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LUCAS HEIGHTS RESEARCH LABORATORIES

RESULTS OF PIPE BEND ANALYSIS

PART IX: STRESS DISTRIBUTIONS IN FLANGED PIPE ELBOWS FROM IN-PLANE SHEAR

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 an in-plane shear force applied to one flange; calculations are based on linear thin shell theory.

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ANALYTICAL SOLUTION; FLANGES; PIPES; STRESS ANALYSIS; STRESSES

CONTENTS

1. INTRODUCTION

The objective of this report is to present the surface stress distributions for a range of flanged elbows subjected to an in-plane shear force, 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:

$$\begin{aligned} \text{Hoop stress: } \sigma_{\theta\theta} &= T_\theta/t + 12zM_\theta/t^3 \quad , \\ \text{Axial stress: } \sigma_{\eta\eta} &= T_\eta/t + 12zM_\eta/t^3 \quad , \\ \text{Shear stress: } \sigma_{\eta\theta} &= S/t + z(12H/t^3 - S/rt) \quad , \end{aligned} \tag{1}$$

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

$$T_\eta = \frac{12M\cos\theta}{(12+\gamma)\pi r^2} \quad ,$$

$$M_\eta = \frac{\gamma M\cos\theta}{(12+\gamma)\pi r} \quad , \tag{2}$$

$$T_\theta = M_\theta = S = H = 0 \quad ,$$

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

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

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

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

$$S = \frac{3T}{2(3+\gamma)\pi r^2} \quad ,$$

$$H = \frac{\gamma T}{4(3+\gamma)\pi r} \quad , \tag{4}$$

$$T_\eta = M_\eta = T_\theta = M_\theta = 0 \quad .$$

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

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

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:

$$\sigma'_{\theta\theta} = \sigma_{\theta\theta} - z(A+\nu B)/(1-\nu^2) \quad ,$$

$$\sigma'_{\eta\eta} = \sigma_{\eta\eta} - z(B+\nu A)/(1-\nu^2) \quad , \tag{6}$$

$$\sigma'_{\eta\theta} = \sigma_{\eta\theta} - \frac{z}{2r}\left[(r/(r+z)+r/(r_\eta+z))\sigma_{\eta\theta} - (r_\eta-r)\bar{\sigma}_{\eta\theta}/(r_\eta+z)\right] \quad ,$$

where

$$r_\eta = r + R/\cos\theta \ ,$$

$$A = (\sigma_{\theta\theta} - \nu\sigma_{\eta\eta})/(r+z) \ ,$$

$$B = (\sigma_{\eta\eta} - \nu\sigma_{\theta\theta})/(r_\eta+z) \ , \quad \text{and}$$

$$\bar{\sigma}_{\eta\theta} = \frac{1}{2}\sigma_{\eta\theta}(\text{inside}) + \frac{1}{2}\sigma_{\eta\theta}(\text{outside}).$$

3. ELBOW CONFIGURATION AND RESULTS

Stresses are duplicated each side of the bend in Figure 1 because of lateral symmetry, and hoop and axial stresses on the outside surface from $\theta = 0$ to 180° are plotted in Appendix A, together with the stresses at $\phi = 90°$ on theoretically unterminated or unflanged pipe bends. The latter stresses vary as $\sin\phi$ and their 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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Whatham, J.F. [1982] - Analysis of circular pipe bends with flanged ends. J. Nucl. Eng. Des., 72(2)175.

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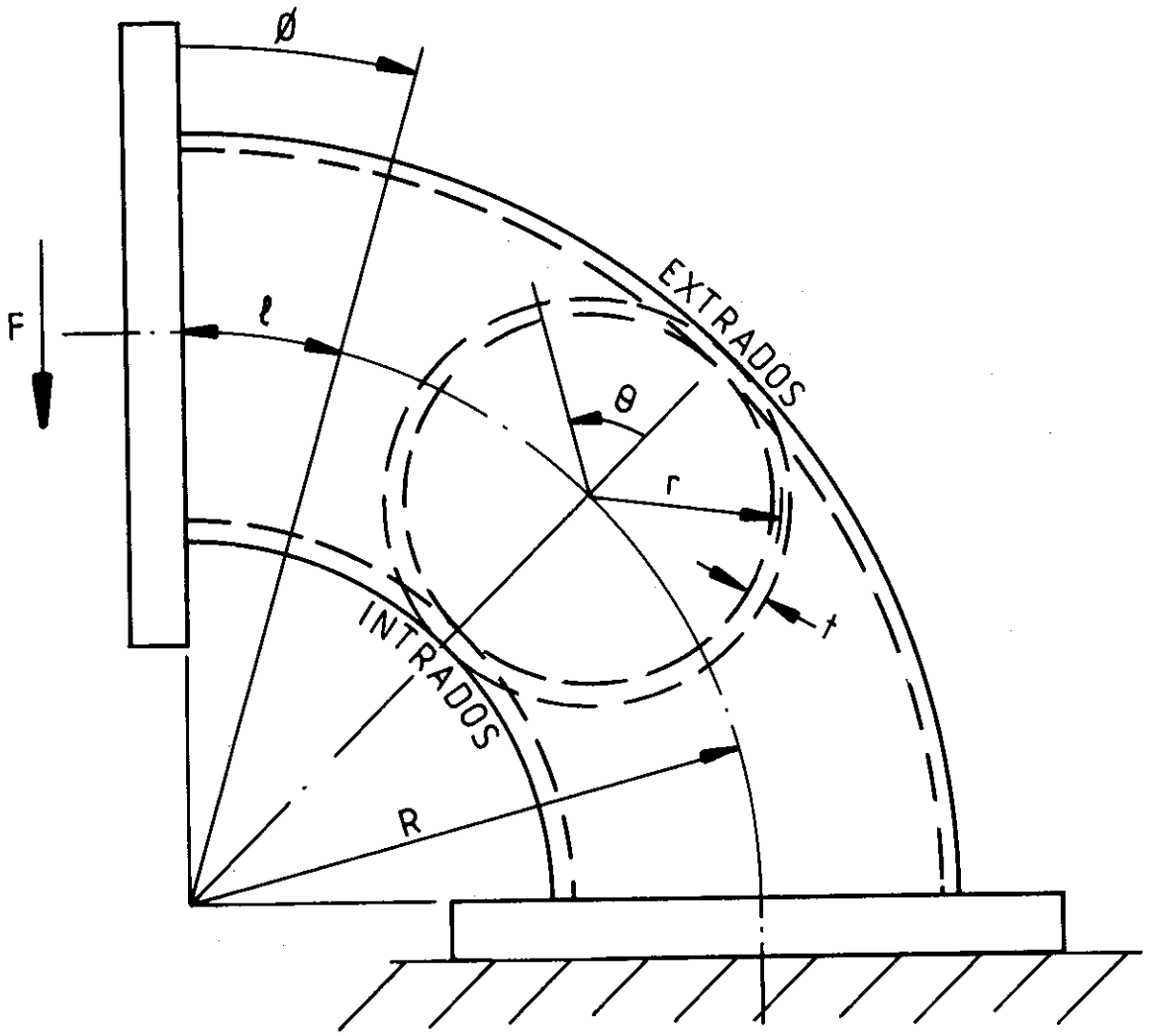


FIGURE 1. PIPE BEND CONFIGURATION

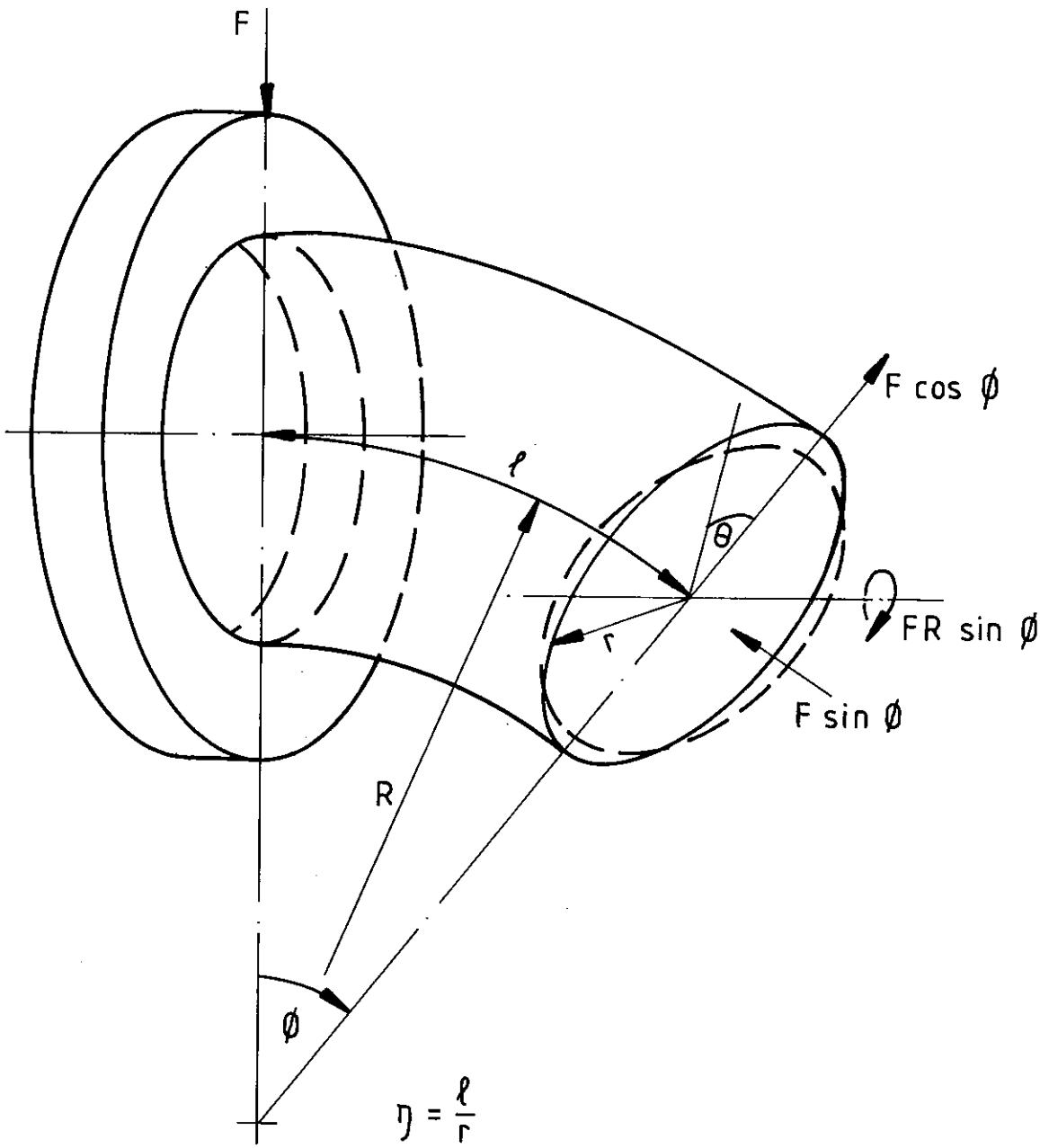


FIGURE 2. PIPE MIDDLE SURFACE

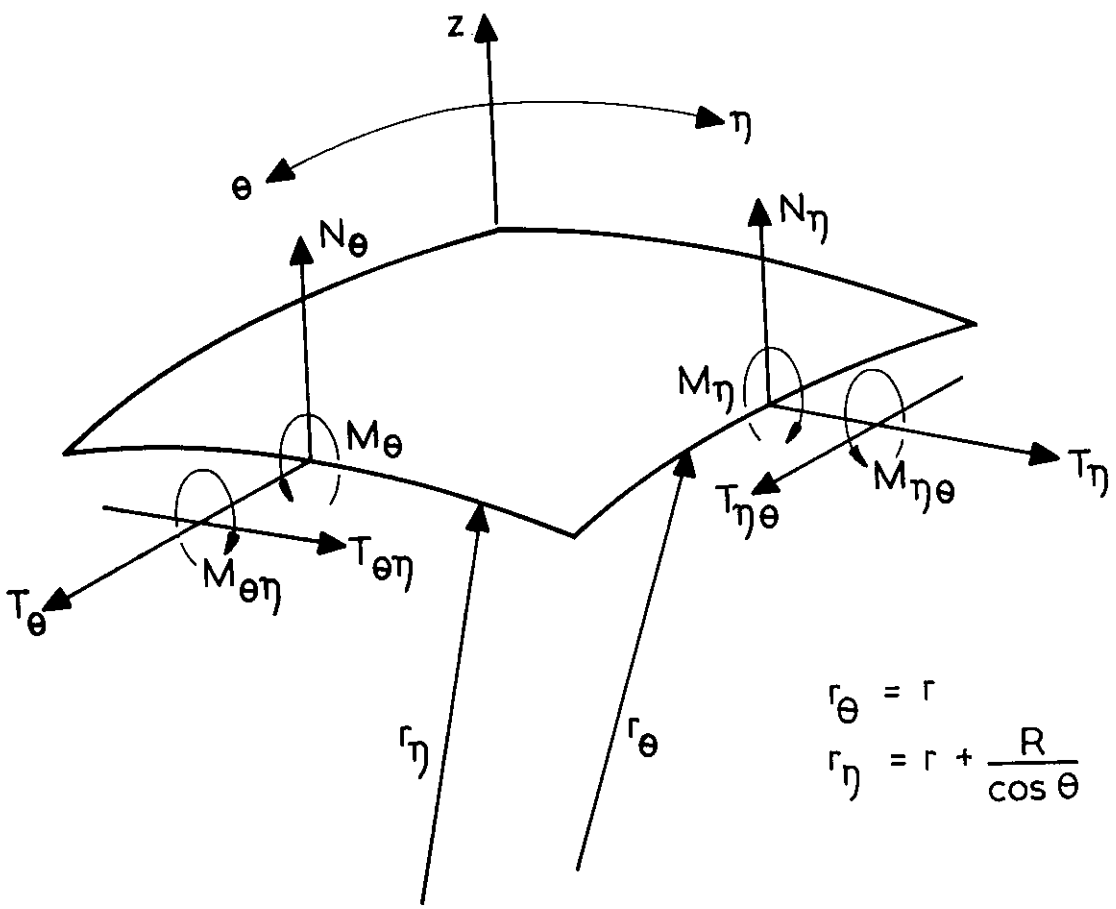


FIGURE 3. ELEMENT OF PIPE MIDDLE SURFACE

APPENDIX A

STRESSES IN FLANGED PIPE ELBOWS FROM AN IN-PLANE SHEAR FORCE

Parameters of pipe elbows considered:

$R/r = 2, 3, 5$

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

$\nu = 0.3$

Stress factor (S) = stress . $\pi r^2 t/FR$

For unflanged pipe bends:

$\left.\begin{matrix} x \sin \\ x \cos \end{matrix}\right\}$ = multiply stress factors by $\left\{\begin{matrix} \sin \phi \\ \cos \phi \end{matrix}\right.$

UF = unflanged pipe bend

Diameter expansion factor = diameter expansion . $\pi rEt/FR$

E = Young's modulus

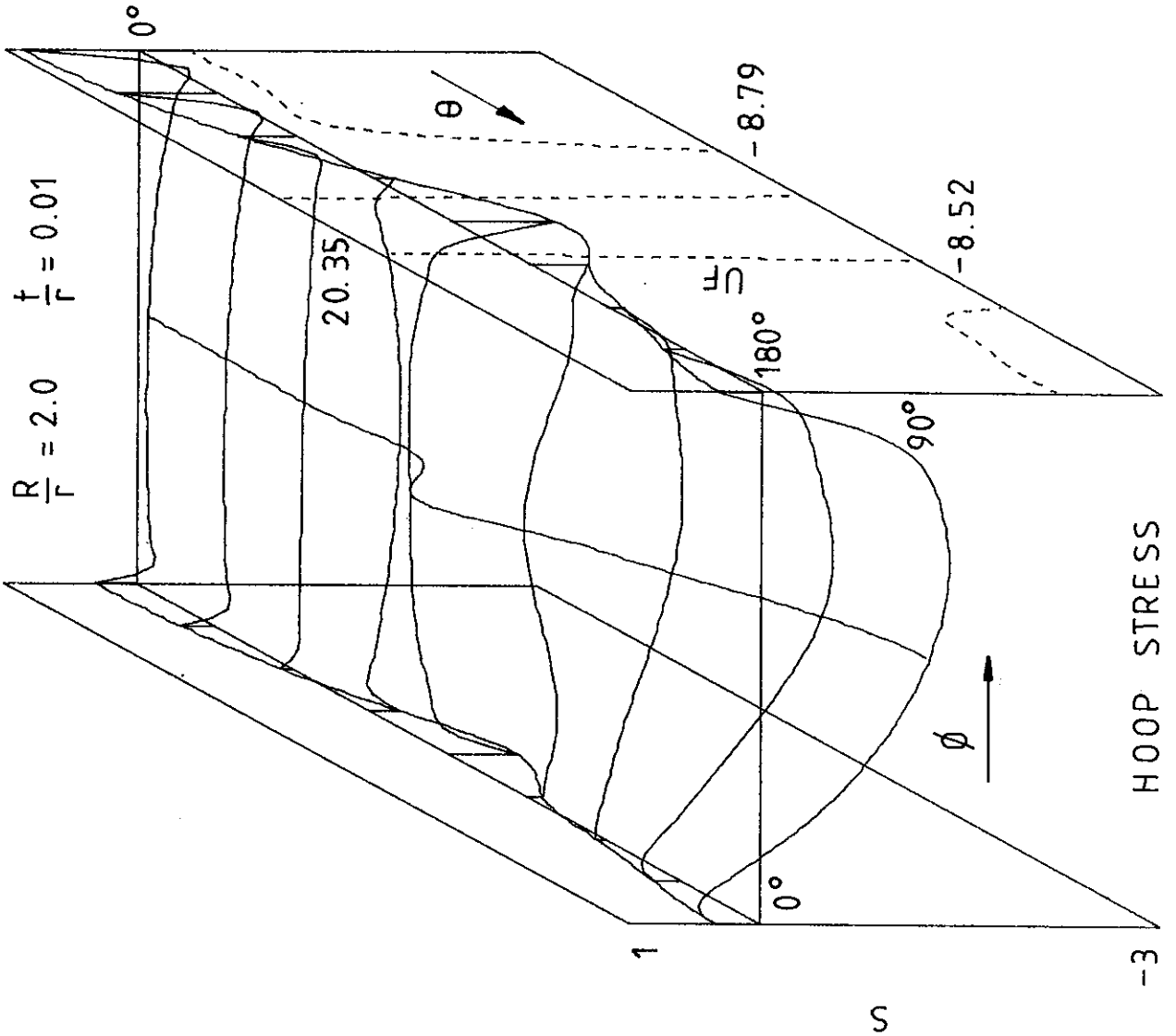

0°
θ
-8.79
-8.52
20.35
180°
90°
0°
$\frac{R}{r} = 2.0$
$\frac{t}{r} = 0.01$
ϕ
1
-3
S
HOOP STRESS

FIGURE A1

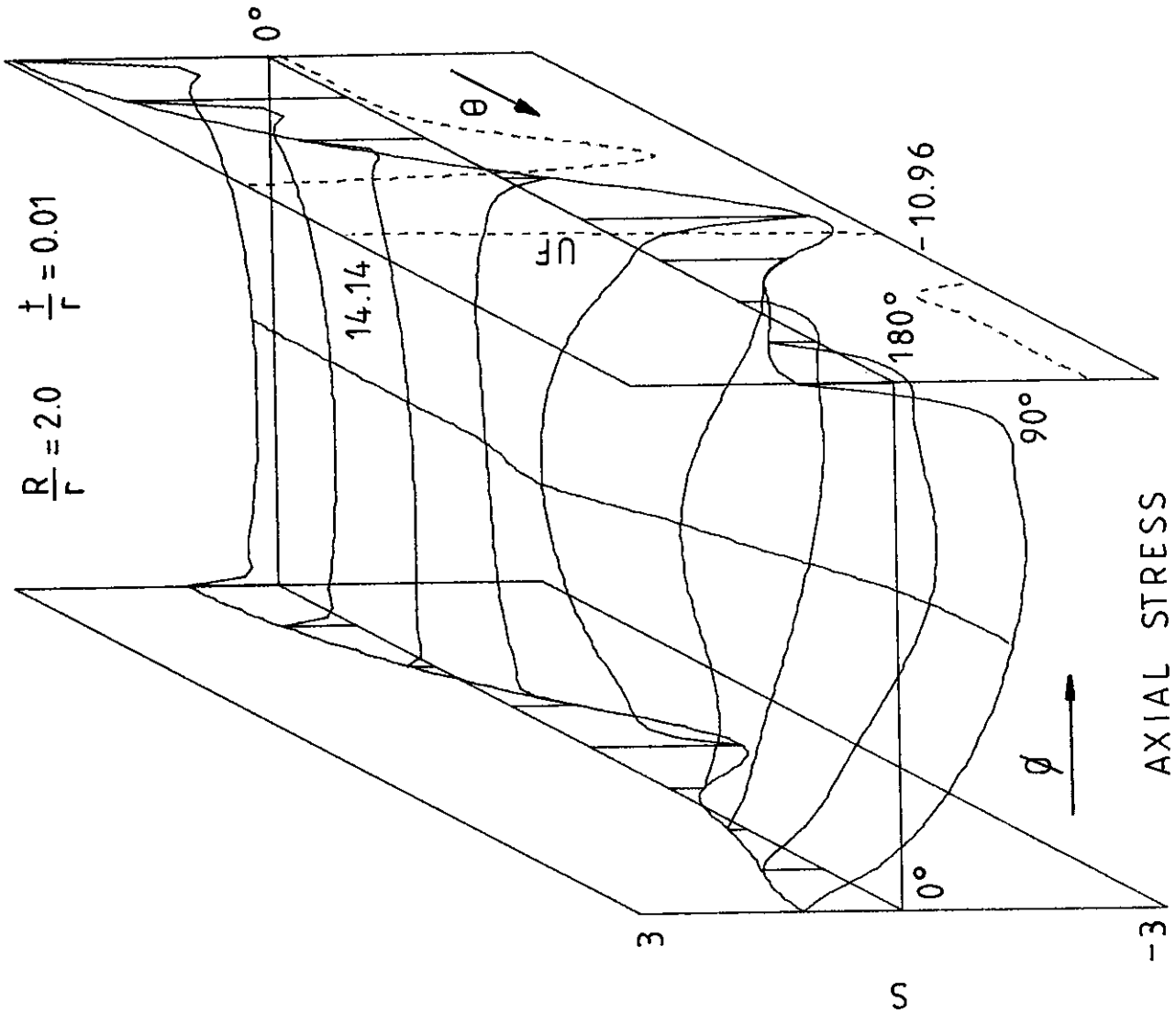

0°
θ
UF
-10.96
14.14
180°
90°
$\frac{R}{r} = 2.0$
$\frac{t}{r} = 0.01$
ϕ
0°
3
-3
S
AXIAL STRESS

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	Unflanged x sin
0.0	0.3088	-0.1094	-0.0875	-0.0765	-0.0730	-0.0760	-0.0852	-0.1013	-0.1260	-0.1623	-0.2151	-0.2937	0.8707	-0.3670
22.5	0.2539	-0.0946	-0.0796	-0.0723	-0.0709	-0.0747	-0.0838	-0.0991	-0.1216	-0.1534	-0.1979	-0.2613	0.7583	-0.3988
45.0	0.0874	-0.0533	-0.0575	-0.0598	-0.0625	-0.0673	-0.0753	-0.0871	-0.1030	-0.1227	-0.1446	-0.1675	0.4246	-0.8666
67.5	-0.2273	-0.0016	-0.0722	-0.1252	-0.1651	-0.1927	-0.2091	-0.2140	-0.2048	-0.1768	-0.1260	-0.0449	-0.1563	-8.7875
90.0	-0.5170	0.1142	0.1921	0.2528	0.2813	0.2920	0.2986	0.3070	0.3117	0.2968	0.2414	0.1627	-0.7765	18.3855
112.5	-0.1281	-0.1958	-0.2289	-0.1814	-0.0940	-0.0121	0.0260	-0.0001	-0.0877	-0.2076	-0.3090	-0.3317	-0.4396	-5.2962
135.0	0.0641	0.0002	-0.0864	-0.1892	-0.3060	-0.4161	-0.5053	-0.5627	-0.5795	-0.5555	-0.5140	-0.4748	-0.1017	-2.9458
157.5	0.2130	0.1747	-0.1242	-0.3900	-0.6506	-0.8801	-1.0432	-1.1190	-1.1098	-1.0375	-0.9470	-0.7288	0.1628	-2.2889
180.0	0.3337	0.2501	-0.2383	-0.6056	-0.8904	-1.1049	-1.2606	-1.3655	-1.4098	-1.3772	-1.2746	-0.8858	0.3316	-2.2104

