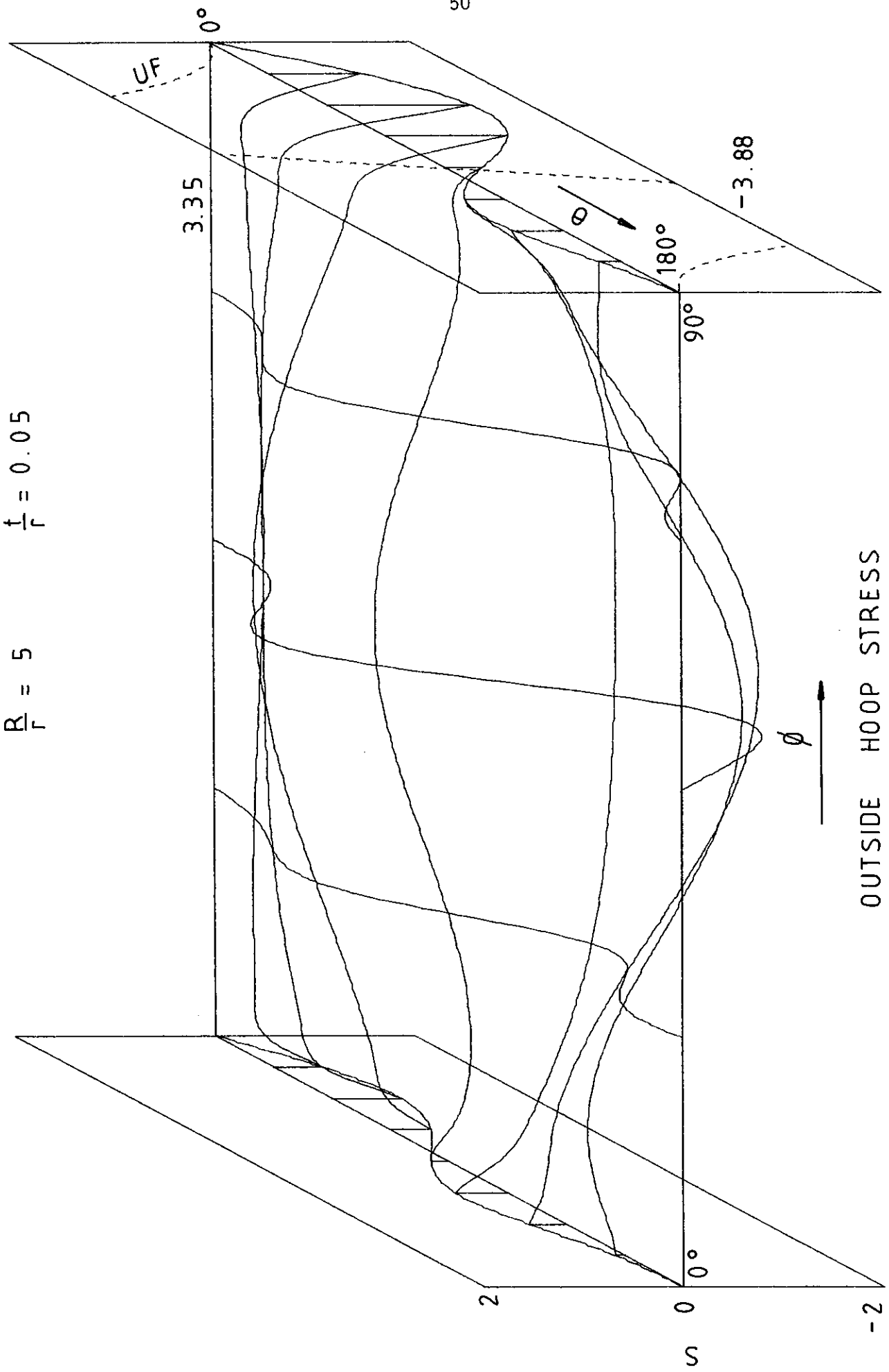
INSIDE HOOP STRESS FACTORS														Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	0.0769	0.0790	0.0982	0.1302	0.1537	0.1662	0.1726	0.1762	0.1746	0.1620	0.1396	0.1324	0.1048	0.5400	
45.0	0.0882	-0.0782	-0.1776	-0.1711	-0.1171	-0.0586	-0.0221	-0.0195	-0.0488	-0.0911	-0.1023	-0.0041	0.1209	-1.8764	
67.5	-0.0585	-0.2697	-0.7156	-1.0247	-1.1688	-1.2010	-1.2008	-1.2138	-1.2123	-1.1102	-0.8184	-0.3168	-0.0805	-6.8150	
90.0	-0.1846	0.3194	0.2041	-0.1737	-0.6160	-0.9826	-1.1805	-1.1600	-0.9208	-0.5128	-0.0542	0.2246	-0.3402	-1.1019	
112.5	0.0841	0.5051	1.0981	1.3999	1.3302	1.0727	0.8996	0.9721	1.2219	1.3885	1.1992	0.6067	-0.1323	7.5183	
135.0	0.3235	-0.1136	-0.0445	0.3324	0.7944	1.1879	1.3955	1.3492	1.0635	0.6174	0.1507	-0.0650	0.2231	2.9899	
157.5	0.1768	-0.0664	-0.4475	-0.5336	-0.1419	0.4362	0.7764	0.6369	0.1101	-0.4063	-0.4838	-0.1300	0.1715	-0.3327	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

INSIDE AXIAL STRESS FACTORS														Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	0.2562	-0.4466	-0.1634	-0.0280	0.0322	0.0531	0.0519	0.0327	-0.0139	-0.1147	-0.3254	-0.7588	0.3492	0.7297	
45.0	0.2941	-0.8330	-0.3523	-0.0651	0.0985	0.1778	0.1955	0.1555	0.0379	-0.2048	-0.6528	-1.4414	0.4031	1.0857	
67.5	-0.1950	-1.0674	-0.8819	-0.6781	-0.4897	-0.3533	-0.3085	-0.3852	-0.5943	-0.9328	-1.3964	-1.9782	-0.2684	-2.2729	
90.0	-0.6152	-0.4162	-0.8599	-1.1030	-1.2236	-1.2852	-1.3499	-1.4548	-1.5911	-1.7059	-1.7173	-1.4990	-1.1339	-4.4593	
112.5	0.2804	0.8421	0.3978	0.0199	-0.3598	-0.7138	-0.9555	-1.0223	-0.9262	-0.7229	-0.4224	0.0846	-0.4409	0.9732	
135.0	1.0784	0.9837	0.7712	0.5333	0.2889	0.0641	-0.0970	-0.1579	-0.1021	0.0656	0.3418	0.7272	0.7435	2.6197	
157.5	0.5894	0.4641	0.3164	0.0964	0.0064	0.0334	0.0446	-0.0397	-0.1519	-0.1252	0.1236	0.4156	0.5718	0.5087	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

INSIDE SHEAR STRESS FACTORS														Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos	
0.0	-0.0229	-0.0583	-0.1789	-0.2392	-0.2717	-0.2917	-0.3083	-0.3279	-0.3383	-0.4122	-0.5141	-0.7150	-0.7921	-0.2851	
22.5	-0.2073	-0.1487	-0.2174	-0.2579	-0.2828	-0.2995	-0.3132	-0.3293	-0.3543	-0.3964	-0.4685	-0.5935	-0.5275	-0.2905	
45.0	-0.6713	-0.4567	-0.3660	-0.3291	-0.3179	-0.3193	-0.3262	-0.3345	-0.3402	-0.3342	-0.2974	-0.1868	0.1676	-0.4039	
67.5	-1.0188	-0.9570	-0.7057	-0.5384	-0.4343	-0.3799	-0.3559	-0.3318	-0.2709	-0.1382	0.1042	0.5123	0.8208	-0.7642	
90.0	-0.7625	-1.1166	-1.0316	-0.8784	-0.7148	-0.5639	-0.4208	-0.2606	-0.0517	0.2280	0.5719	0.9241	0.7091	-0.9396	
112.5	-0.2680	-0.5146	-0.8123	-0.9410	-0.9172	-0.7490	-0.4654	-0.1319	0.1732	0.3884	0.4633	0.3239	0.0134	-0.5218	
135.0	-0.2479	-0.0928	-0.3057	-0.5417	-0.6495	-0.5879	-0.3988	-0.1680	-0.0017	0.0022	-0.1833	-0.4422	-0.3403	-0.2802	
157.5	-0.4818	-0.3390	-0.1758	-0.0933	-0.0823	-0.1436	-0.2659	-0.4120	-0.5363	-0.6096	-0.6116	-0.5028	-0.3112	-0.3924	
180.0	-0.5810	-0.5420	-0.2413	0.0826	0.2116	0.0953	-0.1989	-0.5567	-0.8374	-0.8985	-0.6923	-0.3885	-0.2715	-0.4489	

DIAMETER EXPANSION FACTORS														Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
135.0	0.0	-4.736	-13.014	-24.206	-35.871	-45.362	-50.348	-49.480	-42.875	-32.042	-19.477	-8.271	0.0	-200.304	