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	Unflanged x sin
0.0	1.0293	0.3148	0.2415	0.2061	0.1945	0.2021	0.2282	0.2747	0.3467	0.4535	0.6113	0.8600	2.9022	-0.1328
22.5	0.8462	0.2842	0.2295	0.2032	0.1964	0.2066	0.2337	0.2798	0.3490	0.4487	0.5902	0.8017	2.5276	-0.1215
45.0	0.2914	0.1740	0.1749	0.1772	0.1862	0.2048	0.2351	0.2788	0.3373	0.4114	0.4993	0.5976	1.4153	-1.0070
67.5	-0.7576	-0.0371	0.0791	0.1459	0.1866	0.2181	0.2494	0.2831	0.3152	0.3322	0.3067	0.1955	-0.5210	1.2892
90.0	-1.7235	-0.4499	-0.1377	0.1219	0.3079	0.4310	0.4972	0.5025	0.4296	0.2486	-0.0784	-0.5415	-2.5884	11.9149
112.5	-0.4269	-0.5741	-0.5792	-0.4702	-0.3278	-0.2177	-0.1894	-0.2700	-0.4589	-0.7242	-0.9999	-1.1683	-1.4655	-10.7520
135.0	0.2136	-0.0252	-0.1687	-0.3278	-0.4883	-0.6356	-0.7660	-0.8722	-0.9394	-0.9514	-0.9127	-0.9143	-0.3390	-2.0467
157.5	0.7100	0.2139	-0.1462	-0.4516	-0.7690	-1.0514	-1.2511	-1.3402	-1.3224	-1.2232	-1.1116	-1.0715	0.5427	-2.2081
180.0	1.1124	0.2796	-0.2859	-0.6516	-0.9426	-1.1554	-1.3093	-1.4196	-1.4733	-1.4370	-1.3526	-1.2335	1.1052	-2.2205

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	Unflanged x cos
0.0	0.0	0.0	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	0.1262	0.0847	0.0468	0.0206	0.0000	-0.0185	-0.0378	-0.0606	-0.0901	-0.1309	-0.1907	-0.2822	-0.3907	-0.0260
45.0	0.1797	0.1359	0.0769	0.0311	-0.0084	-0.0462	-0.0867	-0.1340	-0.1932	-0.2709	-0.3766	-0.5248	-0.6610	-0.0279
67.5	0.0301	0.0540	0.0271	-0.0075	-0.0504	-0.1014	-0.1609	-0.2298	-0.3087	-0.3978	-0.4956	-0.6015	-0.6203	-0.5840
90.0	-0.4763	-0.3605	-0.2876	-0.2541	-0.2486	-0.2635	-0.2904	-0.3197	-0.3400	-0.3388	-0.3013	-0.2038	-0.0154	-2.1832
112.5	-0.8330	-0.7863	-0.7009	-0.6256	-0.5607	-0.4972	-0.4267	-0.3422	-0.2363	-0.0981	0.0865	0.3244	0.5300	0.5127
135.0	-0.9690	-1.0231	-1.0420	-0.9827	-0.8604	-0.6944	-0.4962	-0.2706	-0.0232	0.2305	0.4638	0.6287	0.7167	0.3268
157.5	-0.8169	-0.8292	-0.8580	-0.8297	-0.7348	-0.5753	-0.3660	-0.1349	0.0874	0.2799	0.4334	0.5232	0.6119	0.1911
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

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
90.0	0.0	2.612	5.069	7.308	9.088	10.336	11.028	11.119	10.508	9.076	6.769	3.773	0.0	583.979

TABLE A2

R/r = 2.0 t/r = 0.01

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	-0.0506	-0.1006	-0.0737	-0.0613	-0.0570	-0.0592	-0.0675	-0.0825	-0.1059	-0.1409	-0.1934	-0.2807	-0.1453	0.4625
22.5	-0.0364	-0.0854	-0.0651	-0.0559	-0.0532	-0.0559	-0.0640	-0.0780	-0.0992	-0.1303	-0.1752	-0.2479	-0.1149	0.5072
45.0	0.0016	-0.0375	-0.0357	-0.0362	-0.0391	-0.0445	-0.0525	-0.0634	-0.0777	-0.0957	-0.1178	-0.1490	-0.0343	1.0632
67.5	0.0594	0.0358	0.0590	0.0907	0.1159	0.1317	0.1372	0.1318	0.1142	0.0834	0.0421	0.0073	0.0738	9.1739
90.0	0.0368	-0.1165	-0.2277	-0.2929	-0.3203	-0.3280	-0.3329	-0.3425	-0.3508	-0.3391	-0.2821	-0.1624	0.0611	-21.0830
112.5	-0.1181	-0.0054	0.0435	0.0362	-0.0141	-0.0744	-0.1159	-0.1234	-0.1002	-0.0705	-0.0745	-0.1498	-0.2598	3.8851
135.0	-0.0035	-0.0456	-0.1475	-0.1864	-0.1912	-0.1924	-0.2129	-0.2643	-0.3451	-0.4363	-0.5043	-0.4573	-0.3631	2.2479
157.5	0.0271	0.1252	-0.1204	-0.3596	-0.5679	-0.7423	-0.876/	-0.9655	-0.9988	-0.9737	-0.8931	-0.6101	-0.5837	1.4835
180.0	-0.0176	0.2198	-0.1064	-0.4616	-0.7917	-1.0748	-1.2726	-1.3622	-1.3463	-1.2539	-1.0973	-0.6817	-0.7580	1.3495

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	-0.1688	0.3065	0.2421	0.2069	0.1955	0.2034	0.2297	0.2764	0.3487	0.4559	0.6139	0.8383	-0.4843	-0.1607
22.5	-0.1214	0.2758	0.2292	0.2036	0.1972	0.2078	0.2352	0.2815	0.3508	0.4503	0.5911	0.7799	-0.3831	-0.1648
45.0	0.0053	0.1659	0.1728	0.1772	0.1868	0.2056	0.2359	0.2794	0.3374	0.4101	0.4949	0.5765	-0.1145	-0.8644
67.5	0.1979	-0.0662	0.0857	0.1788	0.2403	0.2857	0.3235	0.3557	0.3766	0.3712	0.3118	0.1491	0.2459	4.6817
90.0	0.1227	-0.5412	-0.2846	-0.0918	0.0595	0.1649	0.2185	0.2115	0.1325	-0.0328	-0.2988	-0.7227	0.2037	-2.1123
112.5	-0.3936	-0.4209	-0.3805	-0.3201	-0.2683	-0.2463	-0.2657	-0.3331	-0.4509	-0.6154	-0.8109	-1.0228	-0.8659	-4.7661
135.0	-0.0115	-0.0691	-0.2180	-0.3285	-0.4080	-0.4795	-0.5591	-0.6529	-0.7548	-0.8464	-0.8948	-0.8048	-1.2102	1.5910
157.5	0.0904	0.0617	-0.1416	-0.4138	-0.6498	-0.8453	-0.9959	-1.0952	-1.1350	-1.1118	-0.9890	-0.7083	-1.9456	1.2500
180.0	-0.0586	0.0723	-0.0963	-0.4297	-0.7461	-1.0167	-1.2076	-1.2955	-1.2841	-1.1976	-0.9949	-0.6880	-2.5266	1.3371

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	0.0	0.0	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	0.1250	0.0878	0.0485	0.0215	0.0007	-0.0179	-0.0372	-0.0600	-0.0896	-0.1310	-0.1921	-0.2864	-0.3868	0.0665
45.0	0.1779	0.1424	0.0803	0.0326	-0.0075	-0.0453	-0.0855	-0.1325	-0.1918	-0.2707	-0.3797	-0.5334	-0.6545	0.1882
67.5	0.0298	0.1069	0.0671	0.0191	-0.0343	-0.0923	-0.1568	-0.2310	-0.3182	-0.4209	-0.5383	-0.6654	-0.6141	0.9354
90.0	-0.4715	-0.3274	-0.2118	-0.1623	-0.1657	-0.2075	-0.2733	-0.3475	-0.4110	-0.4405	-0.4060	-0.2754	-0.0153	-0.5143
112.5	-0.8247	-0.8859	-0.8126	-0.7193	-0.6268	-0.5423	-0.4573	-0.3536	-0.2118	-0.0210	0.2113	0.4635	0.5247	-1.8987
135.0	-0.9593	-1.0447	-1.0996	-1.0885	-0.9891	-0.7961	-0.5291	-0.2254	0.0715	0.3241	0.5180	0.6754	0.7096	-0.7934
157.5	-0.8088	-0.9249	-0.9318	-0.8494	-0.7142	-0.5474	-0.3617	-0.1633	0.0445	0.2555	0.4598	0.6259	0.6059	-0.4973
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

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
180.0	0.0	-1.312	-2.832	-4.125	-5.086	-5.714	-6.055	-6.138	-5.928	-5.354	-4.356	-2.744	0.0	-290.940

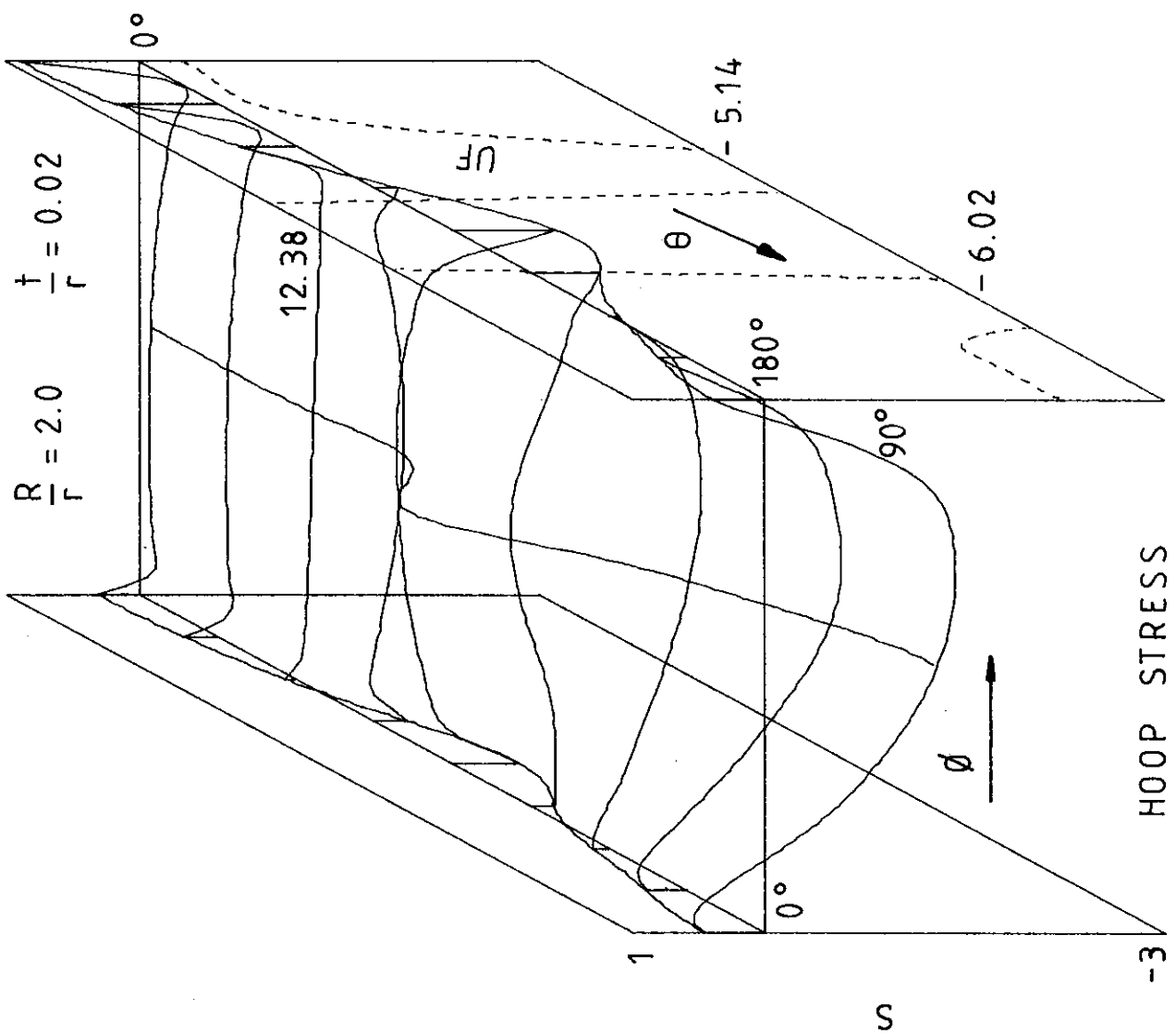


FIGURE A3

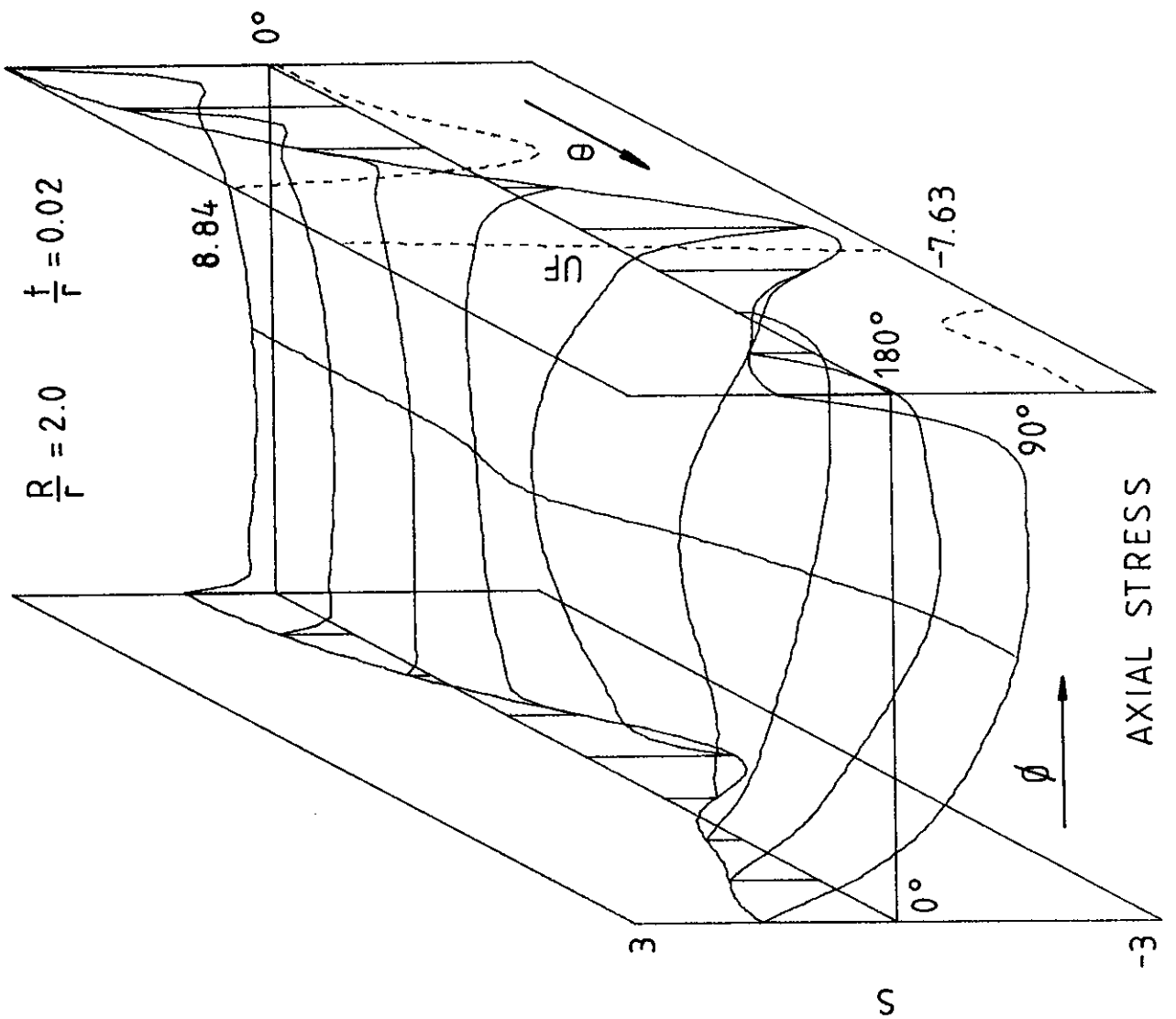


FIGURE A4

TABLE A3

R/r = 2.0 t/r = 0.02

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	Unflanged x sin
0.0	0.3072	-0.1238	-0.0899	-0.0802	-0.0775	-0.0810	-0.0908	-0.1074	-0.1326	-0.1693	-0.2210	-0.3387	0.8914	-0.3264
22.5	0.2517	-0.1071	-0.0810	-0.0734	-0.0712	-0.0745	-0.0836	-0.0994	-0.1230	-0.1566	-0.2015	-0.3016	0.7757	-0.2503
45.0	0.0766	-0.0698	-0.0903	-0.1056	-0.1169	-0.1268	-0.1376	-0.1500	-0.1638	-0.1768	-0.1850	-0.2051	0.4245	-2.3966
67.5	-0.2530	0.0276	-0.0444	-0.1064	-0.1613	-0.2029	-0.2267	-0.2292	-0.2081	-0.1633	-0.0973	-0.0110	-0.1919	-4.1416
90.0	-0.5096	0.1003	0.2132	0.2920	0.3474	0.3824	0.4043	0.4142	0.4063	0.3679	0.2931	0.1542	-0.7738	11.2631
112.5	-0.1841	-0.1859	-0.1725	-0.0922	0.0155	0.1066	0.1487	0.1241	0.0343	-0.0977	-0.2262	-0.3273	-0.5205	0.2206
135.0	0.1206	-0.0026	-0.1614	-0.2895	-0.4097	-0.5193	-0.6099	-0.6727	-0.6981	-0.6847	-0.6382	-0.4823	-0.0594	-4.5244
157.5	0.3050	0.2425	-0.1027	-0.4074	-0.6791	-0.9128	-1.0791	-1.1574	-1.1515	-1.0898	-0.9638	-0.5573	0.2191	-2.1748
180.0	0.4552	0.3298	-0.1883	-0.5968	-0.8991	-1.1295	-1.2947	-1.3941	-1.4301	-1.4041	-1.2417	-0.6400	0.3903	-2.2077

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	Unflanged x sin
0.0	1.0241	0.2892	0.2332	0.1992	0.1884	0.1965	0.2226	0.2688	0.3402	0.4462	0.6029	0.8063	2.9713	-0.0865
22.5	0.8389	0.2594	0.2189	0.1929	0.1866	0.1972	0.2244	0.2702	0.3390	0.4380	0.5796	0.7477	2.5856	-0.2367
45.0	0.2555	0.1669	0.1599	0.1544	0.1563	0.1698	0.1973	0.2408	0.3023	0.3829	0.4809	0.5640	1.4149	-1.2118
67.5	-0.8433	0.0285	0.1307	0.2153	0.2659	0.3034	0.3385	0.3747	0.4065	0.4176	0.3753	0.2725	-0.6398	3.4430
90.0	-1.6987	-0.3668	-0.1118	0.1507	0.3502	0.4889	0.5648	0.5696	0.4873	0.2946	-0.0342	-0.4193	-2.5794	7.3494
112.5	-0.6137	-0.6158	-0.6054	-0.4790	-0.3380	-0.2364	-0.2125	-0.2883	-0.4649	-0.7209	-1.0049	-1.1965	-1.7350	-7.2028
135.0	0.4019	-0.0151	-0.2419	-0.4077	-0.5618	-0.7042	-0.8352	-0.9497	-1.0314	-1.0641	-1.0614	-0.9813	-0.1981	-2.9315
157.5	1.0167	0.3393	-0.1419	-0.4859	-0.8185	-1.1149	-1.3247	-1.4182	-1.3957	-1.3067	-1.2396	-0.9849	0.7303	-2.1526
180.0	1.5174	0.4348	-0.2807	-0.6864	-0.9914	-1.2341	-1.4082	-1.5094	-1.5395	-1.5290	-1.5107	-1.0929	1.3011	-2.2187

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	Unflanged x cos
0.0	0.0	0.0	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	0.1126	0.0828	0.0450	0.0195	-0.0006	-0.0190	-0.0381	-0.0607	-0.0900	-0.1305	-0.1894	-0.2823	-0.3677	-0.0138
45.0	0.1529	0.1298	0.0741	0.0307	-0.0077	-0.0456	-0.0867	-0.1348	-0.1946	-0.2719	-0.3752	-0.5221	-0.6164	-0.0387
67.5	-0.0117	0.0077	-0.0050	-0.0321	-0.0671	-0.1114	-0.1649	-0.2269	-0.2970	-0.3742	-0.4594	-0.5422	-0.5497	-0.7611
90.0	-0.4558	-0.3717	-0.3157	-0.2909	-0.2833	-0.2866	-0.2952	-0.3038	-0.3065	-0.2959	-0.2611	-0.1713	-0.0250	-1.6928
112.5	-0.8208	-0.7419	-0.6768	-0.6094	-0.5488	-0.4872	-0.4184	-0.3373	-0.2380	-0.1103	0.0609	0.2582	0.4907	0.0898
135.0	-0.9534	-0.9855	-0.9787	-0.9065	-0.7879	-0.6426	-0.4768	-0.2879	-0.0721	0.1659	0.3970	0.5548	0.6693	0.4512
157.5	-0.7701	-0.7517	-0.7869	-0.7825	-0.7067	-0.5608	-0.3623	-0.1389	0.0782	0.2599	0.3801	0.4356	0.5412	0.1885
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

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
90.0	0.0	2.120	4.268	6.233	7.878	9.078	9.748	9.809	9.190	7.841	5.795	3.098	0.0	258.470

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	-0.0596	-0.0959	-0.0647	-0.0525	-0.0481	-0.0499	-0.0577	-0.0721	-0.0947	-0.1290	-0.1798	-0.2801	-0.1772	0.4209
22.5	-0.0435	-0.0791	-0.0574	-0.0498	-0.0483	-0.0517	-0.0599	-0.0733	-0.0932	-0.1222	-0.1640	-0.2433	-0.1426	0.3592
45.0	0.0045	-0.0177	0.0045	0.0171	0.0231	0.0230	0.0179	0.0079	-0.0083	-0.0329	-0.0677	-0.1215	-0.0445	2.6453
67.5	0.0885	-0.0145	0.0285	0.0700	0.1132	0.1454	0.1598	0.1522	0.1215	0.0710	0.0145	-0.0529	0.1070	4.2005
90.0	0.0847	-0.1666	-0.2582	-0.3538	-0.4110	-0.4452	-0.4672	-0.4801	-0.4766	-0.4403	-0.3468	-0.2616	0.1280	-13.4035
112.5	-0.0945	-0.0164	-0.0011	-0.0642	-0.1561	-0.2448	-0.3007	-0.3073	-0.2671	-0.2031	-0.1512	-0.1939	-0.2061	-1.9576
135.0	-0.0500	-0.0158	-0.0860	-0.1035	-0.0907	-0.0814	-0.0932	-0.1357	-0.2135	-0.3197	-0.4060	-0.3656	-0.4086	3.8739
157.5	-0.0661	0.1123	-0.1046	-0.3414	-0.5193	-0.6557	-0.7682	-0.8613	-0.9266	-0.9378	-0.8172	-0.4877	-0.6414	1.3728
180.0	-0.1646	0.2036	-0.0263	-0.3738	-0.7084	-0.9975	-1.2022	-1.2945	-1.2795	-1.1742	-0.9328	-0.5173	-0.8352	1.3525