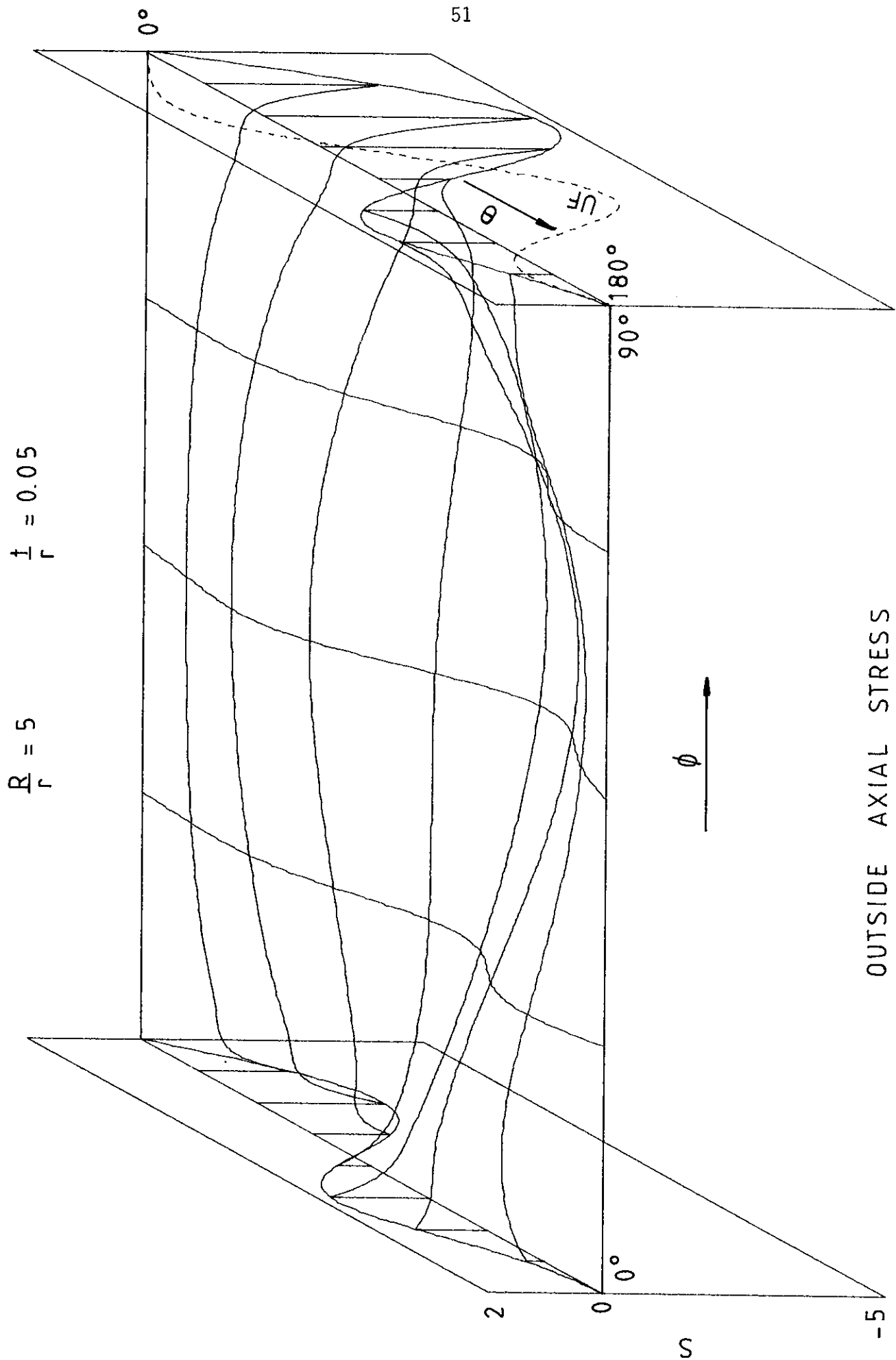
$$\frac{R}{r} = 5 \quad \frac{t}{r} = 0.05$$



OUTSIDE HOOP STRESS

FIGURE A21

$$\frac{R}{r} = 5 \qquad \frac{t}{r} = 0.05$$



OUTSIDE AXIAL STRESS

FIGURE A22

TABLE A21

$$R/r = 5.0 \quad t/r = 0.05$$

Theta	Phi=0.0	OUTSIDE HOOP STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	-0.4942	0.1854	0.1978	0.1814	0.1428	0.1009	0.0751	0.0779	0.1101	0.1609	0.2122	0.2551	-0.9160	0.7673
45.0	-0.6906	0.3276	0.4819	0.5870	0.6398	0.6601	0.6677	0.6746	0.6797	0.6666	0.6070	0.4960	-1.4256	2.4702
67.5	-0.4054	0.1953	0.4546	0.7426	1.0088	1.2179	1.3374	1.3455	1.2377	1.0248	0.7281	0.4098	-1.2080	3.2538
90.0	0.1798	-0.2051	-0.1914	-0.0023	0.2777	0.5443	0.7053	0.7040	0.5361	0.2572	-0.0218	-0.1490	-0.3704	0.3839
112.5	0.5250	-0.2760	-0.6192	-0.8567	-0.9899	-1.0603	-1.0966	-1.1119	-1.1038	-1.0420	-0.8551	-0.4789	0.3903	-3.4100
135.0	0.3753	0.1473	-0.1224	-0.5999	-1.1449	-1.6198	-1.9046	-1.9223	-1.6585	-1.1706	-0.5844	-0.0930	0.5053	-3.2288
157.5	0.0987	0.3311	0.3258	0.0151	-0.4510	-0.8894	-1.1564	-1.1658	-0.8990	-0.4337	0.0333	0.2391	0.2290	-0.9726
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE AXIAL STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	-1.6472	-0.2288	0.0206	0.1556	0.2281	0.2630	0.2723	0.2587	0.2140	0.1151	-0.0865	-0.4922	-3.0534	0.9466
45.0	-2.3021	-0.4928	-0.1054	0.1570	0.3413	0.4607	0.5111	0.4813	0.3566	0.1117	-0.3078	-1.0158	-4.7518	1.2797
67.5	-1.3513	-0.7365	-0.5357	-0.3138	-0.0996	0.0670	0.1414	0.0882	-0.1097	-0.4523	-0.9332	-1.5478	-4.0266	-0.3083