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	-0.1987	0.3103	0.2336	0.2003	0.1899	0.1984	0.2250	0.2718	0.3438	0.4503	0.6068	0.8722	-0.5906	-0.1396
22.5	-0.1451	0.2772	0.2168	0.1915	0.1852	0.1958	0.2232	0.2695	0.3388	0.4384	0.5786	0.8116	-0.4754	-0.3584
45.0	0.0151	0.1608	0.1701	0.1754	0.1844	0.2018	0.2311	0.2745	0.3332	0.4064	0.4890	0.5954	-0.1485	-0.2193
67.5	0.2949	-0.1082	0.0944	0.2031	0.2820	0.3408	0.3855	0.4162	0.4267	0.4023	0.3210	0.0986	0.3567	3.9379
90.0	0.2825	-0.5386	-0.2745	-0.1107	0.0204	0.1120	0.1562	0.1445	0.0679	-0.0827	-0.3188	-0.7622	0.4268	-1.6972
112.5	-0.3149	-0.4269	-0.3887	-0.3670	-0.3545	-0.3624	-0.3966	-0.4597	-0.5544	-0.6810	-0.8361	-1.0301	-0.6869	-5.2371
135.0	-0.1666	-0.0845	-0.1813	-0.2892	-0.3668	-0.4347	-0.5090	-0.5956	-0.6934	-0.7838	-0.8106	-0.7810	-1.3621	1.8217
157.5	-0.2203	-0.0602	-0.1377	-0.3654	-0.5708	-0.7318	-0.8601	-0.9599	-1.0215	-1.0033	-0.8409	-0.7806	-2.1380	1.2396
180.0	-0.5487	-0.1108	-0.0722	-0.3313	-0.6284	-0.8812	-1.0621	-1.1551	-1.1535	-1.0342	-0.7826	-0.8249	-2.7840	1.3470

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	0.0	0.0	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	0.1104	0.0864	0.0471	0.0204	0.0000	-0.0182	-0.0370	-0.0594	-0.0886	-0.1296	-0.1908	-0.2853	-0.3605	0.0586
45.0	0.1499	0.1528	0.0843	0.0353	-0.0058	-0.0441	-0.0844	-0.1316	-0.1917	-0.2724	-0.3843	-0.5487	-0.6042	0.2696
67.5	-0.0114	0.1228	0.0815	0.0361	-0.0186	-0.0810	-0.1522	-0.2343	-0.3293	-0.4380	-0.5573	-0.6962	-0.5388	0.7601
90.0	-0.4468	-0.3276	-0.2139	-0.1668	-0.1699	-0.2111	-0.2760	-0.3486	-0.4098	-0.4366	-0.4032	-0.2744	-0.0245	-0.4476
112.5	-0.8046	-0.9251	-0.8344	-0.7367	-0.6442	-0.5568	-0.4649	-0.3537	-0.2076	-0.0161	0.2232	0.5068	0.4810	-1.8352
135.0	-0.9345	-1.0591	-1.1358	-1.1156	-1.0012	-0.8020	-0.5380	-0.2380	0.0640	0.3359	0.5577	0.7028	0.6560	-0.8402
157.5	-0.7549	-0.8869	-0.9159	-0.8545	-0.7324	-0.5657	-0.3679	-0.1551	0.0580	0.2639	0.4550	0.5816	0.5305	-0.4956
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

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
180.0	0.0	-1.174	-2.586	-3.903	-4.951	-5.689	-6.096	-6.156	-5.860	-5.192	-4.080	-2.434	0.0	-144.758

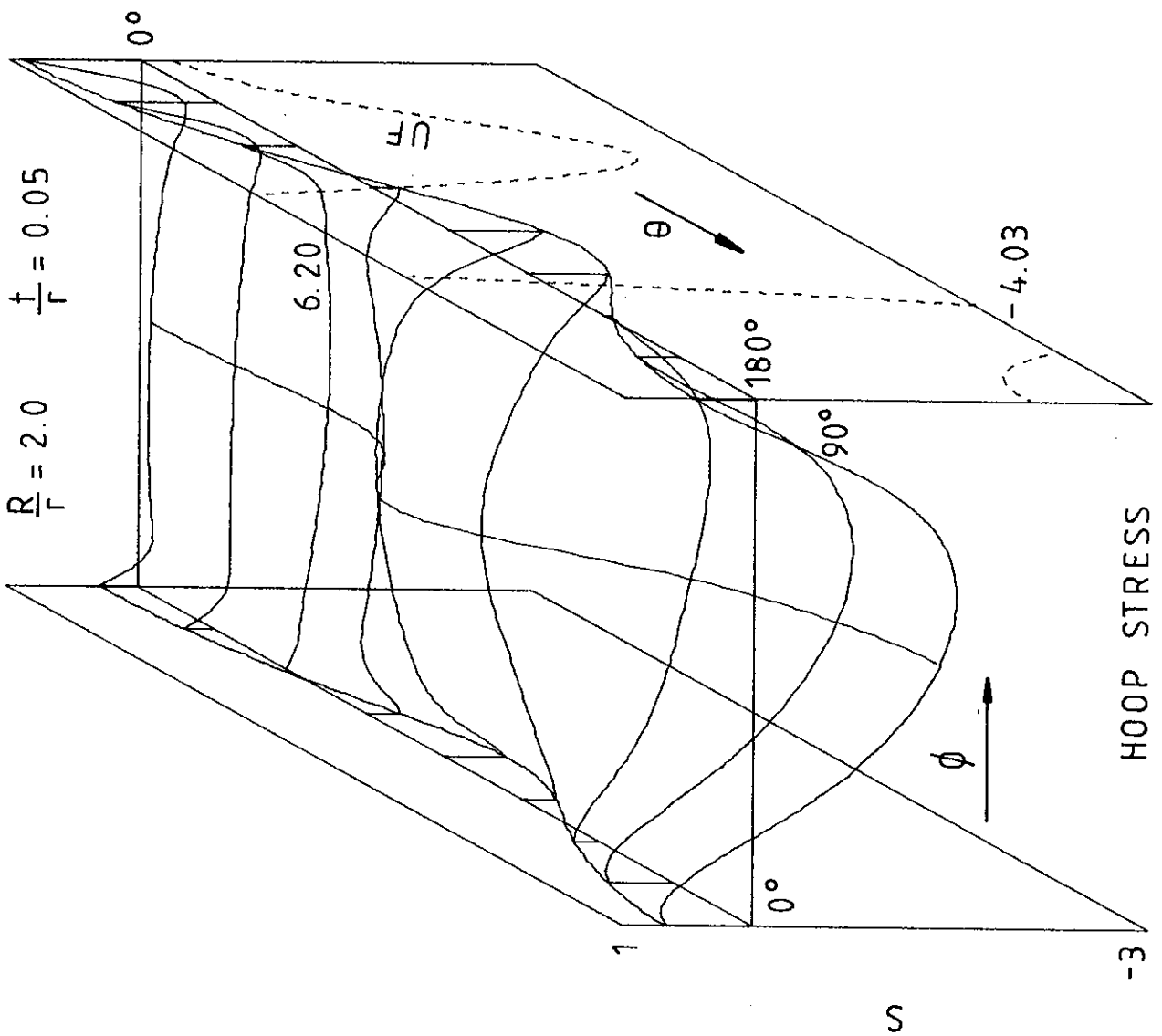


FIGURE A5

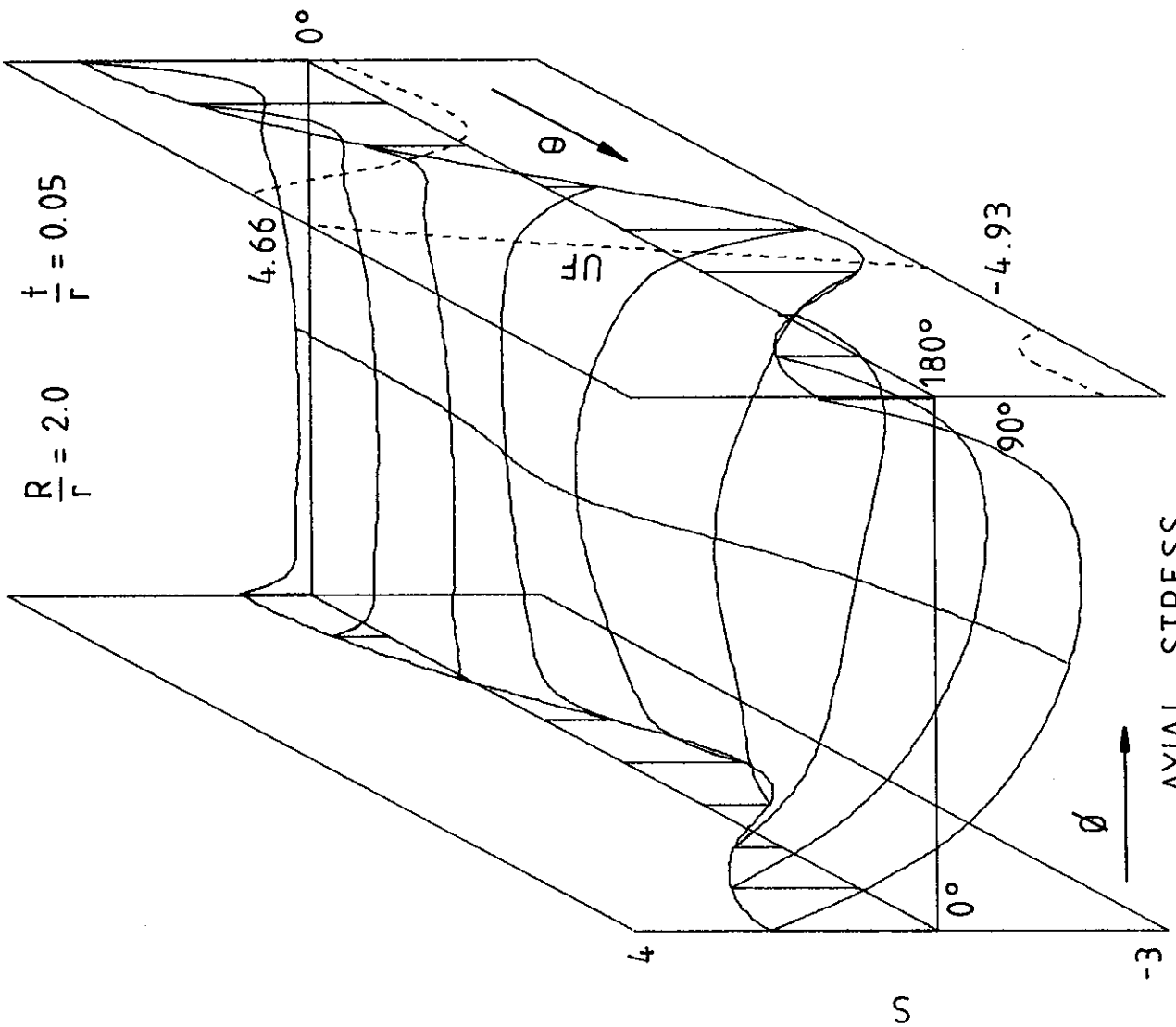


FIGURE A6

TABLE A5

R/r = 2.0 t/r = 0.05

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	Unflanged x sin
0.0	0.2829	-0.1195	-0.0999	-0.0845	-0.0799	-0.0819	-0.0915	-0.1101	-0.1393	-0.1798	-0.2508	-0.3410	0.9052	-0.2459
22.5	0.2247	-0.1100	-0.1151	-0.1163	-0.1223	-0.1311	-0.1439	-0.1618	-0.1855	-0.2141	-0.2623	-0.3056	0.7809	-0.9310
45.0	0.0388	-0.0716	-0.1195	-0.1713	-0.2135	-0.2467	-0.2701	-0.2822	-0.2816	-0.2657	-0.2396	-0.1906	0.3978	-2.3984
67.5	-0.2598	0.0033	0.0375	-0.0112	-0.0540	-0.0860	-0.1020	-0.0979	-0.0735	-0.0297	0.0262	-0.0091	-0.2075	-0.3554
90.0	-0.4681	-0.0145	0.2275	0.3357	0.4222	0.4884	0.5289	0.5397	0.5162	0.4568	0.3453	-0.0060	-0.7223	5.7270
112.5	-0.2642	-0.1638	-0.0452	0.0690	0.1875	0.2808	0.3221	0.2981	0.2090	0.0706	-0.1021	-0.3561	-0.6222	2.4647
135.0	0.1826	0.0028	-0.2353	-0.4074	-0.5237	-0.6126	-0.6911	-0.7623	-0.8167	-0.8270	-0.7377	-0.4706	-0.0663	-3.9147
157.5	0.5060	0.3736	-0.0546	-0.4651	-0.7924	-1.0404	-1.2141	-1.3113	-1.3212	-1.2095	-0.8983	-0.3137	0.3239	-2.6676
180.0	0.6588	0.5191	-0.0053	-0.5161	-0.9181	-1.2131	-1.4127	-1.5195	-1.5213	-1.3720	-0.9773	-0.2704	0.4626	-2.0911

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	Unflanged x sin
0.0	0.9429	0.1960	0.1952	0.1628	0.1530	0.1616	0.1873	0.2321	0.3011	0.4061	0.5642	0.5799	3.0174	-0.3055
22.5	0.7491	0.1891	0.1813	0.1491	0.1374	0.1436	0.1679	0.2128	0.2827	0.3873	0.5381	0.5639	2.6032	-0.5243
45.0	0.1294	0.1697	0.1832	0.1739	0.1746	0.1857	0.2123	0.2579	0.3235	0.4098	0.5158	0.5154	1.3260	0.0885
67.5	-0.8659	0.0565	0.2152	0.3136	0.3987	0.4648	0.5177	0.5581	0.5785	0.5661	0.5150	0.3047	-0.6918	3.3980
90.0	-1.5602	-0.3310	-0.0256	0.1995	0.4018	0.5491	0.6302	0.6353	0.5499	0.3639	0.0937	-0.4007	-2.4077	3.7536
112.5	-0.8807	-0.6064	-0.5233	-0.4069	-0.2732	-0.1818	-0.1634	-0.2325	-0.3947	-0.6346	-0.8993	-1.2248	-2.0741	-3.1330
135.0	0.6086	-0.0369	-0.4237	-0.6335	-0.7655	-0.8802	-1.0003	-1.1291	-1.2596	-1.3658	-1.3727	-1.1084	-0.2211	-4.2586
157.5	1.6868	0.6744	-0.1007	-0.6180	-0.9961	-1.2915	-1.5078	-1.6377	-1.6847	-1.6433	-1.4172	-0.6844	1.0795	-2.1692
180.0	2.1961	0.8838	-0.0944	-0.7285	-1.1715	-1.5020	-1.7295	-1.8517	-1.8829	-1.8211	-1.5349	-0.6152	1.5421	-2.1866

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	Unflanged x cos
0.0	0.0	0.0	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	0.0793	0.0669	0.0434	0.0197	0.0007	-0.0178	-0.0380	-0.0620	-0.0923	-0.1327	-0.1916	-0.2671	-0.3144	-0.0032
45.0	0.0820	0.0617	0.0449	0.0115	-0.0198	-0.0528	-0.0905	-0.1349	-0.1890	-0.2572	-0.3485	-0.4338	-0.5023	-0.1841
67.5	-0.0826	-0.1015	-0.0879	-0.1017	-0.1222	-0.1471	-0.1773	-0.2131	-0.2551	-0.3047	-0.3594	-0.3725	-0.4195	-0.7725
90.0	-0.4246	-0.3819	-0.3658	-0.3477	-0.3327	-0.3161	-0.2971	-0.2759	-0.2524	-0.2248	-0.1838	-0.1256	-0.0383	-1.1841
112.5	-0.7592	-0.6312	-0.6132	-0.5741	-0.5244	-0.4661	-0.3983	-0.3199	-0.2288	-0.1216	-0.0026	0.1000	0.3763	-0.3171
135.0	-0.8948	-0.8093	-0.7713	-0.7183	-0.6421	-0.5473	-0.4353	-0.3044	-0.1534	0.0106	0.1665	0.3036	0.5457	0.4817
157.5	-0.6871	-0.6306	-0.6254	-0.6111	-0.5575	-0.4600	-0.3268	-0.1717	-0.0138	0.1233	0.2220	0.2972	0.4214	0.2453
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

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
90.0	0.0	1.327	3.074	4.605	5.905	6.871	7.406	7.436	6.916	5.838	4.203	1.926	0.0	84.157

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	-0.0697	-0.0275	-0.0424	-0.0314	-0.0314	-0.0361	-0.0444	-0.0565	-0.0739	-0.1001	-0.1568	-0.1077	-0.2293	0.3375
22.5	-0.0486	-0.0144	-0.0079	0.0118	0.0197	0.0210	0.0166	0.0060	-0.0127	-0.0429	-0.1039	-0.0791	-0.1850	1.0634
45.0	0.0203	-0.0158	0.0494	0.1006	0.1389	0.1645	0.1738	0.1642	0.1336	0.0809	-0.0043	-0.0577	-0.0488	2.5960
67.5	0.1238	-0.1235	-0.0684	-0.0374	-0.0053	0.0207	0.0287	0.0133	-0.0241	-0.0736	-0.1332	-0.1986	0.1457	0.0896
90.0	0.1506	-0.2219	-0.3054	-0.4307	-0.5379	-0.6143	-0.6625	-0.6802	-0.6588	-0.5857	-0.4735	-0.3854	0.2099	-7.2996
112.5	-0.0017	-0.0660	-0.1143	-0.2544	-0.4078	-0.5291	-0.5982	-0.6043	-0.5449	-0.4307	-0.3089	-0.2695	-0.0713	-4.2146
135.0	-0.1521	0.0396	0.0662	0.0417	0.0149	-0.0065	-0.0289	-0.0591	-0.0988	-0.1414	-0.1787	-0.2378	-0.4702	3.0823
157.5	-0.2825	0.0456	-0.0118	-0.1636	-0.2939	-0.3936	-0.4823	-0.5689	-0.6353	-0.6343	-0.5253	-0.4039	-0.7676	1.8982
180.0	-0.4118	0.0800	0.0228	-0.2303	-0.4982	-0.7234	-0.8941	-1.0001	-1.0155	-0.9020	-0.6566	-0.4598	-0.9321	1.2535

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	-0.2324	0.3264	0.1953	0.1627	0.1519	0.1593	0.1851	0.2317	0.3045	0.4105	0.5641	1.0259	-0.7645	-0.4069
22.5	-0.1620	0.2833	0.1904	0.1679	0.1618	0.1716	0.1985	0.2450	0.3155	0.4141	0.5511	0.9359	-0.6165	-0.2489
45.0	0.0677	0.1412	0.1732	0.2060	0.2317	0.2608	0.2963	0.3395	0.3909	0.4467	0.4984	0.6352	-0.1628	0.8557
67.5	0.4125	-0.1197	0.0484	0.1842	0.2748	0.3438	0.3923	0.4169	0.4127	0.3672	0.2405	0.0683	0.4857	1.8894
90.0	0.5020	-0.3749	-0.2719	-0.1363	-0.0531	-0.0004	0.0202	0.0025	-0.0593	-0.1796	-0.4042	-0.5962	0.6995	-1.2398
112.5	-0.0057	-0.3321	-0.3764	-0.3958	-0.4376	-0.4858	-0.5378	-0.5959	-0.6607	-0.7389	-0.8465	-0.8624	-0.2377	-3.5085
135.0	-0.5070	-0.2068	-0.1595	-0.2386	-0.3491	-0.4513	-0.5381	-0.6088	-0.6566	-0.6755	-0.6946	-0.8574	-1.5673	0.3030
157.5	-0.9415	-0.4200	-0.1748	-0.1914	-0.3081	-0.4331	-0.5369	-0.6076	-0.6290	-0.6036	-0.6417	-1.1027	-2.5588	1.5710
180.0	-1.3727	-0.6234	-0.2382	-0.2058	-0.3295	-0.4795	-0.6020	-0.6718	-0.6693	-0.6142	-0.6734	-1.2949	-3.1069	1.3454

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	0.0	0.0	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	0.0754	0.0983	0.0484	0.0214	0.0011	-0.0168	-0.0352	-0.0573	-0.0867	-0.1288	-0.1915	-0.3121	-0.2991	0.1073
45.0	0.0780	0.1783	0.1046	0.0537	0.0108	-0.0317	-0.0779	-0.1323	-0.2002	-0.2885	-0.4102	-0.6069	-0.4778	0.3400
67.5	-0.0786	0.1072	0.0918	0.0502	-0.0027	-0.0689	-0.1481	-0.2395	-0.3419	-0.4542	-0.5780	-0.6981	-0.3991	0.4283
90.0	-0.4038	-0.3269	-0.2269	-0.1896	-0.1951	-0.2311	-0.2863	-0.3472	-0.3979	-0.4206	-0.3897	-0.2574	-0.0364	-0.3885
112.5	-0.7221	-0.9160	-0.8541	-0.7566	-0.6634	-0.5732	-0.4773	-0.3628	-0.2152	-0.0205	0.2304	0.4815	0.3580	-1.4586
135.0	-0.8512	-1.1020	-1.2029	-1.1657	-1.0299	-0.8220	-0.5614	-0.2644	0.0510	0.3607	0.6199	0.7260	0.5191	-1.1150
157.5	-0.6536	-0.8107	-0.8996	-0.8909	-0.7899	-0.6150	-0.3898	-0.1415	0.1017	0.3108	0.4520	0.4869	0.4008	-0.4722
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

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
180.0	0.0	-0.900	-2.138	-3.417	-4.532	-5.357	-5.822	-5.881	-5.512	-4.703	-3.485	-1.906	0.0	-57.885

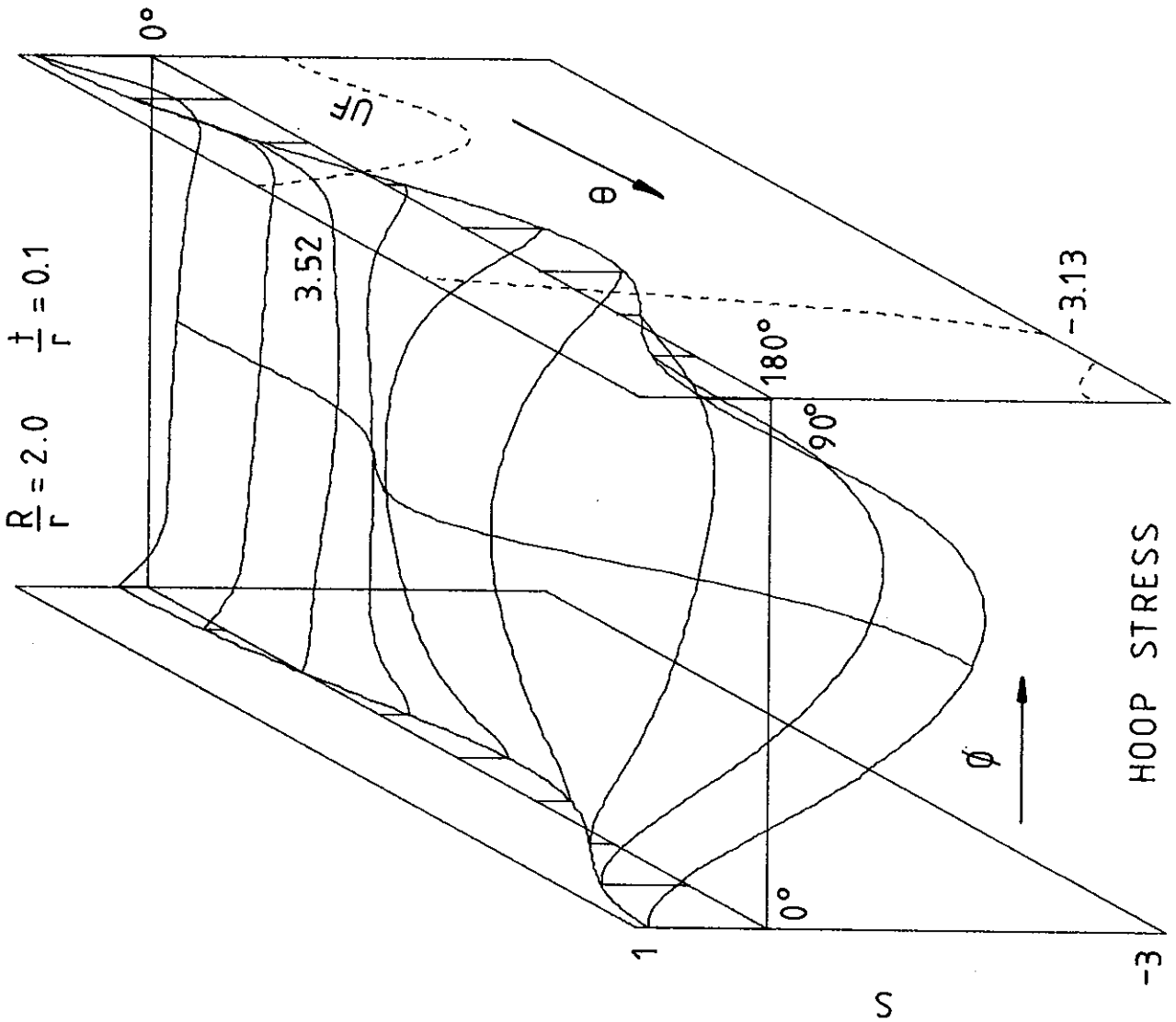


FIGURE A7

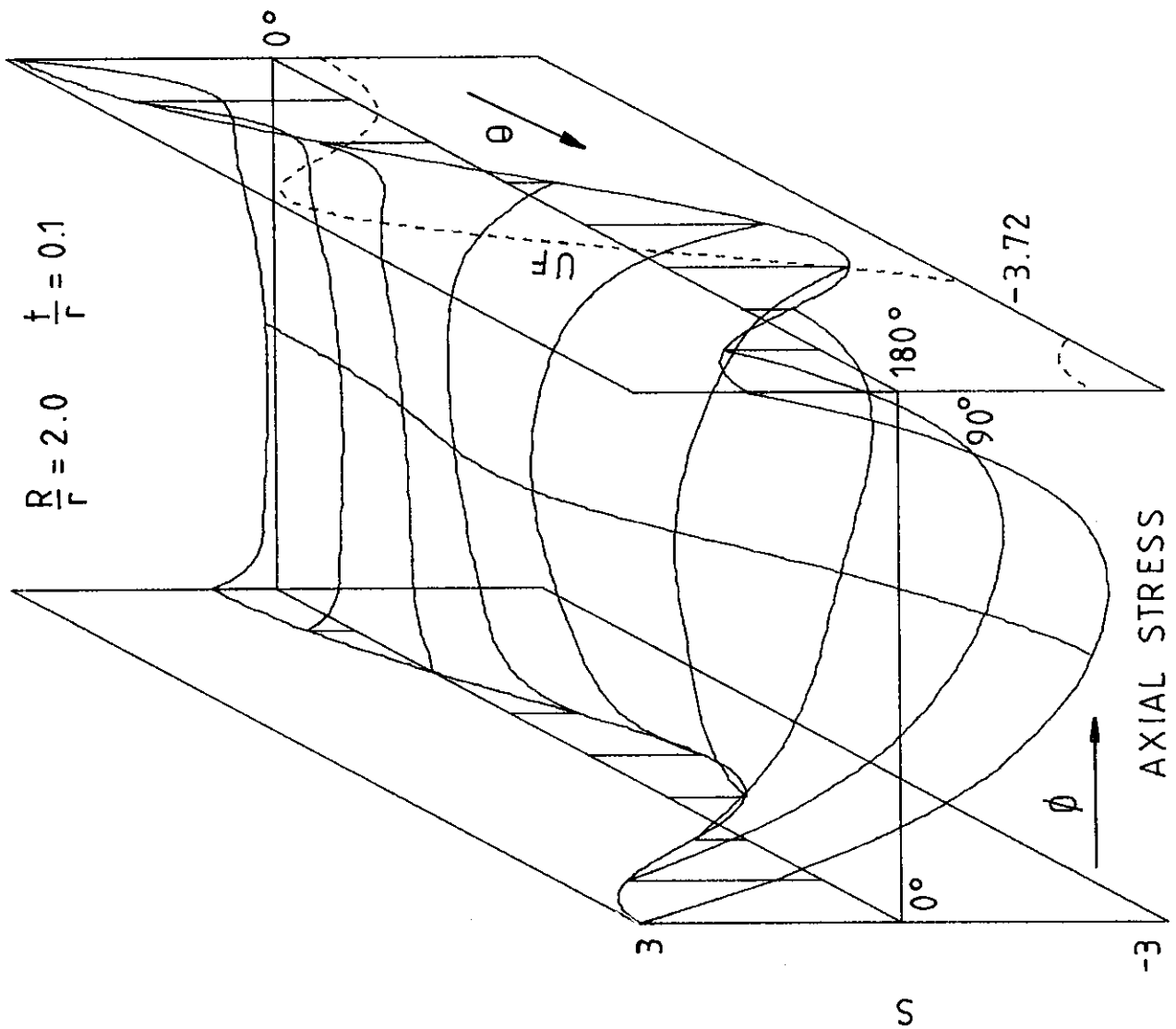


FIGURE A8

TABLE A7

R/r = 2.0 t/r = 0.1

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	Unflanged x sin
0.0	0.2183	-0.0833	-0.1496	-0.1582	-0.1710	-0.1872	-0.2065	-0.2295	-0.2562	-0.2960	-0.3663	-0.2033	0.8685	-0.9720
22.5	0.1623	-0.0782	-0.1448	-0.1724	-0.2007	-0.2268	-0.2500	-0.2700	-0.2856	-0.3047	-0.3408	-0.1729	0.7388	-1.2453
45.0	0.0002	-0.0628	-0.0883	-0.1361	-0.1851	-0.2231	-0.2471	-0.2550	-0.2447	-0.2219	-0.2025	-0.0928	0.3661	-1.2244
67.5	-0.2265	-0.0560	0.0640	0.0812	0.0741	0.0698	0.0725	0.0831	0.1011	0.1172	0.0930	-0.0338	-0.1626	0.6793
90.0	-0.3846	-0.1024	0.1683	0.3234	0.4278	0.5053	0.5529	0.5644	0.5351	0.4516	0.2623	-0.1381	-0.6078	3.3205
112.5	-0.2697	-0.1422	0.0154	0.1431	0.2468	0.3216	0.3522	0.3275	0.2458	0.1086	-0.0966	-0.3854	-0.6312	2.0743
135.0	0.1674	0.0534	-0.1414	-0.3151	-0.4482	-0.5496	-0.6327	-0.7015	-0.7446	-0.7364	-0.6433	-0.4398	-0.1775	-2.0656
157.5	0.6662	0.4612	0.0037	-0.4662	-0.8600	-1.1558	-1.3510	-1.4389	-1.3995	-1.1989	-0.8040	-0.2327	0.3233	-3.0251
180.0	0.8883	0.6735	0.1332	-0.4420	-0.9320	-1.2990	-1.5333	-1.6250	-1.5521	-1.2812	-0.7872	-0.1131	0.5098	-2.4286

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	Unflanged x sin
0.0	0.7277	0.1663	0.1251	0.0974	0.0783	0.0784	0.0983	0.1408	0.2146	0.3275	0.4211	0.5496	2.8951	-0.5232
22.5	0.5411	0.1664	0.1467	0.1245	0.1100	0.1138	0.1365	0.1813	0.2557	0.3653	0.4537	0.5547	2.4628	-0.2682
45.0	0.0005	0.1366	0.2111	0.2301	0.2490	0.2777	0.3159	0.3651	0.4290	0.5069	0.5461	0.5096	1.2203	0.8392
67.5	-0.7549	-0.0157	0.2383	0.3610	0.4640	0.5537	0.6225	0.6657	0.6807	0.6614	0.5583	0.2219	-0.5419	2.5234
90.0	-1.2820	-0.3390	0.0283	0.2347	0.4072	0.5428	0.6205	0.6264	0.5547	0.4031	0.1322	-0.4731	-2.0261	2.1508
112.5	-0.8992	-0.5175	-0.3652	-0.2723	-0.1818	-0.1163	-0.1079	-0.1740	-0.3143	-0.5133	-0.7739	-1.2121	-2.1042	-1.5176
135.0	0.5578	0.0031	-0.4025	-0.6706	-0.8446	-0.9768	-1.1054	-1.2439	-1.3786	-1.4662	-1.4373	-1.1993	-0.5917	-3.7202
157.5	2.2208	0.9527	-0.0374	-0.7415	-1.2369	-1.5932	-1.8494	-2.0142	-2.0662	-1.9433	-1.5211	-0.5952	1.0778	-2.7409
180.0	2.9609	1.3870	0.1369	-0.7692	-1.4131	-1.8678	-2.1714	-2.3318	-2.3280	-2.0957	-1.4973	-0.3097	1.6994	-2.1854

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	Unflanged x cos
0.0	0.0	0.0	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	0.0315	0.0104	0.0156	0.0039	-0.0102	-0.0252	-0.0423	-0.0629	-0.0886	-0.1227	-0.1663	-0.1805	-0.2365	-0.0760
45.0	0.0022	-0.0421	-0.0294	-0.0409	-0.0588	-0.0788	-0.1018	-0.1298	-0.1650	-0.2109	-0.2636	-0.2652	-0.3658	-0.2927
67.5	-0.1385	-0.1860	-0.1780	-0.1778	-0.1816	-0.1851	-0.1886	-0.1944	-0.2051	-0.2223	-0.2376	-0.2154	-0.3039	-0.6718
90.0	-0.3915	-0.3724	-0.3825	-0.3749	-0.3554	-0.3262	-0.2893	-0.2487	-0.2086	-0.1715	-0.1380	-0.1070	-0.0542	-0.8775
112.5	-0.6629	-0.5186	-0.5099	-0.4984	-0.4686	-0.4232	-0.3654	-0.2994	-0.2294	-0.1609	-0.1014	-0.0358	0.2379	-0.4218
135.0	-0.7907	-0.5921	-0.5270	-0.4968	-0.4671	-0.4289	-0.3800	-0.3197	-0.2490	-0.1711	-0.0846	0.0483	0.3808	0.2957
157.5	-0.5951	-0.4589	-0.3991	-0.3707	-0.3467	-0.3152	-0.2718	-0.2163	-0.1511	-0.0799	-0.0004	0.1087	0.2933	0.3511
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

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
90.0	0.0	0.746	1.963	3.091	4.032	4.728	5.110	5.120	4.726	3.908	2.651	1.060	0.0	34.050

TABLE A8

R/r = 2.0 t/r = 0.1

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	-0.0613	0.0417	0.0429	0.0676	0.0836	0.0911	0.0924	0.0869	0.0710	0.0325	-0.0117	0.1141	-0.2592	1.0663
22.5	-0.0358	0.0260	0.0501	0.0931	0.1238	0.1421	0.1489	0.1425	0.1189	0.0669	0.0017	0.0841	-0.2039	1.3675
45.0	0.0380	-0.0366	0.0120	0.0770	0.1257	0.1572	0.1686	0.1561	0.1164	0.0428	-0.0510	-0.0332	-0.0491	1.2984
67.5	0.1359	-0.1418	-0.1575	-0.1515	-0.1532	-0.1598	-0.1738	-0.1971	-0.2286	-0.2676	-0.3026	-0.2354	0.1468	-1.0690
90.0	0.1835	-0.1830	-0.3206	-0.4577	-0.5929	-0.7009	-0.7691	-0.7903	-0.7587	-0.6763	-0.5545	-0.3569	0.2338	-4.5626
112.5	0.0812	-0.0720	-0.1816	-0.3473	-0.5285	-0.6744	-0.7546	-0.7555	-0.6772	-0.5408	-0.3932	-0.2612	0.0351	-3.6131
135.0	-0.1813	0.0136	0.0714	0.0381	-0.0311	-0.0958	-0.1356	-0.1451	-0.1303	-0.1110	-0.1236	-0.2123	-0.4147	1.0521
157.5	-0.5121	-0.0571	0.0766	0.0669	0.0102	-0.0552	-0.1192	-0.1777	-0.2230	-0.2486	-0.2731	-0.3897	-0.8448	2.2527
180.0	-0.6949	-0.1127	0.0321	-0.0239	-0.1442	-0.2703	-0.3816	-0.4651	-0.5029	-0.4824	-0.4349	-0.5034	-1.0235	1.6143

INSIDE AXIAL STRESS FACTORS

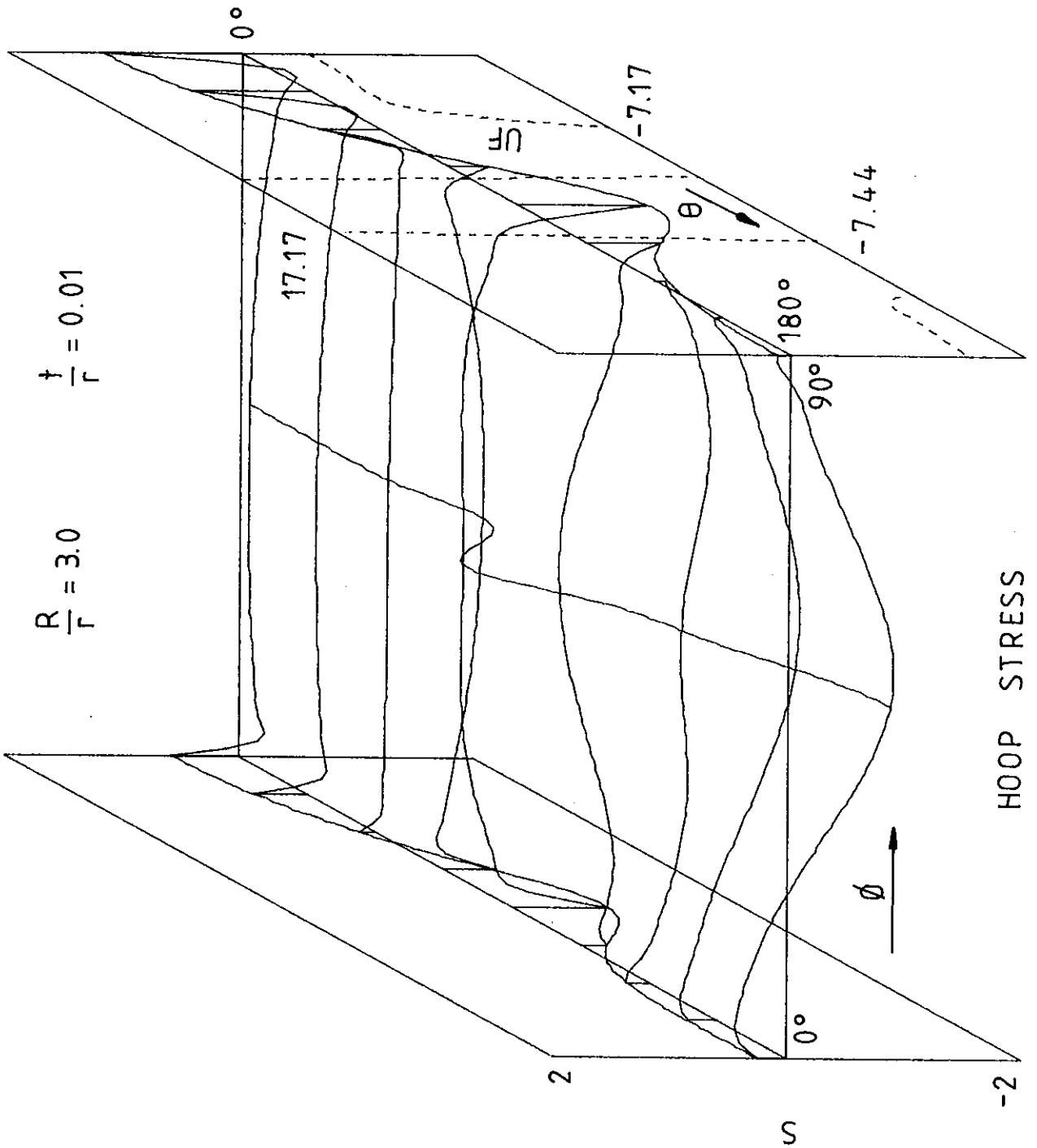
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
0.0	-0.2043	0.2517	0.1803	0.1401	0.1321	0.1409	0.1677	0.2159	0.2874	0.3924	0.6226	0.9674	-0.8640	-0.1898
22.5	-0.1192	0.2169	0.1772	0.1629	0.1696	0.1874	0.2187	0.2662	0.3303	0.4178	0.6044	0.8699	-0.6797	0.1238
45.0	0.1265	0.1170	0.1395	0.1938	0.2422	0.2844	0.3254	0.3659	0.4019	0.4303	0.4901	0.5792	-0.1637	0.7917
67.5	0.4531	-0.0191	0.0018	0.1103	0.1939	0.2513	0.2890	0.3055	0.2919	0.2339	0.1459	0.1399	0.4892	0.7231
90.0	0.6118	-0.1165	-0.2132	-0.1586	-0.1165	-0.1011	-0.1050	-0.1284	-0.1815	-0.2799	-0.3971	-0.2922	0.7793	-0.9615
112.5	0.2708	-0.1518	-0.3004	-0.3617	-0.4253	-0.4961	-0.5610	-0.6146	-0.6625	-0.7138	-0.7397	-0.5737	0.1168	-2.1495
135.0	-0.6044	-0.3483	-0.2459	-0.2584	-0.3360	-0.4318	-0.5133	-0.5658	-0.5930	-0.6177	-0.6848	-0.8777	-1.3824	-0.4856
157.5	-1.7069	-0.8862	-0.3724	-0.1434	-0.0899	-0.1157	-0.1611	-0.2011	-0.2455	-0.3523	-0.6548	-1.3830	-2.8160	1.3283
180.0	-2.3163	-1.2461	-0.5250	-0.1512	-0.0075	0.0182	-0.0026	-0.0399	-0.1075	-0.2796	-0.7179	-1.6767	-3.4115	1.6252

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	0.0	0.0	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	0.0285	0.1007	0.0660	0.0367	0.0147	-0.0062	-0.0293	-0.0572	-0.0930	-0.1418	-0.2192	-0.3377	-0.2140	0.1509
45.0	0.0020	0.1504	0.1170	0.0706	0.0273	-0.0187	-0.0716	-0.1344	-0.2105	-0.3065	-0.4400	-0.5976	-0.3309	0.2849
67.5	-0.1253	0.0450	0.0620	0.0321	-0.0158	-0.0776	-0.1528	-0.2400	-0.3374	-0.4436	-0.5560	-0.6178	-0.2750	0.2054
90.0	-0.3542	-0.3151	-0.2565	-0.2314	-0.2371	-0.2634	-0.3019	-0.3436	-0.3773	-0.3882	-0.3544	-0.2453	-0.0490	-0.3647
112.5	-0.5997	-0.8108	-0.8187	-0.7581	-0.6795	-0.5916	-0.4912	-0.3711	-0.2222	-0.0368	0.1765	0.3405	0.2152	-1.1448
135.0	-0.7154	-1.0559	-1.1907	-1.1679	-1.0393	-0.8370	-0.5809	-0.2872	0.0262	0.3297	0.5650	0.6205	0.3445	-1.2152
157.5	-0.5384	-0.7716	-0.9021	-0.9144	-0.8210	-0.6445	-0.4116	-0.1514	0.1028	0.3121	0.4318	0.4197	0.2653	-0.5886
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

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
180.0	0.0	-0.609	-1.644	-2.753	-3.758	-4.522	-4.955	-5.003	-4.642	-3.888	-2.806	-1.350	0.0	-28.858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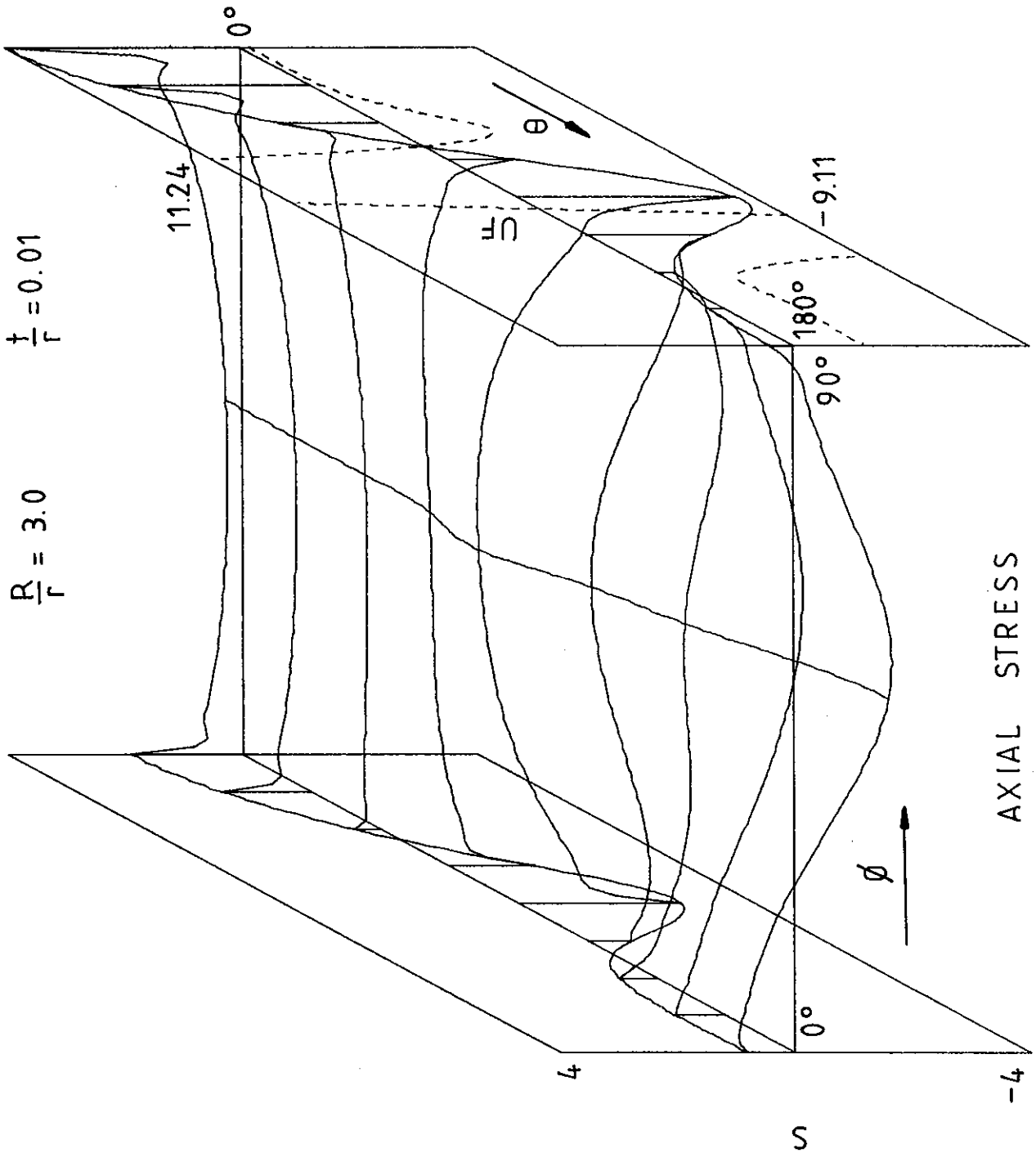
-7.17
UF
-7.44
θ
17.17
180°
90°
$\frac{t}{r} = 0.01$
$\frac{R}{r} = 3.0$
ϕ
0°
2
-2
S
HOOP STRESS

FIGURE A9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θ
11.24
σ_F
-9.11
180°
90°
$\frac{t}{r}$ = 0.01
$\frac{R}{r}$ = 3.0
ϕ
0°
4
-4
S
AXIAL STRESS

FIGURE A10

TABLE A9

R/r = 3.0 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	Unflanged x sin
0.0	0.5684	-0.1481	-0.1102	-0.0884	-0.0779	-0.0761	-0.0820	-0.0962	-0.1206	-0.1589	-0.2179	-0.3075	1.1969	-0.5456
22.5	0.4585	-0.1237	-0.0961	-0.0791	-0.0709	-0.0700	-0.0760	-0.0894	-0.1118	-0.1458	-0.1959	-0.2670	1.0238	-0.4599
45.0	0.1318	-0.0738	-0.0855	-0.0891	-0.0902	-0.0923	-0.0974	-0.1067	-0.1208	-0.1389	-0.1580	-0.1702	0.5148	-2.3238
67.5	-0.4390	-0.0059	-0.1086	-0.1952	-0.2567	-0.2955	-0.3160	-0.3196	-0.3020	-0.2548	-0.1703	-0.0533	-0.3473	-6.1749
90.0	-0.8307	0.1837	0.3455	0.4305	0.4537	0.4484	0.4422	0.4476	0.4590	0.4504	0.3810	0.2209	-1.1093	16.4706
112.5	-0.2273	-0.2619	-0.2464	-0.1215	0.0266	0.1430	0.2038	0.1964	0.1114	-0.0447	-0.2228	-0.3164	-0.6393	-2.9610
135.0	0.1935	-0.0739	-0.2234	-0.3117	-0.3093	-0.2678	-0.2584	-0.3164	-0.4169	-0.4873	-0.4594	-0.3449	-0.0969	-3.6769
157.5	0.2560	0.2274	0.0763	-0.1216	-0.3389	-0.5252	-0.6446	-0.6789	-0.6221	-0.4933	-0.3393	-0.2030	0.0835	-1.6083
180.0	0.2430	0.3878	0.2055	-0.0630	-0.3853	-0.6864	-0.8705	-0.8813	-0.7428	-0.5293	-0.3066	-0.1214	0.1238	-1.5177