90.0	0.5993	-0.5862	-0.8765	-0.9899	-1.0199	-1.0319	-1.0668	-1.1500	-1.2931	-1.4809	-1.6454	-1.6424	-1.2346	-3.0005
112.5	1.7501	0.1950	-0.3906	-0.8773	-1.2976	-1.6482	-1.8924	-1.9984	-1.9586	-1.7766	-1.4184	-0.7894	1.3009	-3.1815
135.0	1.2509	0.9031	0.5087	-0.0423	-0.6156	-1.1091	-1.4396	-1.5448	-1.3869	-0.9652	-0.3315	0.3636	1.6843	-0.7968
157.5	0.3289	0.7598	0.6656	0.3315	-0.0505	-0.3714	-0.5840	-0.6535	-0.5359	-0.2053	0.2688	0.6292	0.7635	0.4826
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE SHEAR STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.2660	-0.3045	-0.3587	-0.3659	-0.3554	-0.3394	-0.3234	-0.3100	-0.3017	-0.3059	-0.3402	-0.4527	-0.4952	-0.5742
22.5	-0.3736	-0.3822	-0.4109	-0.4068	-0.3882	-0.3628	-0.3348	-0.3072	-0.2830	-0.2676	-0.2730	-0.3307	-0.3103	-0.5977
45.0	-0.6071	-0.5516	-0.5298	-0.5079	-0.4748	-0.4270	-0.3663	-0.2986	-0.2308	-0.1671	-0.1061	-0.0383	0.1243	-0.6124
67.5	-0.7516	-0.6596	-0.6075	-0.5840	-0.5488	-0.4870	-0.3988	-0.2938	-0.1845	-0.0770	0.0405	0.2181	0.4897	-0.5027
90.0	-0.6583	-0.6234	-0.5636	-0.5331	-0.5012	-0.4563	-0.3955	-0.3176	-0.2227	-0.1095	0.0345	0.2558	0.4822	-0.2865
112.5	-0.4513	-0.5472	-0.4843	-0.4085	-0.3570	-0.3422	-0.3535	-0.3628	-0.3352	-0.2435	-0.0816	0.1232	0.1416	-0.2249
135.0	-0.3821	-0.5065	-0.4771	-0.3921	-0.3287	-0.3123	-0.3324	-0.3596	-0.3564	-0.2900	-0.1638	-0.0604	-0.1898	-0.4519
157.5	-0.4718	-0.4414	-0.4756	-0.4930	-0.4799	-0.4331	-0.3613	-0.2831	-0.2214	-0.1958	-0.2161	-0.2783	-0.3210	-0.7227
180.0	-0.5354	-0.3947	-0.4576	-0.5526	-0.5829	-0.5193	-0.3850	-0.2322	-0.1269	-0.1287	-0.2491	-0.3953	-0.3382	-0.8214