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	Unflanged x sin
0.0	1.8946	0.5482	0.3790	0.2873	0.2438	0.2352	0.2569	0.3105	0.4040	0.5536	0.7894	1.1689	3.9898	-0.1488
22.5	1.5284	0.4871	0.3549	0.2803	0.2448	0.2400	0.2632	0.3165	0.4065	0.5462	0.7577	1.0801	3.4128	-0.1572
45.0	0.4395	0.2674	0.2407	0.2142	0.2012	0.2070	0.2342	0.2855	0.3640	0.4725	0.6103	0.7652	1.7160	-1.4245
67.5	-1.4634	-0.1170	0.1131	0.2139	0.2597	0.2889	0.3200	0.3597	0.4035	0.4309	0.3922	0.1834	-1.1576	3.7046
90.0	-2.7688	-0.7832	-0.2007	0.1960	0.4451	0.5920	0.6699	0.6861	0.6156	0.3994	-0.0470	-0.8167	-3.6977	8.3006
112.5	-0.7577	-1.0631	-0.9656	-0.6897	-0.3930	-0.1716	-0.0771	-0.1390	-0.3725	-0.7645	-1.2401	-1.6290	-2.1309	-9.1057
135.0	0.6450	-0.1387	-0.4521	-0.5879	-0.5637	-0.4954	-0.4999	-0.6330	-0.8631	-1.0784	-1.1379	-0.9761	-0.3230	-1.5531
157.5	0.8535	0.4986	0.1572	-0.2603	-0.6756	-1.0139	-1.2373	-1.3274	-1.2656	-1.0561	-0.7548	-0.4495	0.2782	-1.2755
180.0	0.8099	0.7596	0.4147	-0.0914	-0.6940	-1.2565	-1.6072	-1.6438	-1.4009	-1.0083	-0.5909	-0.2372	0.4126	-1.2011

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	Unflanged x cos
0.0	0.0	0.0	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	0.2375	0.1542	0.0877	0.0463	0.0174	-0.0061	-0.0291	-0.0556	-0.0903	-0.1402	-0.2172	-0.3431	-0.5070	-0.0306
45.0	0.3361	0.2506	0.1526	0.0834	0.0297	-0.0173	-0.0647	-0.1191	-0.1882	-0.2821	-0.4161	-0.6137	-0.8135	-0.0525
67.5	0.0897	0.1347	0.1032	0.0609	0.0103	-0.0477	-0.1140	-0.1906	-0.2798	-0.3828	-0.4985	-0.6226	-0.6401	-0.6435
90.0	-0.5633	-0.3443	-0.2179	-0.1547	-0.1382	-0.1568	-0.1975	-0.2449	-0.2816	-0.2883	-0.2423	-0.1117	0.1813	-1.2668
112.5	-0.8117	-0.7186	-0.5730	-0.4641	-0.3876	-0.3321	-0.2840	-0.2278	-0.1458	-0.0185	0.1765	0.4593	0.7400	0.3668
135.0	-0.5544	-0.7241	-0.7873	-0.7482	-0.6431	-0.4957	-0.3169	-0.1127	0.1111	0.3422	0.5500	0.6795	0.6639	0.2867
157.5	-0.2449	-0.3912	-0.5438	-0.6271	-0.6004	-0.4602	-0.2363	0.0215	0.2545	0.4103	0.4639	0.4333	0.3677	0.1182
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

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
90.0	0.0	5.279	10.592	15.129	18.397	20.450	21.466	21.496	20.351	17.662	13.132	7.040	0.0	609.657

TABLE A10

R/r = 3.0 t/r = 0.01

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	-0.0619	-0.1239	-0.0798	-0.0561	-0.0449	-0.0425	-0.0475	-0.0603	-0.0827	-0.1192	-0.1779	-0.2733	-0.1257	0.6044
22.5	-0.0407	-0.1031	-0.0708	-0.0528	-0.0443	-0.0430	-0.0480	-0.0597	-0.0799	-0.1116	-0.1608	-0.2371	-0.0897	0.5254
45.0	0.0112	-0.0281	-0.0119	-0.0018	0.0021	0.0010	-0.0047	-0.0148	-0.0299	-0.0512	-0.0808	-0.1197	-0.0004	2.4724
67.5	0.0733	0.0452	0.1028	0.1687	0.2192	0.2500	0.2626	0.2574	0.2311	0.1790	0.1028	0.0280	0.1029	6.1819
90.0	-0.0164	-0.2034	-0.3892	-0.4791	-0.5005	-0.4919	-0.4834	-0.4889	-0.5027	-0.4969	-0.4256	-0.2409	0.0161	-18.3146
112.5	-0.2236	0.0172	0.0332	-0.0329	-0.1196	-0.1902	-0.2341	-0.2465	-0.2195	-0.1536	-0.0843	-0.0865	-0.3243	2.1115
135.0	-0.0478	-0.0144	-0.0169	0.0139	0.0166	-0.0083	-0.0329	-0.0429	-0.0533	-0.0976	-0.1840	-0.2462	-0.2987	3.4790
157.5	0.1803	0.1956	0.0333	-0.1131	-0.2154	-0.2846	-0.3396	-0.3877	-0.4216	-0.4143	-0.3364	-0.2039	-0.1772	1.3713
180.0	0.2921	0.3150	0.1517	-0.0449	-0.2568	-0.4410	-0.5653	-0.6113	-0.5681	-0.4495	-0.2981	-0.1440	-0.1110	1.2820

INSIDE AXIAL STRESS FACTORS

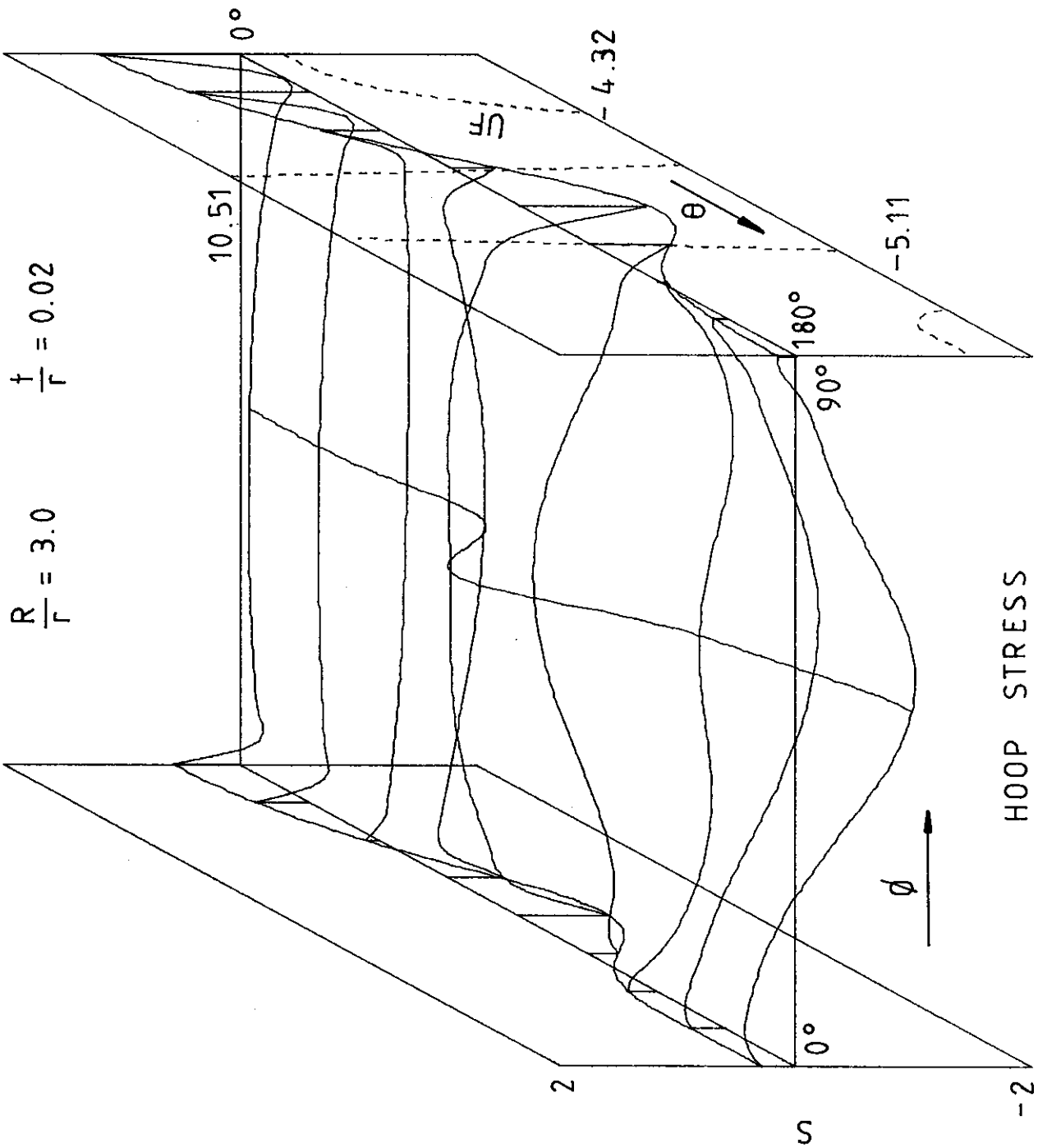
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
0.0	-0.2063	0.5466	0.3813	0.2905	0.2474	0.2391	0.2610	0.3151	0.4090	0.5588	0.7941	1.1680	-0.4190	-0.0797
22.5	-0.1357	0.4818	0.3541	0.2806	0.2456	0.2412	0.2648	0.3184	0.4087	0.5483	0.7587	1.0736	-0.2992	-0.1686
45.0	0.0373	0.2618	0.2492	0.2295	0.2194	0.2260	0.2533	0.3040	0.3812	0.4866	0.6167	0.7525	-0.0015	-0.4362
67.5	0.2443	-0.1393	0.1293	0.2755	0.3557	0.4065	0.4479	0.4865	0.5151	0.5090	0.4173	0.1525	0.3431	5.7464
90.0	-0.0547	-0.8636	-0.4542	-0.1403	0.0824	0.2280	0.3058	0.3127	0.2292	0.0207	-0.3585	-0.9478	0.0537	-3.0436
112.5	-0.7452	-0.8274	-0.7459	-0.5755	-0.4006	-0.2739	-0.2314	-0.2947	-0.4695	-0.7436	-1.0802	-1.3952	-1.0810	-5.4392
135.0	-0.1594	-0.0964	-0.3096	-0.3855	-0.3918	-0.3915	-0.4298	-0.5275	-0.6776	-0.8413	-0.9459	-0.8936	-0.9957	1.8034
157.5	0.6011	0.4397	0.0985	-0.2537	-0.5662	-0.8137	-0.9881	-1.0816	-1.0813	-0.9715	-0.7527	-0.4533	-0.5906	0.7266
180.0	0.9737	0.6343	0.3069	-0.1217	-0.5903	-1.0040	-1.2734	-1.3459	-1.2199	-0.9483	-0.6160	-0.2793	-0.3701	0.7425

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	0.0	0.0	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	0.2351	0.1598	0.0899	0.0471	0.0178	-0.0058	-0.0286	-0.0549	-0.0897	-0.1402	-0.2191	-0.3502	-0.5020	0.0544
45.0	0.3327	0.2635	0.1572	0.0845	0.0298	-0.0172	-0.0641	-0.1179	-0.1866	-0.2816	-0.4201	-0.6296	-0.8054	0.1927
67.5	0.0888	0.2188	0.1688	0.1029	0.0339	-0.0363	-0.1110	-0.1958	-0.2973	-0.4205	-0.5655	-0.7186	-0.6337	0.6154
90.0	-0.5577	-0.3075	-0.1188	-0.0439	-0.0466	-0.0982	-0.1783	-0.2704	-0.3556	-0.4042	-0.3705	-0.1888	0.1795	-0.5771
112.5	-0.8036	-0.8792	-0.7032	-0.5177	-0.3850	-0.3170	-0.2893	-0.2573	-0.1702	0.0123	0.2985	0.6382	0.7326	-1.2277
135.0	-0.5489	-0.7294	-0.8668	-0.8828	-0.7791	-0.5911	-0.3500	-0.0734	0.2180	0.4813	0.6577	0.7145	0.6573	-0.3831
157.5	-0.2425	-0.3882	-0.5749	-0.7047	-0.7080	-0.5469	-0.2537	0.0789	0.3460	0.4856	0.5035	0.4476	0.3640	-0.2086
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

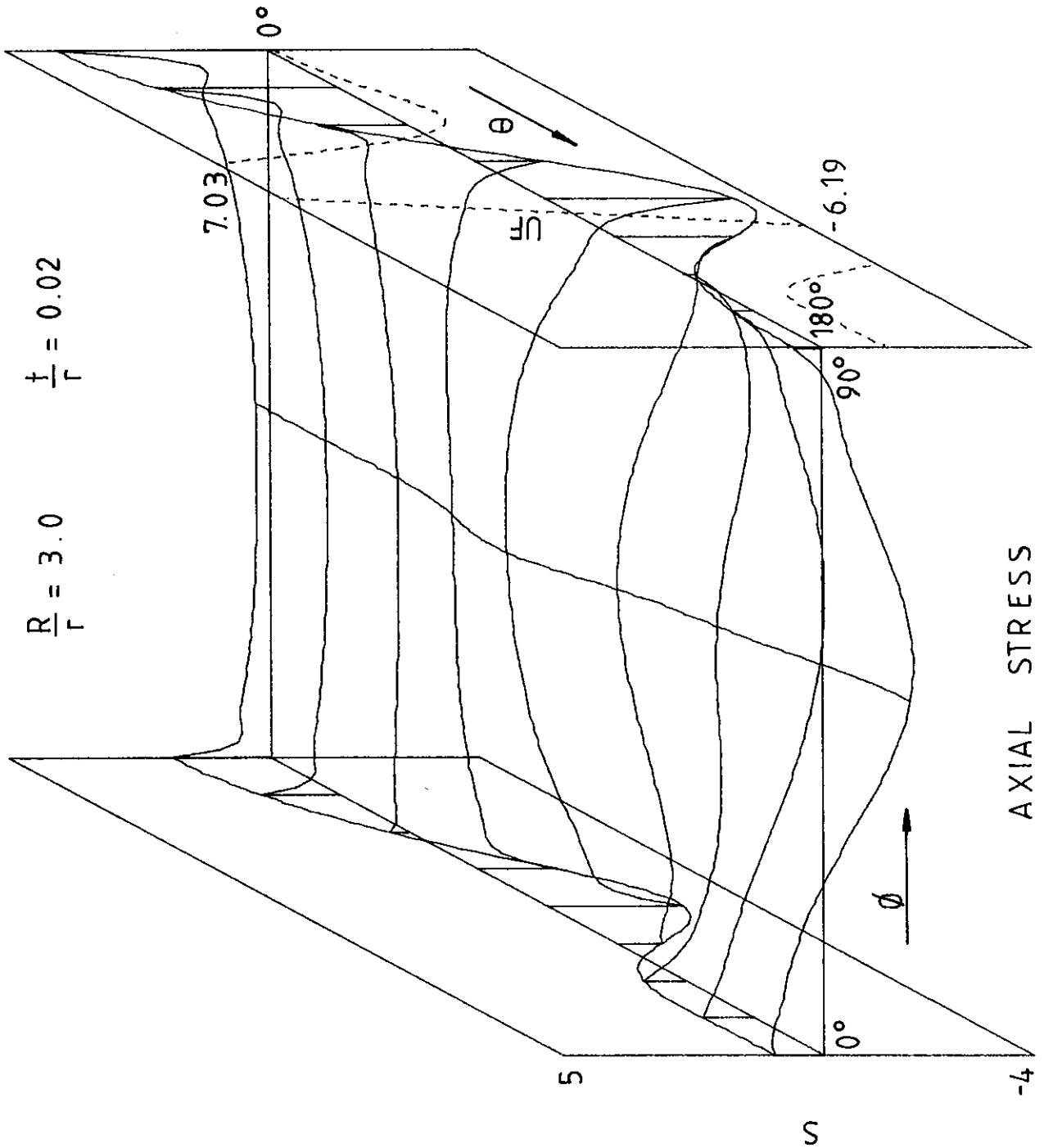
DIAMETER EXPANSION FACTORS

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
180.0	0.0	-1.791	-4.118	-7.137	-10.407	-13.180	-14.652	-14.377	-12.512	-9.661	-6.495	-3.509	0.0	-313.478



HOOP STRESS

FIGURE A11



AXIAL STRESS

FIGURE A12

TABLE A11

R/r = 3.0 t/r = 0.02

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	Unflanged x sin
0.0	0.5595	-0.1523	-0.1113	-0.0893	-0.0787	-0.0770	-0.0834	-0.0983	-0.1237	-0.1633	-0.2237	-0.3212	1.2113	-0.3517
22.5	0.4500	-0.1348	-0.1070	-0.0903	-0.0811	-0.0791	-0.0845	-0.0981	-0.1217	-0.1577	-0.2092	-0.2868	1.0358	-0.6758
45.0	0.1054	-0.1040	-0.1578	-0.1931	-0.2144	-0.2277	-0.2380	-0.2475	-0.2551	-0.2565	-0.2441	-0.2147	0.4982	-3.3810
67.5	-0.4661	0.0622	-0.0338	-0.1275	-0.2095	-0.2689	-0.3015	-0.3039	-0.2720	-0.2031	-0.1033	0.0179	-0.3898	-1.7609
90.0	-0.7836	0.2198	0.3942	0.5126	0.5616	0.5734	0.5778	0.5879	0.5944	0.5660	0.4607	0.2862	-1.0762	10.1053
112.5	-0.2609	-0.2258	-0.1589	0.0227	0.2201	0.3741	0.4541	0.4439	0.3351	0.1378	-0.0979	-0.2478	-0.6988	1.2184
135.0	0.2418	-0.1584	-0.3717	-0.4647	-0.4449	-0.3824	-0.3611	-0.4228	-0.5414	-0.6348	-0.6145	-0.4464	-0.0649	-4.6966
157.5	0.2910	0.2546	0.0723	-0.1644	-0.4110	-0.6135	-0.7419	-0.7803	-0.7205	-0.5715	-0.3781	-0.1947	0.1237	-1.6386
180.0	0.2761	0.3957	0.2281	-0.0462	-0.4142	-0.7714	-0.9880	-0.9905	-0.8065	-0.5407	-0.3018	-0.1179	0.1624	-1.4871

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	Unflanged x sin
0.0	1.8650	0.5258	0.3586	0.2718	0.2313	0.2242	0.2463	0.2993	0.3911	0.5375	0.7682	1.1533	4.0378	-0.1011
22.5	1.5001	0.4586	0.3214	0.2465	0.2113	0.2069	0.2302	0.2830	0.3722	0.5111	0.7225	1.0565	3.4528	-0.4856
45.0	0.3514	0.2569	0.2205	0.1832	0.1605	0.1589	0.1816	0.2319	0.3136	0.4303	0.5808	0.7533	1.6606	-0.7885
67.5	-1.5535	-0.0514	0.2053	0.3326	0.3920	0.4265	0.4600	0.5015	0.5446	0.5628	0.4998	0.2637	-1.2992	4.3795
90.0	-2.6120	-0.6876	-0.1632	0.2338	0.4997	0.6658	0.7557	0.7727	0.6918	0.4615	0.0115	-0.6883	-3.5873	5.0986
112.5	-0.8696	-1.0745	-0.9562	-0.6773	-0.3784	-0.1505	-0.0498	-0.1091	-0.3409	-0.7281	-1.2034	-1.5933	-2.3292	-5.6298
135.0	0.8059	-0.2366	-0.5654	-0.7066	-0.6892	-0.6293	-0.6382	-0.7705	-0.9977	-1.2146	-1.2800	-1.1102	-0.2164	-3.0197
157.5	0.9700	0.5322	0.1707	-0.2722	-0.6997	-1.0460	-1.2768	-1.3713	-1.3135	-1.1022	-0.7761	-0.4642	0.4125	-1.0715
180.0	0.9202	0.7673	0.4402	-0.0682	-0.7075	-1.3071	-1.6797	-1.7186	-1.4511	-1.0176	-0.5841	-0.2793	0.5413	-1.2161

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	Unflanged x cos
0.0	0.0	0.0	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	0.2103	0.1493	0.0853	0.0452	0.0168	-0.0065	-0.0292	-0.0554	-0.0899	-0.1393	-0.2151	-0.3383	-0.4697	-0.0126
45.0	0.2816	0.2322	0.1423	0.0794	0.0289	-0.0168	-0.0640	-0.1185	-0.1872	-0.2791	-0.4074	-0.5969	-0.7403	-0.1108
67.5	0.0234	0.0723	0.0515	0.0255	-0.0109	-0.0584	-0.1169	-0.1853	-0.2629	-0.3487	-0.4427	-0.5506	-0.5426	-0.6883
90.0	-0.5191	-0.3521	-0.2562	-0.2044	-0.1830	-0.1857	-0.2044	-0.2273	-0.2411	-0.2330	-0.1892	-0.0844	0.1555	-0.9879
112.5	-0.7570	-0.6492	-0.5404	-0.4662	-0.4075	-0.3495	-0.2853	-0.2110	-0.1223	-0.0089	0.1504	0.3891	0.6689	0.0909
135.0	-0.5449	-0.6764	-0.6960	-0.6513	-0.5686	-0.4518	-0.3032	-0.1316	0.0536	0.2480	0.4448	0.6067	0.6314	0.3722
157.5	-0.2562	-0.3952	-0.5119	-0.5450	-0.4910	-0.3744	-0.2178	-0.0353	0.1555	0.3210	0.4168	0.4172	0.3568	0.1192
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

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
90.0	0.0	4.290	8.683	12.661	15.721	17.764	18.812	18.840	17.693	15.150	11.105	5.928	0.0	267.158

TABLE A12

R/r = 3.0 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	-0.0810	-0.1164	-0.0677	-0.0462	-0.0363	-0.0344	-0.0391	-0.0509	-0.0717	-0.1057	-0.1611	-0.2694	-0.1694	0.4101
22.5	-0.0564	-0.0879	-0.0488	-0.0323	-0.0259	-0.0262	-0.0319	-0.0432	-0.0616	-0.0903	-0.1364	-0.2261	-0.1273	0.7501
45.0	0.0170	0.0135	0.0728	0.1149	0.1390	0.1490	0.1487	0.1391	0.1182	0.0806	0.0196	-0.0727	-0.0076	3.5397
67.5	0.1155	-0.0158	0.0201	0.0968	0.1706	0.2242	0.2503	0.2444	0.2031	0.1272	0.0314	-0.0354	0.1523	1.5497
90.0	0.0427	-0.2341	-0.4645	-0.5915	-0.6381	-0.6441	-0.6451	-0.6569	-0.6692	-0.6462	-0.5372	-0.2996	0.1019	-11.5691
112.5	-0.2073	0.0216	-0.0474	-0.1950	-0.3529	-0.4748	-0.5445	-0.5540	-0.4940	-0.3662	-0.2107	-0.1149	-0.2679	-2.2371
135.0	-0.1167	0.0930	0.1586	0.2004	0.1623	0.0867	0.0346	0.0372	0.0721	0.0771	-0.0031	-0.1246	-0.3596	4.4837
157.5	0.1337	0.1581	0.0103	-0.0677	-0.1126	-0.1516	-0.1931	-0.2364	-0.2828	-0.3227	-0.3223	-0.2078	-0.2313	1.4084
180.0	0.2330	0.2681	0.0835	-0.0923	-0.2095	-0.2717	-0.3272	-0.4033	-0.4661	-0.4518	-0.3419	-0.1516	-0.1814	1.2516

INSIDE AXIAL STRESS FACTORS

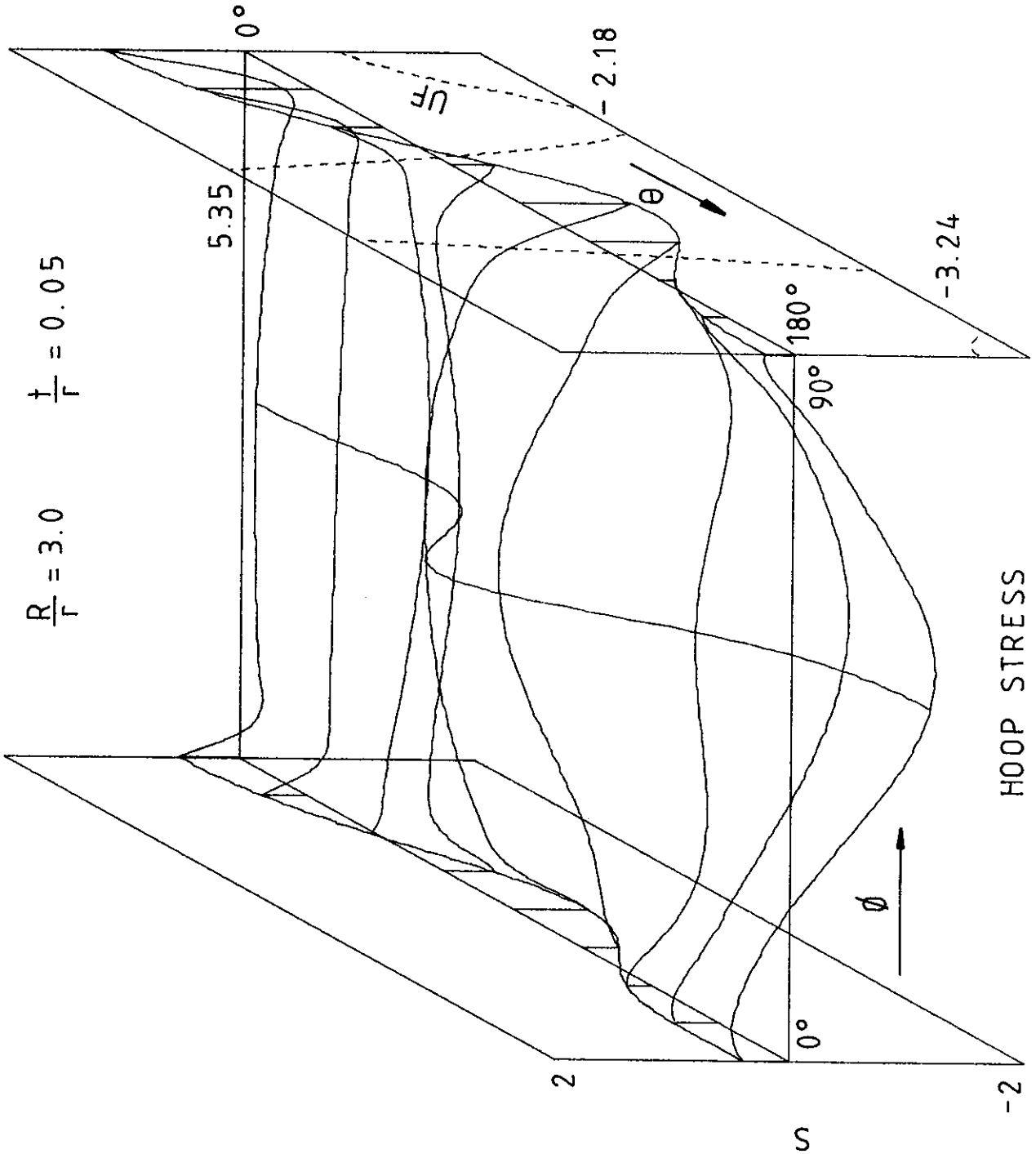
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
0.0	-0.2698	0.5109	0.3587	0.2723	0.2319	0.2251	0.2478	0.3016	0.3944	0.5419	0.7732	1.1264	-0.5646	-0.1488
22.5	-0.1879	0.4456	0.3238	0.2504	0.2152	0.2104	0.2336	0.2870	0.3772	0.5169	0.7273	1.0308	-0.4245	-0.3571
45.0	0.0568	0.2492	0.2582	0.2489	0.2423	0.2490	0.2753	0.3251	0.4012	0.5028	0.6228	0.7338	-0.0252	0.7179
67.5	0.3851	-0.1601	0.1350	0.3078	0.4134	0.4825	0.5333	0.5710	0.5869	0.5553	0.4294	0.1212	0.5078	3.8747
90.0	0.1422	-0.8137	-0.4546	-0.1824	0.0267	0.1717	0.2489	0.2498	0.1596	-0.0428	-0.3833	-0.9315	0.3396	-2.0883
112.5	-0.6911	-0.7656	-0.7195	-0.6174	-0.5074	-0.4267	-0.4056	-0.4635	-0.6034	-0.8139	-1.0696	-1.3511	-0.8931	-4.9739
135.0	-0.3890	-0.0508	-0.2305	-0.3132	-0.3713	-0.4305	-0.4999	-0.5829	-0.6809	-0.7866	-0.8698	-0.8427	-1.1988	1.1087
157.5	0.4456	0.3827	0.0786	-0.2089	-0.4634	-0.6759	-0.8335	-0.9247	-0.9424	-0.8813	-0.7335	-0.4610	-0.7712	0.9457
180.0	0.7768	0.5302	0.2140	-0.1673	-0.5255	-0.8146	-1.0150	-1.1135	-1.0896	-0.9317	-0.6657	-0.3223	-0.6046	0.7112

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	0.0	0.0	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	0.2061	0.1549	0.0863	0.0445	0.0161	-0.0066	-0.0286	-0.0539	-0.0877	-0.1371	-0.2153	-0.3454	-0.4604	0.0590
45.0	0.2760	0.2724	0.1645	0.0891	0.0324	-0.0157	-0.0629	-0.1171	-0.1871	-0.2848	-0.4277	-0.6415	-0.7256	0.2622
67.5	0.0229	0.2202	0.1805	0.1194	0.0494	-0.0250	-0.1057	-0.1977	-0.3068	-0.4362	-0.5823	-0.7303	-0.5319	0.4258
90.0	-0.5088	-0.3131	-0.1275	-0.0462	-0.0428	-0.0933	-0.1767	-0.2729	-0.3587	-0.4029	-0.3628	-0.1858	0.1524	-0.4759
112.5	-0.7420	-0.8929	-0.7089	-0.5306	-0.4009	-0.3291	-0.2937	-0.2533	-0.1608	0.0206	0.3005	0.6502	0.6557	-1.1383
135.0	-0.5342	-0.7453	-0.8893	-0.8998	-0.7938	-0.6046	-0.3593	-0.0777	0.2175	0.4887	0.6805	0.7489	0.6189	-0.4825
157.5	-0.2511	-0.3596	-0.5636	-0.7082	-0.7163	-0.5547	-0.2604	0.0757	0.3497	0.4912	0.4960	0.4226	0.3497	-0.1906
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

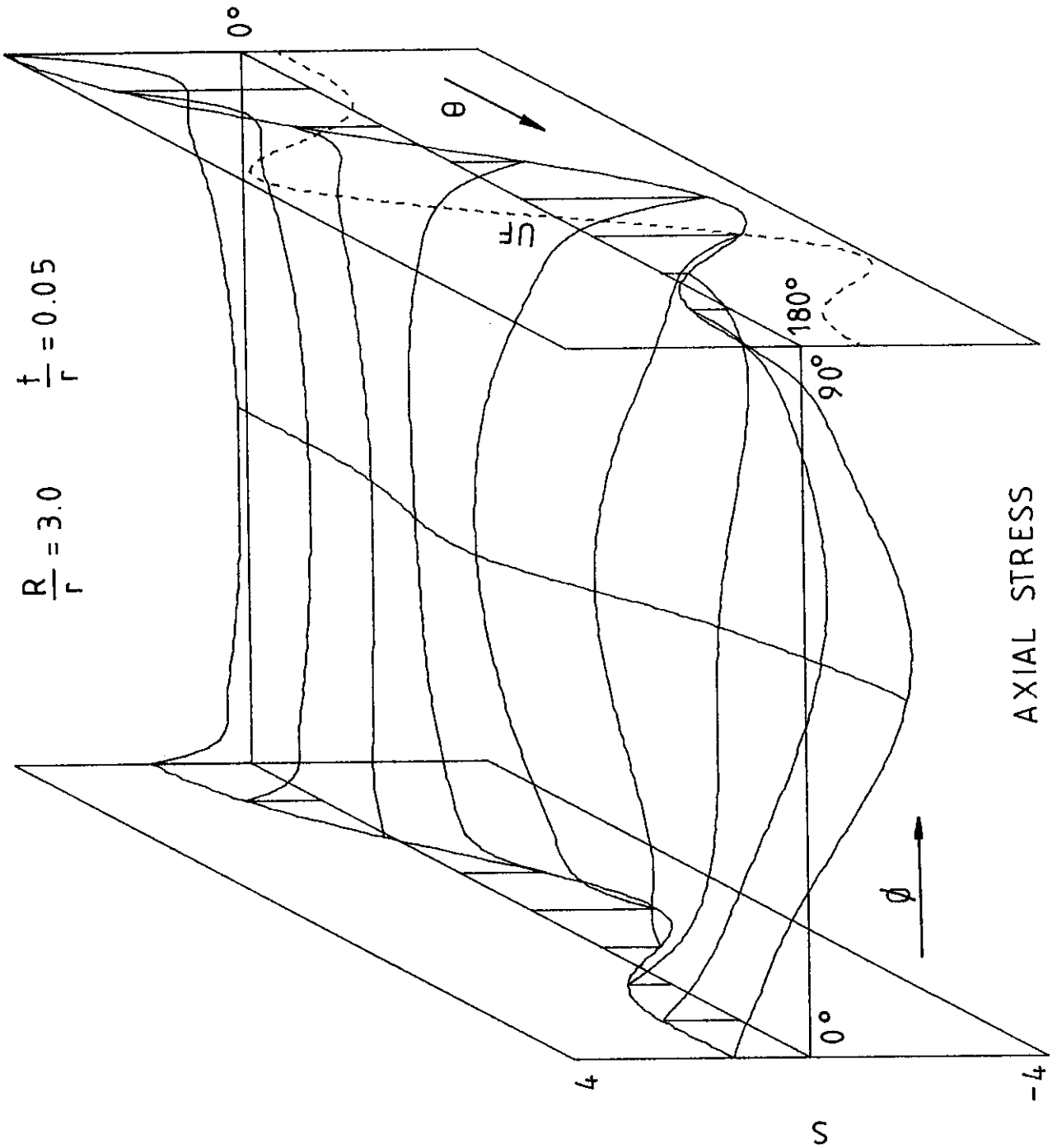
DIAMETER EXPANSION FACTORS

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
180.0	0.0	-1.711	-3.880	-6.744	-9.900	-12.600	-14.055	-13.826	-12.032	-9.256	-6.208	-3.367	0.0	-156.388



HOOP STRESS

FIGURE A13



AXIAL STRESS

FIGURE A14

TABLE A13

R/r = 3.0 t/r = 0.05

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	Unflanged x sin
0.0	0.5049	-0.1974	-0.1516	-0.1352	-0.1234	-0.1186	-0.1233	-0.1395	-0.1690	-0.2136	-0.2723	-0.4176	1.1956	-0.8007
22.5	0.3855	-0.1811	-0.1858	-0.2018	-0.2128	-0.2224	-0.2338	-0.2488	-0.2678	-0.2895	-0.3099	-0.3835	1.0024	-1.4880
45.0	0.0351	-0.0831	-0.1718	-0.2578	-0.3286	-0.3809	-0.4127	-0.4220	-0.4062	-0.3631	-0.2913	-0.2229	0.4318	-2.1254
67.5	-0.4297	0.1251	0.1218	0.0688	0.0014	-0.0589	-0.0926	-0.0891	-0.0487	0.0159	0.0858	0.1053	-0.3754	0.7810
90.0	-0.6437	0.1653	0.3947	0.5569	0.6708	0.7405	0.7784	0.7884	0.7616	0.6774	0.5249	0.2411	-0.9404	5.1789
112.5	-0.3036	-0.1357	-0.0166	0.2026	0.4431	0.6386	0.7428	0.7285	0.5926	0.3587	0.0903	-0.1721	-0.7575	2.4628
135.0	0.2137	-0.1651	-0.4102	-0.4634	-0.4272	-0.3696	-0.3496	-0.3976	-0.5005	-0.6051	-0.6302	-0.4636	-0.1389	-2.7850
157.5	0.3923	0.2287	-0.0785	-0.3639	-0.6428	-0.8757	-1.0247	-1.0675	-0.9982	-0.8328	-0.5990	-0.2333	0.2090	-2.5731
180.0	0.3826	0.4366	0.1897	-0.1565	-0.5707	-0.9470	-1.1783	-1.2050	-1.0344	-0.7417	-0.4276	-0.0644	0.2673	-1.5761

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	Unflanged x sin
0.0	1.6829	0.3728	0.2605	0.1709	0.1302	0.1228	0.1437	0.1943	0.2828	0.4261	0.6622	0.9112	3.9852	-0.5708
22.5	1.2850	0.3470	0.2487	0.1660	0.1226	0.1106	0.1284	0.1790	0.2696	0.4134	0.6375	0.8637	3.3414	-0.4949
45.0	0.1171	0.2755	0.2746	0.2571	0.2379	0.2324	0.2515	0.3017	0.3861	0.5017	0.6404	0.7333	1.4393	0.7256
67.5	-1.4325	0.0542	0.2899	0.4670	0.5737	0.6436	0.6973	0.7419	0.7686	0.7495	0.6360	0.3960	-1.2514	3.3097
90.0	-2.1455	-0.4943	-0.1202	0.2479	0.5325	0.7335	0.8470	0.8620	0.7606	0.5146	0.0935	-0.4412	-3.1345	2.6066
112.5	-1.0121	-0.9046	-0.8155	-0.5590	-0.2883	-0.0746	0.0256	-0.0243	-0.2335	-0.5836	-1.0175	-1.3595	-2.5251	-2.3814
135.0	0.7123	-0.3832	-0.7211	-0.8307	-0.8531	-0.8560	-0.8975	-1.0071	-1.1749	-1.3508	-1.4501	-1.2890	-0.4632	-3.5619
157.5	1.3078	0.5166	0.0495	-0.3900	-0.8250	-1.1905	-1.4411	-1.5483	-1.4986	-1.3019	-1.0081	-0.5704	0.6967	-1.5792
180.0	1.2754	0.8697	0.4334	-0.1294	-0.7766	-1.3460	-1.7092	-1.7941	-1.5940	-1.1825	-0.7214	-0.2489	0.8910	-0.9911

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	Unflanged x cos
0.0	0.0	0.0	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	0.1421	0.1218	0.0734	0.0418	0.0176	-0.0045	-0.0278	-0.0552	-0.0901	-0.1373	-0.2059	-0.3156	-0.3794	-0.0412
45.0	0.1484	0.1296	0.0799	0.0416	0.0091	-0.0255	-0.0656	-0.1135	-0.1715	-0.2446	-0.3445	-0.4848	-0.5583	-0.2372
67.5	-0.0738	-0.0578	-0.0596	-0.0696	-0.0815	-0.1010	-0.1288	-0.1638	-0.2045	-0.2517	-0.3122	-0.3716	-0.3766	-0.6069
90.0	-0.4312	-0.3341	-0.3038	-0.2837	-0.2645	-0.2419	-0.2159	-0.1886	-0.1622	-0.1374	-0.1093	-0.0514	0.1011	-0.7007
112.5	-0.6293	-0.4969	-0.4708	-0.4425	-0.4090	-0.3552	-0.2801	-0.1930	-0.1041	-0.0145	0.0932	0.2233	0.5039	-0.1501
135.0	-0.5287	-0.5360	-0.5157	-0.4668	-0.4104	-0.3468	-0.2720	-0.1815	-0.0706	0.0675	0.2348	0.3855	0.5544	0.3110
157.5	-0.2797	-0.3869	-0.3912	-0.3435	-0.2783	-0.2228	-0.1764	-0.1186	-0.0262	0.1065	0.2500	0.3377	0.3368	0.2034
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

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
90.0	0.0	2.660	5.754	8.726	11.270	13.126	14.122	14.134	13.080	10.942	7.837	3.923	0.0	85.891

TABLE A14

R/r = 3.0 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	-0.1061	-0.0335	0.0064	0.0261	0.0303	0.0269	0.0198	0.0101	-0.0039	-0.0281	-0.0764	-0.1545	-0.2403	0.8600
22.5	-0.0678	-0.0041	0.0648	0.1088	0.1323	0.1420	0.1420	0.1332	0.1128	0.0739	0.0034	-0.1028	-0.1785	1.5775
45.0	0.0409	-0.0040	0.1065	0.2001	0.2765	0.3279	0.3511	0.3427	0.2988	0.2159	0.0955	-0.0595	-0.0020	2.1935
67.5	0.1548	-0.1690	-0.1635	-0.1284	-0.0610	0.0010	0.0324	0.0198	-0.0356	-0.1160	-0.1816	-0.2343	0.2031	-1.1452
90.0	0.1108	-0.2791	-0.4940	-0.6899	-0.8090	-0.8765	-0.9136	-0.9284	-0.9099	-0.8287	-0.6435	-0.4348	0.2042	-6.2579
112.5	-0.1149	-0.0146	-0.1470	-0.3921	-0.6467	-0.8554	-0.9728	-0.9732	-0.8538	-0.6375	-0.3726	-0.2240	-0.1137	-3.4689
135.0	-0.1967	0.2021	0.2769	0.2557	0.1487	0.0172	-0.0655	-0.0620	0.0111	0.0879	0.0954	-0.0155	-0.3978	2.4018
157.5	-0.0176	0.1623	0.1066	0.1328	0.1888	0.2286	0.2314	0.1869	0.0951	-0.0299	-0.1346	-0.1213	-0.3905	2.3558
180.0	0.1003	0.1457	-0.0392	-0.0762	0.0118	0.1218	0.1591	0.0760	-0.1036	-0.2913	-0.3541	-0.1843	-0.3341	1.3405

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	-0.3535	0.4791	0.2782	0.1954	0.1525	0.1425	0.1626	0.2153	0.3086	0.4579	0.6830	1.1738	-0.8009	-0.3466
22.5	-0.2259	0.4169	0.2833	0.2257	0.1950	0.1903	0.2123	0.2645	0.3533	0.4886	0.6805	1.0742	-0.5949	0.0791
45.0	0.1365	0.1976	0.2721	0.3107	0.3390	0.3677	0.4041	0.4524	0.5129	0.5813	0.6444	0.7240	-0.0068	1.3241
67.5	0.5159	-0.2329	0.0731	0.2471	0.3776	0.4739	0.5389	0.5707	0.5616	0.4978	0.3520	0.0161	0.6769	1.6084
90.0	0.3693	-0.6733	-0.3938	-0.2200	-0.0759	0.0311	0.0881	0.0838	0.0092	-0.1421	-0.3878	-0.8557	0.6807	-1.2786
112.5	-0.3831	-0.6054	-0.5648	-0.5653	-0.5663	-0.5769	-0.6023	-0.6467	-0.7157	-0.8138	-0.9499	-1.1883	-0.3789	-3.0804
135.0	-0.6555	-0.0994	-0.1803	-0.3155	-0.4446	-0.5683	-0.6706	-0.7406	-0.7821	-0.8065	-0.8135	-0.8550	-1.3259	-0.5557
157.5	-0.0587	0.2274	0.0804	-0.1152	-0.2706	-0.4024	-0.5161	-0.6090	-0.6746	-0.6956	-0.6289	-0.5606	-1.3017	1.0644
180.0	0.3342	0.2980	0.0957	-0.1292	-0.2818	-0.3944	-0.4992	-0.6068	-0.7009	-0.7341	-0.6324	-0.4992	-1.1138	1.0043

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	0.0	0.0	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	0.1352	0.1702	0.0924	0.0493	0.0192	-0.0044	-0.0265	-0.0521	-0.0870	-0.1393	-0.2212	-0.3698	-0.3609	0.1198
45.0	0.1411	0.2893	0.1815	0.1115	0.0531	-0.0003	-0.0549	-0.1178	-0.1972	-0.3035	-0.4498	-0.6848	-0.5311	0.2604
67.5	-0.0702	0.1798	0.1635	0.1273	0.0697	-0.0054	-0.0961	-0.2009	-0.3180	-0.4443	-0.5735	-0.7143	-0.3583	0.1838
90.0	-0.4102	-0.3148	-0.1545	-0.0777	-0.0660	-0.1055	-0.1791	-0.2654	-0.3391	-0.3722	-0.3333	-0.1807	0.0961	-0.3783
112.5	-0.5986	-0.8364	-0.6842	-0.5477	-0.4433	-0.3675	-0.3057	-0.2356	-0.1314	0.0318	0.2722	0.5938	0.4794	-0.8909
135.0	-0.5029	-0.7997	-0.9085	-0.9028	-0.8024	-0.6213	-0.3781	-0.0967	0.1953	0.4671	0.6882	0.8121	0.5274	-0.6591
157.5	-0.2661	-0.3850	-0.5953	-0.7083	-0.6841	-0.5272	-0.2733	0.0212	0.2901	0.4715	0.5282	0.4598	0.3203	-0.2197
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

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
180.0	0.0	-1.608	-3.723	-6.272	-8.849	-10.946	-12.103	-12.055	-10.803	-8.614	-5.916	-3.125	0.0	-64.094