DIAMETER EXPANSION FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged
45.0	0.0	3.392	8.724	15.392	22.118	27.600	30.714	30.742	27.536	21.592	14.013	6.420	0.0	73.726

TABLE A22

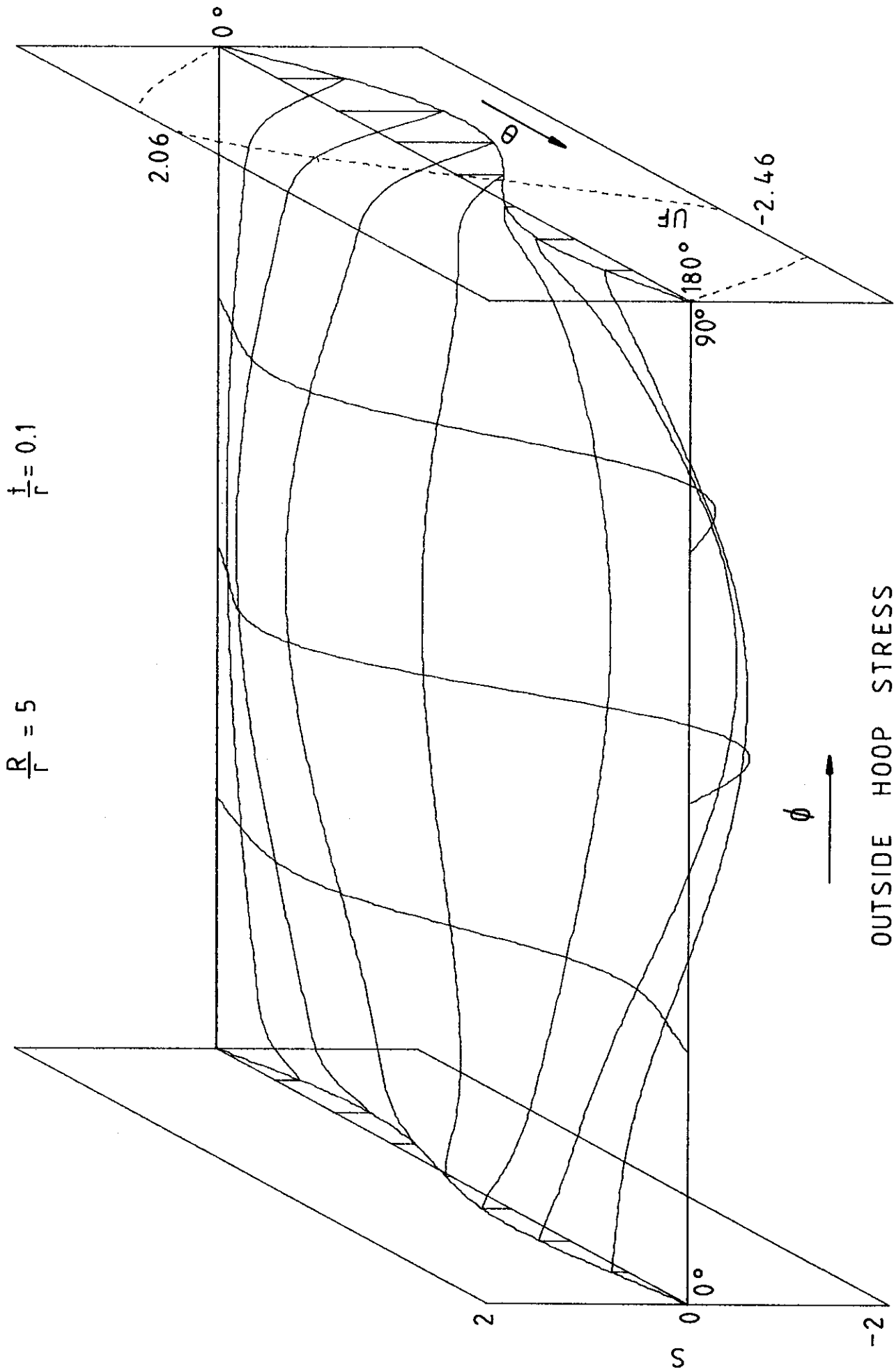
R/r = 5.0 t/r = 0.05

Theta	Phi=0.0	INSIDE HOOP STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	0.0996	-0.0947	-0.1720	-0.1788	-0.1486	-0.1076	-0.0792	-0.0772	-0.1001	-0.1307	-0.1377	-0.0617	0.1628	-0.8508	
45.0	0.1018	-0.2117	-0.4642	-0.6126	-0.6859	-0.7134	-0.7201	-0.7193	-0.7066	-0.6562	-0.5213	-0.2254	0.1859	-2.7092	
67.5	-0.0235	-0.1162	-0.4518	-0.7946	-1.1030	-1.3411	-1.4735	-1.4749	-1.3386	-1.0724	-0.6907	-0.2117	-0.0052	-3.5787	
90.0	-0.1407	0.2632	0.2380	0.0027	-0.3386	-0.6624	-0.8581	-0.8573	-0.6547	-0.3163	0.0280	0.2194	-0.2680	-0.4637	
112.5	-0.0524	0.3810	0.7361	0.9419	1.0209	1.0353	1.0308	1.0310	1.0370	1.0102	0.8568	0.4921	-0.2918	3.7104	
135.0	0.1588	0.0282	0.2424	0.6722	1.1889	1.6450	1.9080	1.8955	1.6013	1.1028	0.5485	0.1433	-0.0502	3.5730	
157.5	0.1931	-0.1728	-0.2593	-0.0055	0.4525	0.9005	1.1657	1.1475	0.8352	0.3401	-0.0881	-0.1616	0.0986	1.1241	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	INSIDE AXIAL STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	0.3321	-0.3011	-0.1006	0.0253	0.1107	0.1652	0.1873	0.1718	0.1109	-0.0093	-0.2193	-0.5884	0.5426	0.4133	
45.0	0.3393	-0.5831	-0.3567	-0.1983	-0.0777	0.0048	0.0362	0.0016	-0.1117	-0.3180	-0.6474	-1.1746	0.6196	-0.2143	
67.5	-0.0784	-0.6475	-0.6448	-0.6358	-0.6281	-0.6308	-0.6553	-0.7137	-0.8181	-0.9793	-1.2086	-1.5214	-0.0173	-1.8465	
90.0	-0.4691	-0.2394	-0.4932	-0.7042	-0.9094	-1.0949	-1.2359	-1.3168	-1.3419	-1.3306	-1.2981	-1.2034	-0.8935	-2.2635	
112.5	-0.1746	0.3882	0.1145	-0.1272	-0.3730	-0.5987	-0.7706	-0.8628	-0.8657	-0.7863	-0.6323	-0.3395	-0.9726	-0.2131	
135.0	0.5294	0.6000	0.4249	0.3175	0.2601	0.2204	0.1644	0.0785	-0.0171	-0.0696	-0.0107	0.2446	-0.1674	1.5298	
157.5	0.6435	0.3462	0.2350	0.2131	0.2796	0.3666	0.4017	0.3469	0.2183	0.0904	0.0697	0.2313	0.3288	1.1406	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

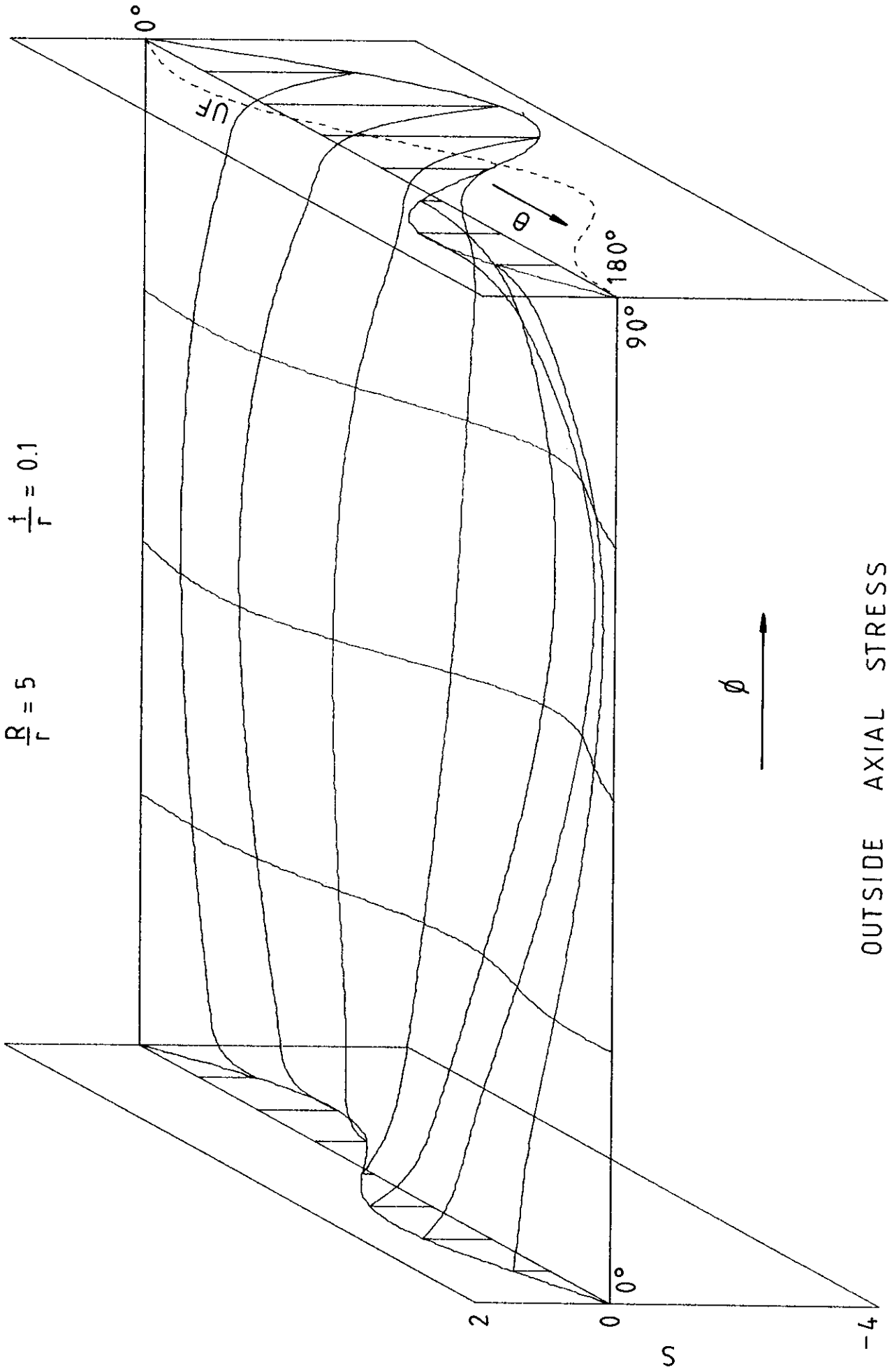
Theta	Phi=0.0	INSIDE SHEAR STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.2530	-0.1177	-0.1889	-0.2266	-0.2503	-0.2699	-0.2905	-0.3160	-0.3512	-0.4052	-0.4957	-0.6582	-0.4710	-0.2657
22.5	-0.3554	-0.2134	-0.2385	-0.2518	-0.2624	-0.2760	-0.2951	-0.3195	-0.3493	-0.3872	-0.4419	-0.5287	-0.2952	-0.3135
45.0	-0.5775	-0.4878	-0.4065	-0.3571	-0.3285	-0.3168	-0.3169	-0.3211	-0.3192	-0.2995	-0.2477	-0.1374	0.1183	-0.4707
67.5	-0.7149	-0.8173	-0.6779	-0.5786	-0.5021	-0.4359	-0.3708	-0.2990	-0.2102	-0.0861	0.1032	0.4023	0.4658	-0.6915
90.0	-0.6262	-0.9076	-0.8770	-0.8185	-0.7309	-0.6055	-0.4419	-0.2493	-0.0391	0.1852	0.4308	0.7021	0.4587	-0.7745
112.5	-0.4293	-0.6167	-0.7784	-0.8316	-0.7865	-0.6566	-0.4605	-0.2214	0.0300	0.2535	0.3997	0.4130	0.1347	-0.5948
135.0	-0.3635	-0.2960	-0.4502	-0.5260	-0.5223	-0.4658	-0.3768	-0.2655	-0.1459	-0.0542	-0.0520	-0.1875	-0.1806	-0.3795
157.5	-0.4488	-0.2845	-0.1874	-0.1383	-0.1366	-0.1773	-0.2514	-0.3461	-0.4446	-0.5256	-0.5652	-0.5406	-0.3053	-0.3489
180.0	-0.5093	-0.3625	-0.1073	0.0302	0.0394	-0.0454	-0.1936	-0.3843	-0.5890	-0.7495	-0.7753	-0.6054	-0.3217	-0.3810

DIAMETER EXPANSION FACTORS															Unflanged	
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin		
135.0	0.0	-3.392	-8.724	-15.392	-22.118	-27.600	-30.714	-30.742	-27.536	-21.592	-14.013	-6.420	0.0	-73.726		