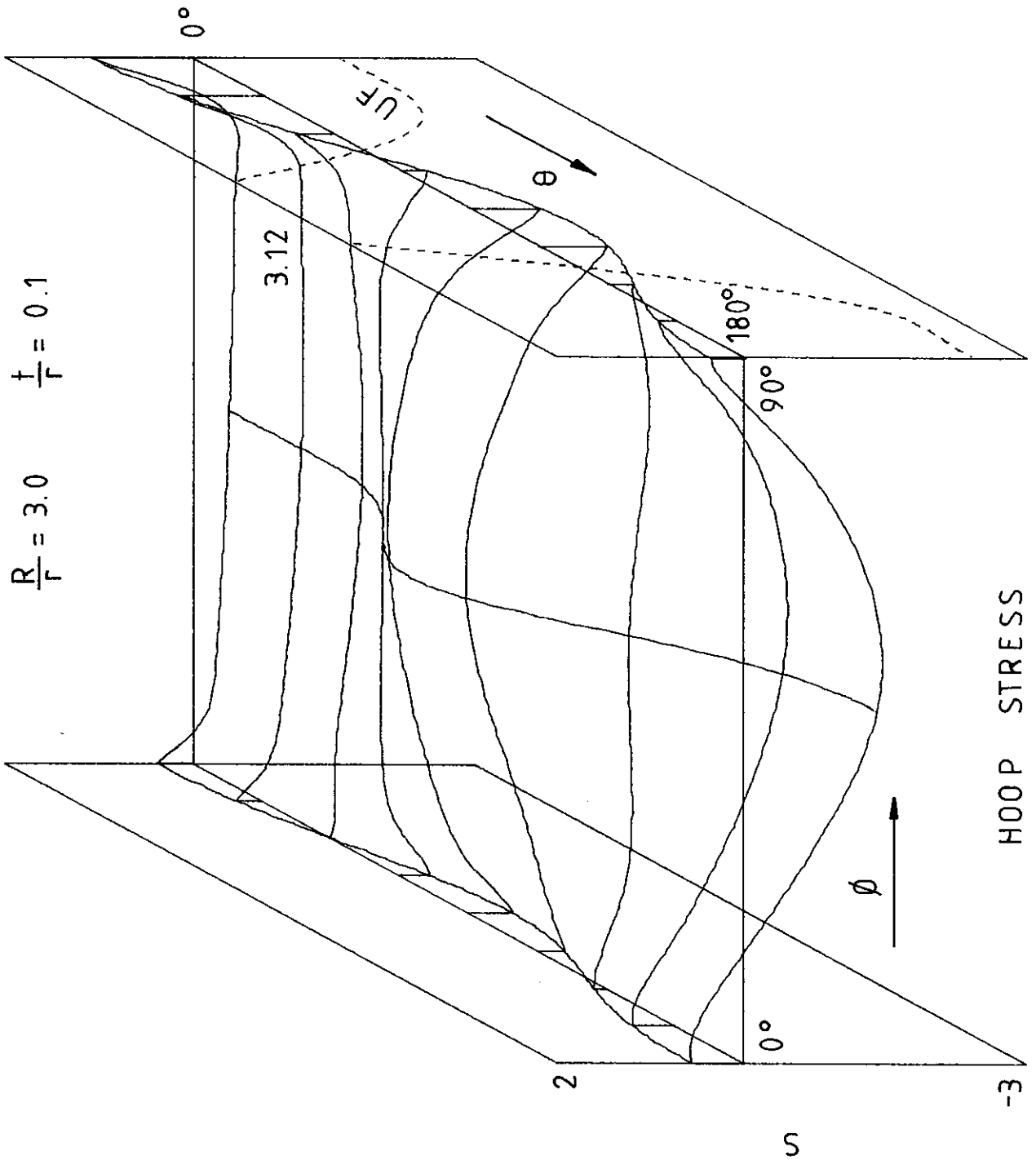


FIGURE A15

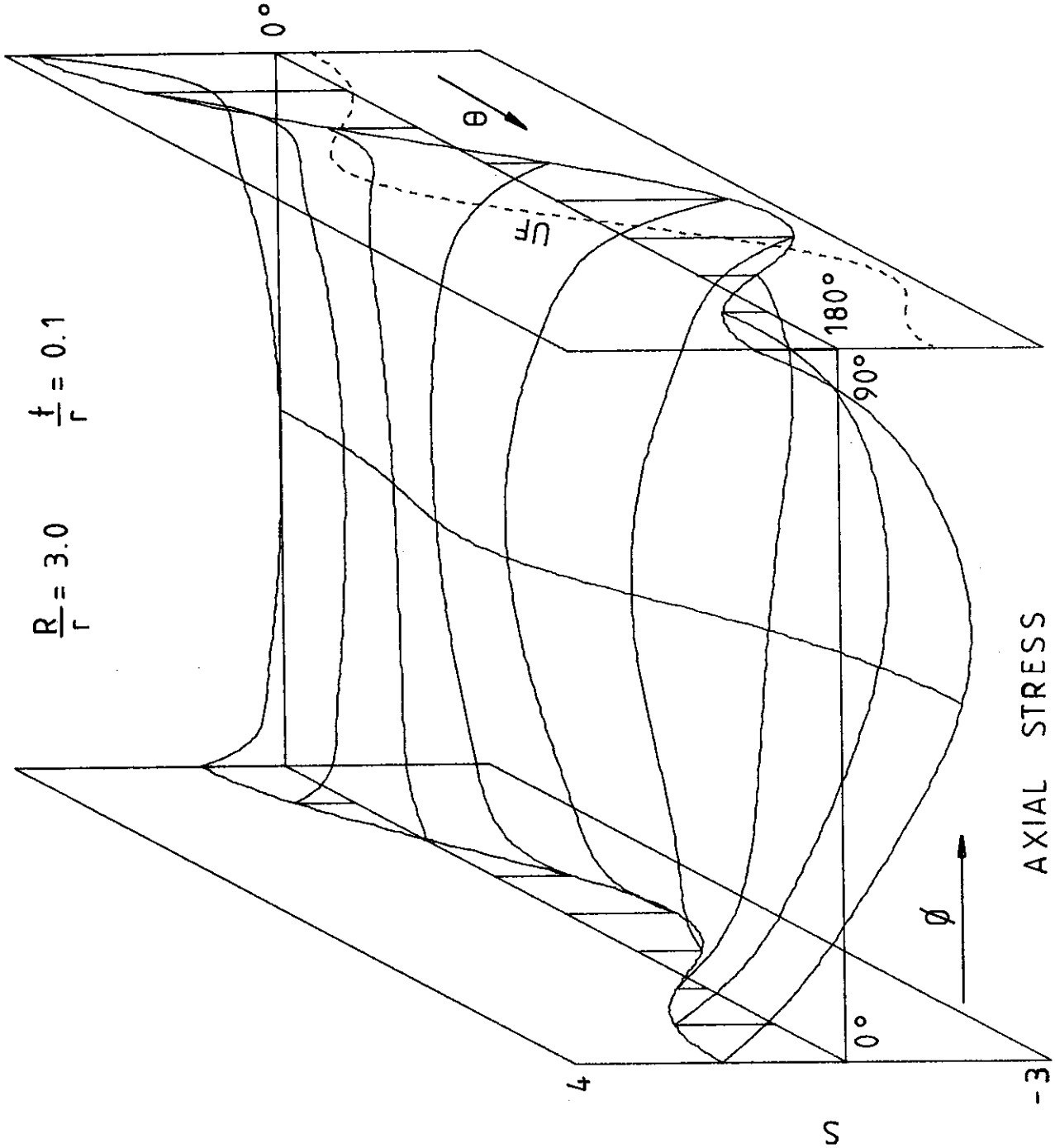


FIGURE A16

TABLE A15

R/r = 3.0 t/r = 0.1

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	Unflanged x sin
0.0	0.3745	-0.1903	-0.2650	-0.3040	-0.3384	-0.3659	-0.3886	-0.4079	-0.4237	-0.4333	-0.4548	-0.4012	1.0891	-1.5419
22.5	0.2704	-0.1536	-0.2343	-0.2947	-0.3484	-0.3907	-0.4207	-0.4375	-0.4400	-0.4263	-0.4134	-0.3353	0.9009	-1.5240
45.0	-0.0064	-0.0487	-0.0889	-0.1646	-0.2369	-0.2953	-0.3313	-0.3391	-0.3173	-0.2673	-0.2066	-0.1457	0.3856	-0.8621
67.5	-0.3302	0.0630	0.1860	0.1979	0.1936	0.1843	0.1796	0.1850	0.1991	0.2154	0.2143	0.0711	-0.2771	1.1551
90.0	-0.4830	0.0501	0.3362	0.5152	0.6681	0.7826	0.8485	0.8584	0.8062	0.6910	0.5061	0.0844	-0.7551	3.0439
112.5	-0.2929	-0.0790	0.0939	0.2907	0.5007	0.6712	0.7638	0.7563	0.6439	0.4455	0.1934	-0.1805	-0.7322	1.9883
135.0	0.1267	-0.0542	-0.2276	-0.2758	-0.2614	-0.2392	-0.2397	-0.2761	-0.3451	-0.4201	-0.4472	-0.3770	-0.2659	-1.0673
157.5	0.4505	0.2100	-0.1837	-0.5064	-0.7760	-0.9940	-1.1393	-1.1927	-1.1469	-0.9994	-0.7250	-0.2626	0.2029	-2.4663
180.0	0.5466	0.3745	-0.0555	-0.4765	-0.8679	-1.1954	-1.4064	-1.4631	-1.3587	-1.1100	-0.7170	-0.1399	0.3705	-2.4164

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	Unflanged x sin
0.0	1.2485	0.2714	0.1768	0.0844	0.0282	0.0046	0.0137	0.0601	0.1523	0.3080	0.5423	0.7139	3.6305	-0.4753
22.5	0.9014	0.2734	0.2164	0.1482	0.1062	0.0903	0.1036	0.1516	0.2411	0.3849	0.5911	0.7194	3.0029	-0.0758
45.0	-0.0213	0.2326	0.3047	0.3285	0.3509	0.3760	0.4113	0.4619	0.5291	0.6129	0.7069	0.6672	1.2852	1.0875
67.5	-1.1007	0.0244	0.2869	0.4693	0.6211	0.7371	0.8192	0.8652	0.8671	0.8128	0.6918	0.3543	-0.9238	2.2142
90.0	-1.6100	-0.3904	-0.0569	0.2313	0.4910	0.6876	0.8041	0.8244	0.7326	0.5176	0.1917	-0.3673	-2.5169	1.4965
112.5	-0.9764	-0.6743	-0.5735	-0.3923	-0.1975	-0.0504	0.0183	-0.0136	-0.1610	-0.4213	-0.7444	-1.1487	-2.4406	-1.1480
135.0	0.4224	-0.3285	-0.6475	-0.7704	-0.8406	-0.9081	-0.9851	-1.0773	-1.1884	-1.3080	-1.3751	-1.2678	-0.8863	-2.7108
157.5	1.5018	0.4608	-0.1528	-0.5928	-0.9874	-1.3284	-1.5777	-1.7074	-1.7071	-1.5810	-1.3091	-0.7147	0.6762	-2.0410
180.0	1.8220	0.8663	0.1742	-0.4015	-0.9510	-1.4257	-1.7559	-1.8944	-1.8249	-1.5663	-1.1338	-0.3623	1.2351	-1.3985

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	Unflanged x cos
0.0	0.0	0.0	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	0.0532	0.0285	0.0228	0.0078	-0.0036	-0.0160	-0.0314	-0.0507	-0.0749	-0.1071	-0.1558	-0.1983	-0.2547	-0.1119
45.0	0.0208	-0.0196	-0.0203	-0.0372	-0.0490	-0.0612	-0.0769	-0.0981	-0.1268	-0.1681	-0.2326	-0.2752	-0.3632	-0.2930
67.5	-0.1357	-0.1573	-0.1561	-0.1633	-0.1617	-0.1539	-0.1440	-0.1363	-0.1360	-0.1498	-0.1834	-0.1897	-0.2414	-0.5018
90.0	-0.3594	-0.3033	-0.3181	-0.3183	-0.3012	-0.2663	-0.2183	-0.1654	-0.1172	-0.0819	-0.0602	-0.0334	0.0594	-0.5289
112.5	-0.5086	-0.3713	-0.3859	-0.3784	-0.3548	-0.3147	-0.2599	-0.1955	-0.1271	-0.0574	0.0132	0.0723	0.3454	-0.2185
135.0	-0.4751	-0.3665	-0.3391	-0.3024	-0.2709	-0.2505	-0.2350	-0.2121	-0.1669	-0.0877	0.0210	0.1301	0.4279	0.1667
157.5	-0.2784	-0.2610	-0.2166	-0.1661	-0.1328	-0.1277	-0.1417	-0.1528	-0.1353	-0.0723	0.0273	0.1303	0.2806	0.2237
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

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
90.0	0.0	1.479	3.561	5.583	7.396	8.781	9.555	9.594	8.841	7.325	5.130	2.296	0.0	33.951

TABLE A16

R/r = 3.0 t/r = 0.1

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	-0.0918	0.0925	0.1628	0.2346	0.2791	0.3050	0.3158	0.3116	0.2890	0.2392	0.1360	0.1175	-0.2672	1.6069
22.5	-0.0505	0.0589	0.1461	0.2341	0.2981	0.3407	0.3608	0.3558	0.3222	0.2537	0.1307	0.0775	-0.1939	1.5883
45.0	0.0532	-0.0569	0.0227	0.1102	0.1909	0.2531	0.2838	0.2749	0.2237	0.1335	0.0030	-0.0772	-0.0037	0.8255
67.5	0.1507	-0.2189	-0.2610	-0.2880	-0.2880	-0.2782	-0.2770	-0.2929	-0.3233	-0.3525	-0.3669	-0.3321	0.1998	-1.5532
90.0	0.1395	-0.2526	-0.4478	-0.6740	-0.8610	-0.9958	-1.0750	-1.0920	-1.0377	-0.9002	-0.6885	-0.4659	0.2448	-3.8974
112.5	-0.0138	-0.0545	-0.2053	-0.4801	-0.7613	-0.9880	-1.1184	-1.1254	-1.0021	-0.7654	-0.4793	-0.2937	0.0251	-2.8730
135.0	-0.1703	0.1471	0.1792	0.0913	-0.0335	-0.1504	-0.2234	-0.2309	-0.1752	-0.0828	-0.0108	-0.0699	-0.3169	0.5732
157.5	-0.1841	0.1511	0.2098	0.2861	0.3929	0.4811	0.5147	0.4763	0.3660	0.2095	0.0579	-0.0830	-0.5252	2.2051
180.0	-0.1491	0.1093	0.1152	0.2224	0.4192	0.6006	0.6815	0.6198	0.4229	0.1587	-0.0509	-0.1494	-0.5707	2.1704

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	-0.3059	0.4067	0.2577	0.2025	0.1758	0.1720	0.1937	0.2454	0.3343	0.4676	0.6762	1.1960	-0.8907	0.1919
22.5	-0.1683	0.3388	0.2569	0.2382	0.2353	0.2474	0.2771	0.3278	0.4049	0.5124	0.6707	1.0699	-0.6464	0.4684
45.0	0.1772	0.1334	0.2016	0.2736	0.3314	0.3844	0.4332	0.4779	0.5188	0.5524	0.5728	0.6788	-0.0122	0.9084
67.5	0.5023	-0.1688	-0.0060	0.1374	0.2417	0.3239	0.3808	0.4075	0.3990	0.3451	0.2115	0.0577	0.6661	0.5530
90.0	0.4651	-0.4069	-0.3094	-0.2118	-0.1528	-0.1117	-0.0911	-0.0963	-0.1335	-0.2170	-0.3948	-0.5714	0.8161	-0.9069
112.5	-0.0461	-0.3923	-0.4111	-0.4560	-0.5227	-0.5852	-0.6376	-0.6784	-0.7102	-0.7474	-0.8329	-0.8824	0.0835	-1.8685
135.0	-0.5676	-0.1853	-0.1903	-0.3189	-0.4580	-0.5784	-0.6744	-0.7421	-0.7781	-0.7847	-0.7899	-0.8509	-1.0562	-0.9211
157.5	-0.6135	-0.0355	0.0386	-0.0614	-0.1621	-0.2445	-0.3245	-0.4086	-0.4869	-0.5362	-0.5658	-0.7765	-1.7506	0.5699
180.0	-0.4971	-0.0034	0.0955	0.0279	-0.0326	-0.0773	-0.1373	-0.2277	-0.3351	-0.4216	-0.4855	-0.7702	-1.9022	1.0969

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	0.0	0.0	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	0.0481	0.1669	0.1042	0.0676	0.0390	0.0113	-0.0185	-0.0535	-0.0972	-0.1550	-0.2399	-0.3953	-0.2305	0.1196
45.0	0.0188	0.2411	0.1729	0.1216	0.0731	0.0188	-0.0442	-0.1181	-0.2058	-0.3123	-0.4532	-0.6696	-0.3286	0.1762
67.5	-0.1228	0.1028	0.1112	0.0909	0.0497	-0.0130	-0.0945	-0.1908	-0.2973	-0.4092	-0.5264	-0.6391	-0.2184	0.0484
90.0	-0.3251	-0.2883	-0.1881	-0.1377	-0.1285	-0.1499	-0.1916	-0.2423	-0.2885	-0.3126	-0.2912	-0.1858	0.0538	-0.3246
112.5	-0.4601	-0.7093	-0.6414	-0.5532	-0.4753	-0.4004	-0.3207	-0.2289	-0.1165	0.0298	0.2283	0.4556	0.3125	-0.6996
135.0	-0.4299	-0.7911	-0.8830	-0.8551	-0.7554	-0.5966	-0.3886	-0.1444	0.1204	0.3885	0.6346	0.7591	0.3871	-0.6870
157.5	-0.2519	-0.4731	-0.6261	-0.6665	-0.6097	-0.4740	-0.2796	-0.0500	0.1862	0.3944	0.5305	0.5179	0.2539	-0.3420
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

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
180.0	0.0	-1.224	-3.082	-5.084	-6.954	-8.424	-9.265	-9.325	-8.561	-7.042	-4.946	-2.436	0.0	-30.678

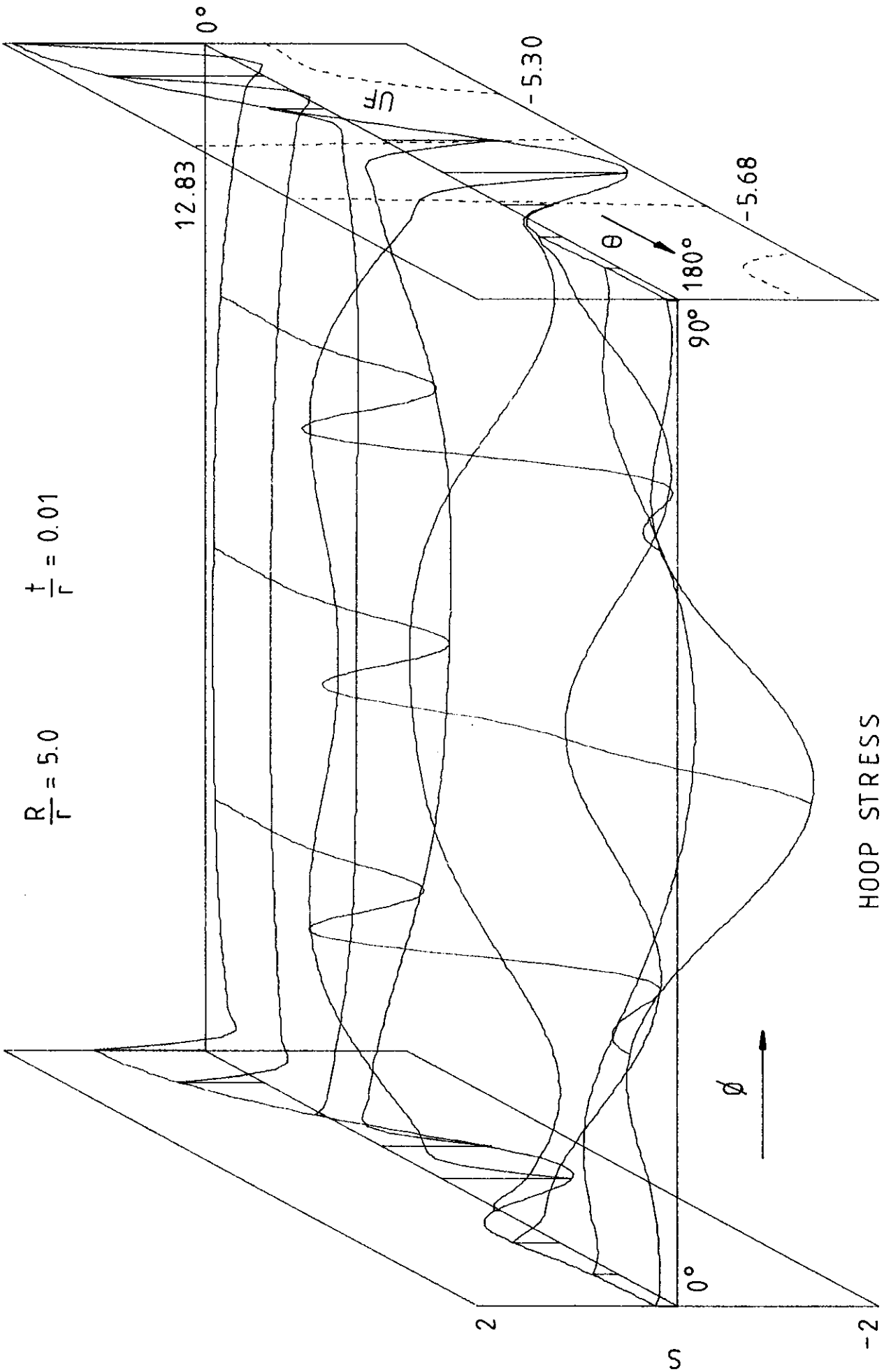


FIGURE A17

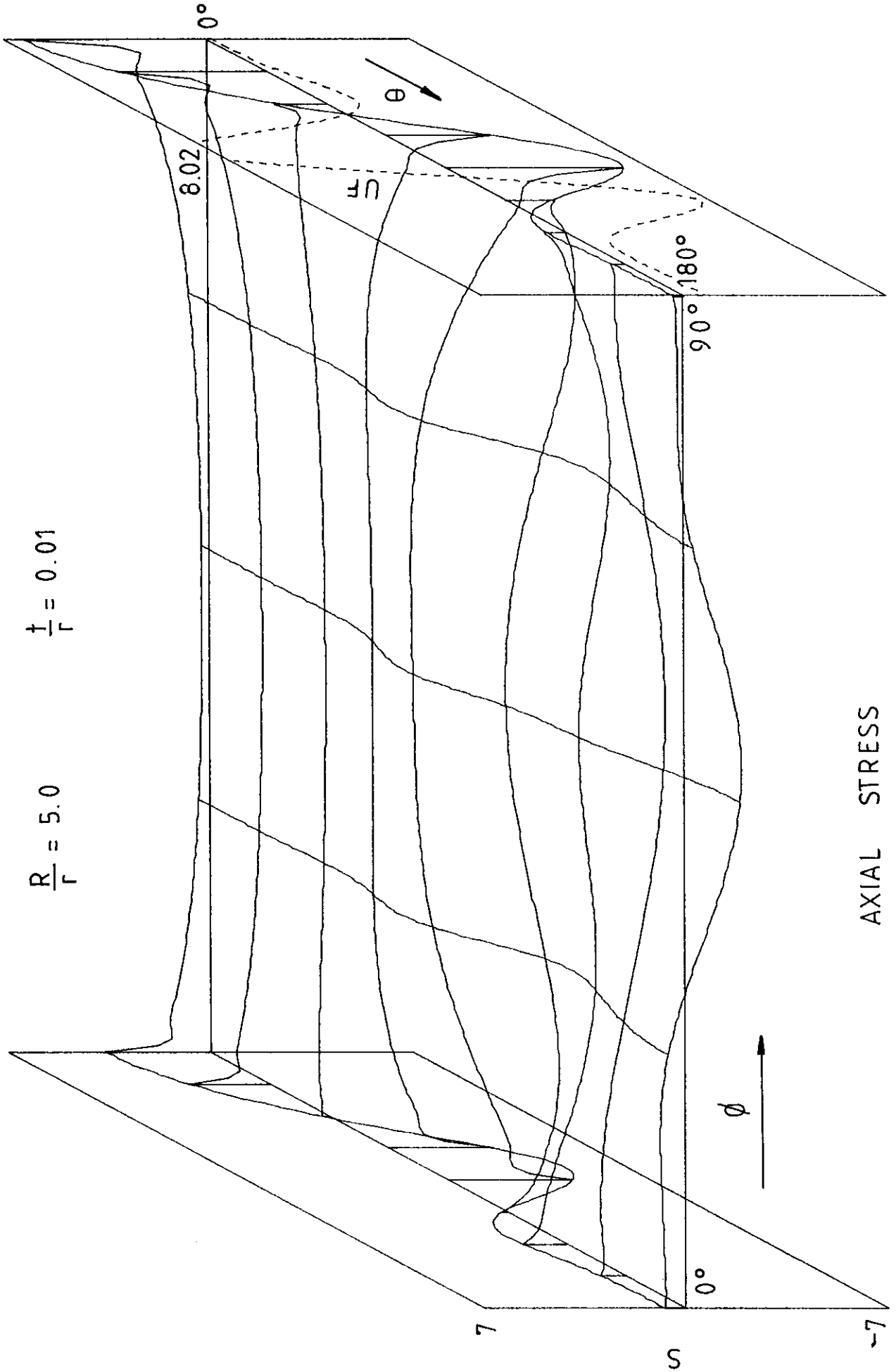


FIGURE A18

TABLE A17

R/r = 5.0 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	Unflanged x sin
0.0	1.0888	-0.1913	-0.1333	-0.1033	-0.0890	-0.0846	-0.0880	-0.0996	-0.1218	-0.1599	-0.2243	-0.3341	1.9050	-0.5932
22.5	0.8353	-0.1533	-0.1085	-0.0825	-0.0699	-0.0663	-0.0692	-0.0785	-0.0968	-0.1298	-0.1863	-0.2768	1.5581	-0.6870
45.0	0.0730	-0.1653	-0.2713	-0.3180	-0.3286	-0.3275	-0.3275	-0.3322	-0.3417	-0.3473	-0.3260	-0.2486	0.5283	-3.7204
67.5	-1.0907	0.0825	-0.1404	-0.3782	-0.5438	-0.6280	-0.6661	-0.6816	-0.6506	-0.5233	-0.2822	0.0011	-1.0930	-2.2738
90.0	-1.2940	0.5027	1.0633	1.3035	1.2616	1.1132	1.0228	1.0694	1.2152	1.3111	1.1474	0.6048	-1.8436	12.6496
112.5	0.0619	-0.5410	-0.4927	-0.0161	0.4722	0.7630	0.8855	0.8963	0.7277	0.2896	-0.2796	-0.5314	-0.5162	-0.2267
135.0	0.4607	-0.0601	-0.6521	-1.0029	-0.8294	-0.3533	-0.0572	-0.2448	-0.7513	-1.0931	-0.9040	-0.3125	0.2129	-4.5276
157.5	0.2593	0.3145	0.3057	0.0043	-0.3524	-0.6063	-0.7369	-0.7427	-0.6021	-0.2954	0.0557	0.1632	0.1411	-1.2406
180.0	0.2119	0.2102	0.4103	0.4800	-0.0050	-0.8208	-1.3279	-1.1276	-0.4171	0.1756	0.2468	0.0943	0.1168	-1.1948