OUTSIDE HOOP STRESS

FIGURE A23



OUTSIDE AXIAL STRESS

FIGURE A24

TABLE A23

R/r = 5.0 t/r = 0.1

Theta	Phi=0.0	OUTSIDE HOOP STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	-0.2586	0.1709	0.2614	0.3418	0.4068	0.4553	0.4847	0.4927	0.4794	0.4452	0.3865	0.3169	-0.6668	1.0911
45.0	-0.3590	0.2351	0.4126	0.5928	0.7549	0.8844	0.9658	0.9872	0.9437	0.8370	0.6703	0.4828	-1.0455	1.9482
67.5	-0.2274	0.1245	0.2999	0.5218	0.7438	0.9309	1.0519	1.0832	1.0125	0.8427	0.5949	0.3508	-0.9607	1.8137
90.0	0.0561	-0.0764	-0.0696	0.0155	0.1253	0.2262	0.2941	0.3111	0.2658	0.1606	0.0252	-0.0334	-0.4750	0.1969
112.5	0.2849	-0.1440	-0.3622	-0.5533	-0.7231	-0.8594	-0.9470	-0.9732	-0.9320	-0.8215	-0.6393	-0.3304	0.0873	-1.8190
135.0	0.3055	-0.0136	-0.2968	-0.6630	-1.0420	-1.3653	-1.5797	-1.6438	-1.5299	-1.2345	-0.8007	-0.2847	0.3668	-2.4299
157.5	0.1675	0.0845	-0.0804	-0.3565	-0.6613	-0.9264	-1.1045	-1.1592	-1.0633	-0.8121	-0.4559	-0.0889	0.2797	-1.4583
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	OUTSIDE AXIAL STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	-0.8620	-0.1330	0.0035	0.1153	0.2063	0.2755	0.3142	0.3125	0.2614	0.1511	-0.0413	-0.3242	-2.2227	0.5184	
45.0	-1.1966	-0.3046	-0.1274	0.0323	0.1672	0.2705	0.3263	0.3171	0.2256	0.0337	-0.2912	-0.7345	-3.4851	0.4059	
67.5	-0.7579	-0.4474	-0.3945	-0.3229	-0.2603	-0.2175	-0.2057	-0.2394	-0.3379	-0.5239	-0.8237	-1.1716	-3.2025	-0.6359	
90.0	0.1870	-0.3742	-0.5633	-0.7128	-0.8515	-0.9787	-1.0851	-1.1662	-1.2295	-1.2908	-1.3624	-1.3461	-1.5833	-1.9525	
112.5	0.9496	0.0025	-0.3664	-0.7272	-1.0658	-1.3617	-1.5880	-1.7201	-1.7409	-1.6397	-1.4085	-0.9833	0.2911	-2.2417	
135.0	1.0185	0.4089	0.0547	-0.3465	-0.7197	-1.0379	-1.2826	-1.4289	-1.4396	-1.2681	-0.8824	-0.2995	1.2227	-1.2688	
157.5	0.5584	0.4206	0.2255	-0.0265	-0.2545	-0.4428	-0.5911	-0.6884	-0.7032	-0.5855	-0.3009	0.0971	0.9325	-0.2776	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	OUTSIDE SHEAR STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos	
0.0	-0.4303	-0.4536	-0.4755	-0.4672	-0.4401	-0.3994	-0.3493	-0.2960	-0.2470	-0.2111	-0.2020	-0.2509	-0.2359	-0.6011	
22.5	-0.4688	-0.4784	-0.4935	-0.4841	-0.4561	-0.4128	-0.3583	-0.2985	-0.2409	-0.1944	-0.1706	-0.1901	-0.1417	-0.5965	
45.0	-0.5519	-0.5279	-0.5264	-0.5135	-0.4841	-0.4377	-0.3772	-0.3071	-0.2336	-0.1640	-0.1043	-0.0532	0.0788	-0.5648	
67.5	-0.6077	-0.5535	-0.5295	-0.5075	-0.4777	-0.4374	-0.3863	-0.3241	-0.2508	-0.1672	-0.0705	0.0562	0.2737	-0.4795	
90.0	-0.5883	-0.5402	-0.4867	-0.4443	-0.4132	-0.3903	-0.3707	-0.3456	-0.3034	-0.2311	-0.1128	0.0660	0.3002	-0.3707	
112.5	-0.5219	-0.5242	-0.4493	-0.3855	-0.3495	-0.3393	-0.3460	-0.3555	-0.3485	-0.2999	-0.1830	0.0018	0.1377	-0.3451	
135.0	-0.4824	-0.5256	-0.4783	-0.4279	-0.3906	-0.3665	-0.3504	-0.3361	-0.3138	-0.2686	-0.1853	-0.0736	-0.0969	-0.4747	
157.5	-0.4946	-0.5190	-0.5495	-0.5567	-0.5294	-0.4711	-0.3895	-0.2961	-0.2062	-0.1394	-0.1177	-0.1411	-0.2697	-0.6719	
180.0	-0.5105	-0.5091	-0.5850	-0.6287	-0.6094	-0.5326	-0.4139	-0.2747	-0.1443	-0.0634	-0.0766	-0.1739	-0.3283	-0.7644	

DIAMETER EXPANSION FACTORS														Unflanged
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
45.0	0.0	1.799	4.600	7.929	11.231	13.981	15.726	16.122	14.978	12.314	8.445	4.016	0.0	27.900

TABLE A24

 $R/r = 5.0$ $t/r = 0.1$

Theta	Phi=0.0	INSIDE HOOP STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.5	0.0641	-0.1395	-0.2673	-0.3654	-0.4403	-0.4942	-0.5246	-0.5290	-0.5063	-0.4539	-0.3599	-0.2041	0.1474	-1.1949
45.0	0.0689	-0.1878	-0.4243	-0.6412	-0.8304	-0.9788	-1.0690	-1.0864	-1.0234	-0.8781	-0.6438	-0.3183	0.1787	-2.1576
67.5	0.0021	-0.0694	-0.2992	-0.5691	-0.8368	-1.0608	-1.2035	-1.2354	-1.1397	-0.9168	-0.5861	-0.2071	0.0456	-2.0382
90.0	-0.0747	0.1481	0.1101	-0.0120	-0.1666	-0.3074	-0.4027	-0.4285	-0.3680	-0.2217	-0.0269	0.1211	-0.1750	-0.2492
112.5	-0.0722	0.2351	0.4312	0.6150	0.7711	0.8932	0.9654	0.9752	0.9201	0.8031	0.6184	0.3641	-0.3103	2.0151
135.0	0.0101	0.1023	0.3427	0.7226	1.1251	1.4687	1.6878	1.7333	1.5765	1.2226	0.7320	0.2801	-0.2607	2.7069
157.5	0.0556	-0.0298	0.0874	0.3756	0.7098	1.0022	1.1918	1.2338	1.0978	0.7867	0.3760	0.0732	-0.1170	1.6206
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Theta	Phi=0.0	INSIDE AXIAL STRESS FACTORS												Unflanged	
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x sin	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22.5	0.2136	-0.2200	-0.1420	-0.1021	-0.0712	-0.0495	-0.0411	-0.0516	-0.0884	-0.1611	-0.2841	-0.5492	0.4912	-0.1872	
45.0	0.2296	-0.3752	-0.3106	-0.2950	-0.2903	-0.2939	-0.3076	-0.3371	-0.3927	-0.4907	-0.6538	-1.0200	0.5958	-0.7094	
67.5	0.0071	-0.3685	-0.4175	-0.4966	-0.5821	-0.6647	-0.7364	-0.7952	-0.8472	-0.9085	-1.0007	-1.2453	0.1519	-1.3424	
90.0	-0.2490	-0.1529	-0.3170	-0.4777	-0.6383	-0.7862	-0.9078	-0.9938	-1.0414	-1.0562	-1.0454	-1.0665	-0.5834	-1.3385	
112.5	-0.2406	0.1404	-0.0381	-0.1733	-0.2960	-0.4092	-0.5127	-0.6028	-0.6717	-0.7068	-0.6836	-0.5792	-1.0343	-0.4057	
135.0	0.0335	0.2802	0.1694	0.1373	0.1342	0.1297	0.1007	0.0353	-0.0620	-0.1654	-0.2181	-0.1376	-0.8690	0.6001	
157.5	0.1852	0.1960	0.1523	0.1787	0.2335	0.2828	0.3002	0.2701	0.1920	0.0870	0.0067	0.0279	-0.3902	0.7052	
180.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Theta	Phi=0.0	INSIDE SHEAR STRESS FACTORS										Unflanged		
		7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	x cos
0.0	-0.3893	-0.2199	-0.2413	-0.2422	-0.2431	-0.2504	-0.2665	-0.2915	-0.3251	-0.3695	-0.4335	-0.5633	-0.2135	-0.3125
22.5	-0.4241	-0.2892	-0.2894	-0.2808	-0.2745	-0.2735	-0.2794	-0.2921	-0.3114	-0.3378	-0.3740	-0.4468	-0.1282	-0.3553
45.0	-0.4993	-0.4703	-0.4267	-0.3972	-0.3717	-0.3461	-0.3194	-0.2924	-0.2657	-0.2364	-0.1948	-0.1249	0.0713	-0.4704
67.5	-0.5499	-0.6711	-0.6105	-0.5677	-0.5199	-0.4585	-0.3814	-0.2908	-0.1889	-0.0736	0.0694	0.2823	0.2477	-0.6037
90.0	-0.5323	-0.7505	-0.7361	-0.7041	-0.6444	-0.5548	-0.4355	-0.2885	-0.1167	0.0760	0.2877	0.5338	0.2716	-0.6609
112.5	-0.4722	-0.6335	-0.6897	-0.6832	-0.6312	-0.5463	-0.4324	-0.2883	-0.1141	0.0812	0.2697	0.4088	0.1246	-0.5848
135.0	-0.4364	-0.4220	-0.4746	-0.4752	-0.4468	-0.4045	-0.3522	-0.2875	-0.2073	-0.1176	-0.0456	-0.0402	-0.0876	-0.4424
157.5	-0.4475	-0.2837	-0.2396	-0.2178	-0.2143	-0.2240	-0.2459	-0.2817	-0.3325	-0.3945	-0.4553	-0.4915	-0.2440	-0.3498
180.0	-0.4619	-0.2493	-0.1422	-0.1039	-0.1111	-0.1437	-0.1973	-0.2774	-0.3893	-0.5238	-0.6414	-0.6684	-0.2970	-0.3274

DIAMETER EXPANSION FACTORS														
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged
135.0	0.0	-1.799	-4.600	-7.929	-11.231	-13.981	-15.726	-16.122	-14.978	-12.314	-8.445	-4.016	0.0	-27.900