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	Unflanged x sin
0.0	3.6293	0.9570	0.5600	0.3577	0.2583	0.2228	0.2365	0.3001	0.4278	0.6532	1.0459	1.7526	6.3499	-0.1293
22.5	2.7844	0.8065	0.4911	0.3210	0.2353	0.2054	0.2215	0.2852	0.4086	0.6189	0.9693	1.5625	5.1937	-0.4155
45.0	0.2433	0.3179	0.2342	0.1400	0.0814	0.0633	0.0823	0.1395	0.2440	0.4114	0.6501	0.9224	1.7609	-1.1308
67.5	-3.6355	-0.2836	0.3140	0.4980	0.5159	0.5021	0.5115	0.5584	0.6387	0.7054	0.6108	0.0381	-3.6434	4.8372
90.0	-4.3132	-1.4086	-0.2610	0.5250	0.9433	1.1110	1.1821	1.2349	1.1930	0.8576	0.0050	-1.5104	-6.1454	5.1888
112.5	0.2062	-1.5995	-1.7749	-1.3393	-0.7289	-0.2198	0.0260	-0.0765	-0.5382	-1.2825	-2.0796	-2.4363	-1.7208	-6.4888
135.0	1.5357	0.3314	-0.5525	-1.0151	-0.9573	-0.6417	-0.4706	-0.6852	-1.1732	-1.5418	-1.3928	-0.6200	0.7097	-2.0601
157.5	0.8643	0.8702	0.6175	0.0714	-0.5165	-1.0203	-1.3354	-1.3792	-1.1600	-0.7279	-0.1688	0.2445	0.4703	-0.5904
180.0	0.7063	0.7647	0.8706	0.5858	-0.2740	-1.2895	-1.9078	-1.8266	-1.1267	-0.2766	0.1826	0.2451	0.3893	-0.7341

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	Unflanged x cos
0.0	0.0	0.0	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	0.4279	0.2516	0.1309	0.0673	0.0300	0.0038	-0.0196	-0.0468	-0.0847	-0.1450	-0.2497	-0.4448	-0.7354	-0.0206
45.0	0.5433	0.3809	0.2206	0.1228	0.0566	0.0059	-0.0409	-0.0950	-0.1694	-0.2810	-0.4558	-0.7420	-1.0595	-0.0807
67.5	-0.0113	0.0994	0.1038	0.0902	0.0541	-0.0005	-0.0681	-0.1475	-0.2387	-0.3368	-0.4365	-0.5390	-0.4921	-0.4884
90.0	-0.8219	-0.4726	-0.2893	-0.1733	-0.1015	-0.0867	-0.1246	-0.1748	-0.1884	-0.1417	-0.0295	0.1866	0.6723	-0.6071
112.5	-0.5867	-0.5513	-0.4339	-0.3886	-0.3521	-0.2859	-0.1850	-0.0705	0.0349	0.1347	0.2724	0.5348	0.8004	0.1665
135.0	-0.0506	-0.3364	-0.3942	-0.3869	-0.3863	-0.3292	-0.1809	0.0008	0.1415	0.2478	0.3800	0.4717	0.2737	0.2123
157.5	0.0358	-0.0657	-0.2613	-0.3225	-0.2325	-0.1354	-0.1043	-0.0648	0.0748	0.2603	0.3151	0.1840	0.0733	0.0618
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

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
90.0	0.0	13.838	33.403	50.594	61.803	67.489	69.797	69.965	66.855	57.753	40.927	18.870	0.0	583.737

TABLE A18

R/r = 5.0 t/r = 0.01

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	-0.0428	-0.1267	-0.0533	-0.0163	0.0024	0.0096	0.0083	-0.0013	-0.0217	-0.0586	-0.1248	-0.2495	-0.0608	0.6205
22.5	-0.0172	-0.0995	-0.0492	-0.0231	-0.0090	-0.0032	-0.0052	-0.0156	-0.0357	-0.0681	-0.1202	-0.2115	-0.0215	0.7200
45.0	0.0414	0.0857	0.1998	0.2601	0.2801	0.2818	0.2764	0.2663	0.2503	0.2183	0.1475	0.0177	0.0668	3.8054
67.5	0.0719	-0.0204	0.1435	0.3651	0.5261	0.6066	0.6402	0.6509	0.6144	0.4820	0.2480	0.0212	0.1239	2.0951
90.0	-0.1793	-0.5582	-1.1653	-1.4102	-1.3522	-1.1875	-1.0891	-1.1378	-1.2964	-1.4102	-1.2499	-0.6682	-0.1681	-13.6544
112.5	-0.2869	0.3826	0.3064	-0.1655	-0.6127	-0.8437	-0.9324	-0.9678	-0.8688	-0.5053	0.0092	0.2307	-0.4514	-0.2588
135.0	0.1137	0.1412	0.5712	0.8551	0.6691	0.1925	-0.1151	0.0431	0.4985	0.7852	0.5900	0.1126	-0.0979	4.4917
157.5	0.2204	0.0305	-0.1100	0.0071	0.1724	0.2432	0.2512	0.2353	0.1650	-0.0161	-0.1965	-0.1081	0.0670	1.1788
180.0	0.2030	0.1819	-0.0435	-0.3384	-0.1833	0.3504	0.6898	0.4590	-0.1184	-0.4360	-0.2363	0.0294	0.0667	1.1332

INSIDE AXIAL STRESS FACTORS

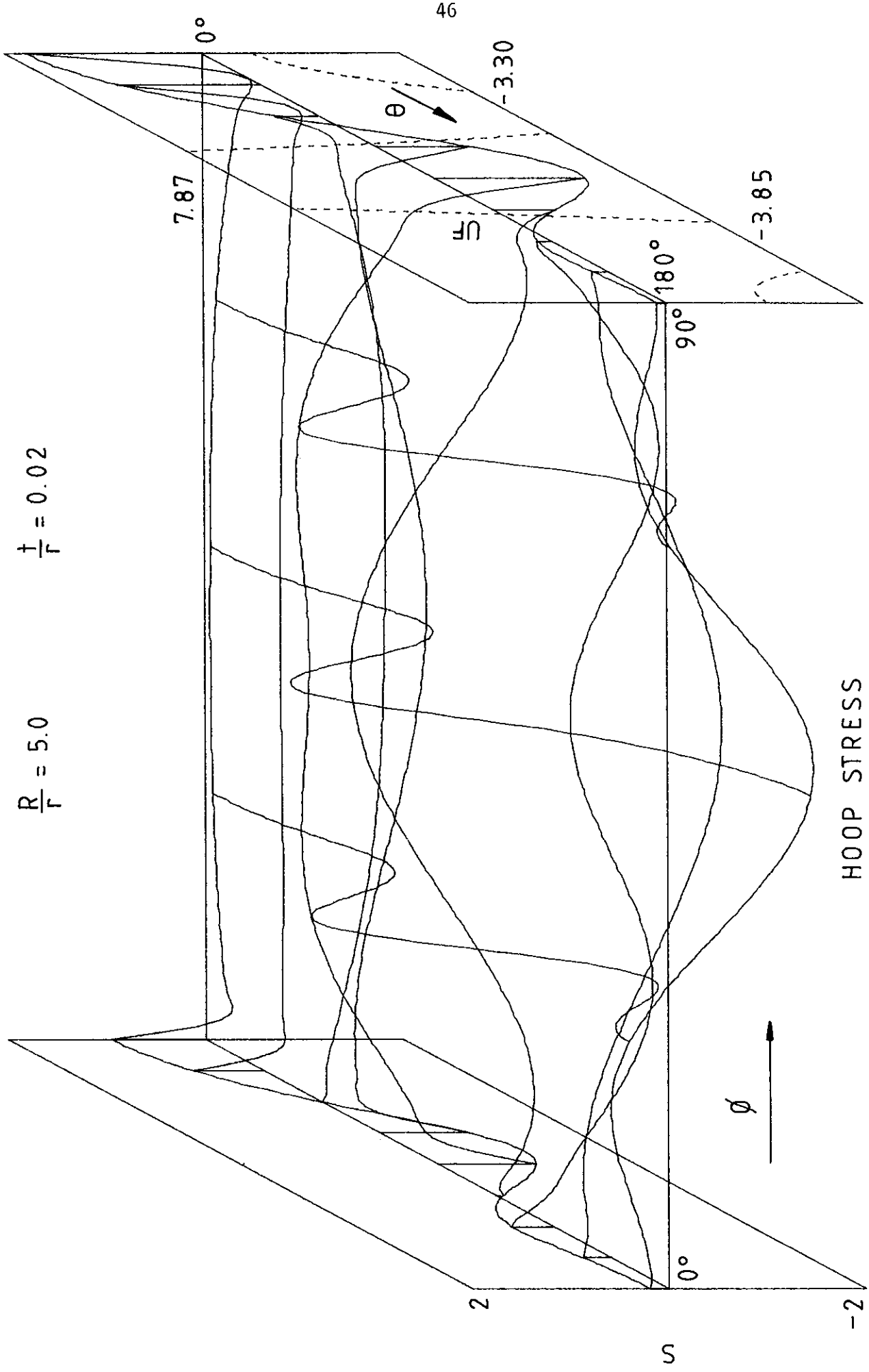
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
0.0	-0.1426	0.9561	0.5673	0.3683	0.2705	0.2358	0.2502	0.3143	0.4424	0.6675	1.0576	1.7545	-0.2025	0.0142
22.5	-0.0573	0.7992	0.4911	0.3225	0.2373	0.2080	0.2243	0.2877	0.4105	0.6202	0.9692	1.5539	-0.0716	-0.2317
45.0	0.1379	0.3550	0.3464	0.2872	0.2381	0.2199	0.2373	0.2936	0.3968	0.5554	0.7611	0.9557	0.2226	0.7254
67.5	0.2396	-0.3800	0.2980	0.6117	0.7310	0.7710	0.8036	0.8572	0.9125	0.8941	0.6566	-0.0458	0.4129	5.1145
90.0	-0.5975	-1.6284	-0.9526	-0.3869	0.0335	0.2982	0.4301	0.4406	0.2883	-0.1017	-0.7922	-1.8311	-0.5605	-2.9811
112.5	-0.9563	-1.1021	-1.2731	-1.2005	-0.9769	-0.7071	-0.5653	-0.6734	-0.9942	-1.3903	-1.7474	-1.9422	-1.5047	-5.3559
135.0	0.3792	0.3107	-0.0549	-0.2087	-0.3148	-0.4432	-0.5539	-0.6063	-0.6413	-0.7108	-0.7434	-0.5119	-0.3264	1.3351
157.5	0.7345	0.6875	0.3731	0.0531	-0.2628	-0.5802	-0.8068	-0.8630	-0.7695	-0.5941	-0.3239	0.0583	0.2232	0.6477
180.0	0.6768	0.7520	0.5812	0.1050	-0.3721	-0.6507	-0.8152	-0.9536	-0.9473	-0.6286	-0.1253	0.2001	0.2224	0.4604

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	0.0	0.0	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	0.4236	0.2594	0.1335	0.0691	0.0314	0.0047	-0.0193	-0.0469	-0.0850	-0.1455	-0.2516	-0.4544	-0.7281	0.0392
45.0	0.5379	0.4258	0.2410	0.1299	0.0587	0.0062	-0.0422	-0.0975	-0.1722	-0.2859	-0.4717	-0.7861	-1.0489	0.1691
67.5	-0.0112	0.3087	0.2755	0.1881	0.0944	0.0114	-0.0644	-0.1500	-0.2653	-0.4211	-0.6070	-0.7733	-0.4872	0.2808
90.0	-0.8137	-0.4848	-0.1089	0.0666	0.0913	0.0235	-0.0900	-0.2205	-0.3377	-0.3837	-0.2678	0.1193	0.6656	-0.3977
112.5	-0.5809	-0.9100	-0.7351	-0.4481	-0.2145	-0.1218	-0.1588	-0.2109	-0.1392	0.1218	0.5319	0.9377	0.7924	-0.6730
135.0	-0.0501	-0.2548	-0.5960	-0.7326	-0.6760	-0.4943	-0.2297	0.0747	0.3711	0.6037	0.6671	0.4730	0.2709	-0.2067
157.5	0.0354	0.0565	-0.1166	-0.4465	-0.6621	-0.5661	-0.1897	0.2595	0.5301	0.4858	0.2362	0.0601	0.0726	-0.0800
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

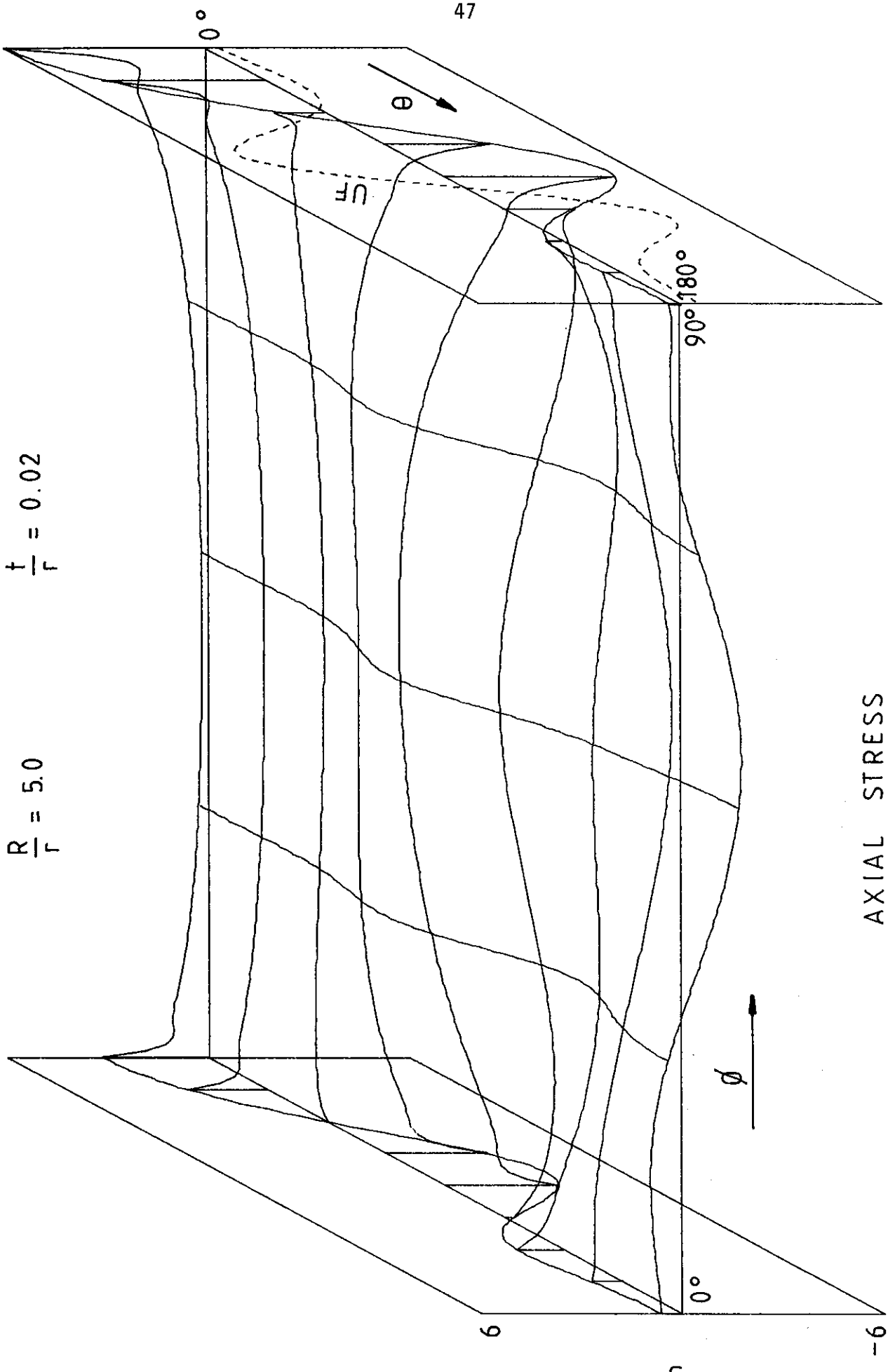
DIAMETER EXPANSION FACTORS

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
180.0	0.0	-3.541	-7.896	-17.172	-32.862	-49.765	-59.119	-55.642	-41.688	-25.286	-13.308	-6.258	0.0	-324.114



HOOP STRESS

FIGURE A19



AXIAL STRESS

FIGURE A20

TABLE A19

R/r = 5.0 t/r = 0.02

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	Unflanged x sin
0.0	0.9493	-0.1754	-0.1187	-0.0837	-0.0656	-0.0596	-0.0619	-0.0717	-0.0929	-0.1336	-0.2046	-0.3168	1.7797	-0.4985
22.5	0.7115	-0.1980	-0.2081	-0.2052	-0.1951	-0.1858	-0.1839	-0.1932	-0.2150	-0.2477	-0.2868	-0.3263	1.4484	-1.4076
45.0	-0.0086	-0.1738	-0.3716	-0.5196	-0.6049	-0.6434	-0.6605	-0.6709	-0.6648	-0.6138	-0.4902	-0.2926	0.4401	-3.2761
67.5	-0.9123	0.2421	0.1921	0.0142	-0.2012	-0.3826	-0.4822	-0.4748	-0.3597	-0.1626	0.0553	0.1873	-0.9505	0.5156
90.0	-1.0028	0.4017	0.9268	1.2646	1.3673	1.3276	1.2857	1.3232	1.3991	1.3716	1.0945	0.5413	-1.5235	7.7677
112.5	-0.0790	-0.3855	-0.2665	0.1757	0.7168	1.1799	1.4294	1.3883	1.0644	0.5420	-0.0197	-0.3468	-0.6496	2.0428
135.0	0.4235	-0.2910	-0.8205	-1.0172	-0.8016	-0.4169	-0.1875	-0.2987	-0.6822	-1.0372	-1.0164	-0.5413	0.1417	-3.8366
157.5	0.2786	0.2814	0.1465	-0.1840	-0.5739	-0.9147	-1.1109	-1.1031	-0.8987	-0.5582	-0.1788	0.0725	0.1685	-1.9620
180.0	0.1849	0.3575	0.5788	0.4014	-0.2409	-0.9974	-1.4436	-1.3408	-0.7531	-0.0451	0.3235	0.2328	0.1032	-1.0258

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	Unflanged x sin
0.0	3.1642	0.7767	0.4301	0.2593	0.1800	0.1554	0.1728	0.2331	0.3494	0.5531	0.9100	1.5602	5.9324	-0.3458
22.5	2.3717	0.6389	0.3415	0.1772	0.0956	0.0696	0.0861	0.1443	0.2579	0.4575	0.7975	1.3737	4.8279	-0.6694
45.0	-0.0287	0.3256	0.2911	0.1973	0.1122	0.0643	0.0644	0.1194	0.2377	0.4256	0.6706	0.9084	1.4670	0.1553
67.5	-3.0409	-0.1460	0.4697	0.7311	0.8005	0.7933	0.7976	0.8565	0.9486	0.9871	0.8229	0.2062	-3.1683	4.1560
90.0	-3.3428	-1.1157	-0.2469	0.4286	0.8941	1.1815	1.3308	1.3539	1.2128	0.8170	0.0488	-1.1903	-5.0785	3.1733
112.5	-0.2634	-1.3992	-1.4613	-1.1239	-0.6127	-0.1263	0.1353	0.0452	-0.3866	-1.0337	-1.7112	-2.1439	-2.1653	-3.6436
135.0	1.4117	-0.0578	-0.7708	-1.0739	-1.0586	-0.9407	-0.8993	-1.0255	-1.3057	-1.5869	-1.5831	-1.0364	0.4723	-3.0907
157.5	0.9287	0.8188	0.4878	-0.0167	-0.5735	-1.0759	-1.4006	-1.4631	-1.2642	-0.8714	-0.3681	0.1159	0.5615	-0.7237
180.0	0.6163	0.8733	0.9009	0.4177	-0.4087	-1.2105	-1.7025	-1.7324	-1.2828	-0.5324	0.1203	0.3301	0.3440	-0.5408

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	Unflanged x cos
0.0	0.0	0.0	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	0.3295	0.2143	0.1147	0.0604	0.0269	0.0029	-0.0183	-0.0432	-0.0791	-0.1364	-0.2332	-0.4073	-0.6200	-0.0169
45.0	0.3657	0.2678	0.1584	0.0967	0.0512	0.0088	-0.0372	-0.0917	-0.1610	-0.2552	-0.3948	-0.6250	-0.8479	-0.1455
67.5	-0.0839	-0.0099	-0.0072	0.0034	0.0036	-0.0210	-0.0716	-0.1355	-0.1972	-0.2521	-0.3111	-0.3958	-0.3633	-0.4565
90.0	-0.6116	-0.3762	-0.2863	-0.2377	-0.1981	-0.1657	-0.1406	-0.1186	-0.0928	-0.0564	-0.0006	0.1152	0.4666	-0.4757
112.5	-0.5229	-0.4249	-0.3392	-0.3444	-0.3561	-0.3083	-0.1922	-0.0544	0.0485	0.1060	0.1793	0.3811	0.6861	0.0256
135.0	-0.1154	-0.3115	-0.3020	-0.2741	-0.2501	-0.2140	-0.1589	-0.0847	0.0060	0.1136	0.2522	0.4067	0.3322	0.2239
157.5	0.0348	-0.1457	-0.2546	-0.1902	-0.0743	-0.0321	-0.0776	-0.1270	-0.0782	0.0909	0.2618	0.2546	0.0810	0.0873
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

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

TABLE A20

R/r = 5.0 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	-0.0790	-0.0848	-0.0327	-0.0117	-0.0026	0.0006	-0.0022	-0.0125	-0.0306	-0.0587	-0.1062	-0.2027	-0.1267	0.5257
22.5	-0.0430	-0.0038	0.0852	0.1254	0.1368	0.1344	0.1270	0.1178	0.1045	0.0778	0.0186	-0.1046	-0.0743	1.4519
45.0	0.0612	0.1125	0.3199	0.4828	0.5777	0.6180	0.6296	0.6270	0.5983	0.5119	0.3393	0.0885	0.0753	3.3293
67.5	0.1231	-0.2196	-0.2238	-0.0553	0.1662	0.3544	0.4554	0.4420	0.3138	0.1013	-0.1193	-0.2032	0.1941	-0.7837
90.0	-0.0844	-0.4593	-1.0497	-1.4125	-1.5055	-1.4408	-1.3828	-1.4274	-1.5276	-1.5191	-1.2300	-0.6157	-0.0335	-8.5665
112.5	-0.2776	0.2603	0.1163	-0.3448	-0.8843	-1.3349	-1.5782	-1.5482	-1.2520	-0.7607	-0.2191	0.0920	-0.3889	-2.5811
135.0	-0.0308	0.3075	0.7691	0.9347	0.6732	0.2254	-0.0530	0.0453	0.4379	0.7894	0.7463	0.2884	-0.2523	3.7475
157.5	0.2003	-0.0038	-0.0065	0.1735	0.4074	0.6084	0.7070	0.6618	0.4858	0.2303	-0.0218	-0.1072	0.0123	1.9110
180.0	0.2257	0.0399	-0.3115	-0.3787	0.0359	0.6302	0.9686	0.8062	0.2375	-0.3277	-0.4450	-0.1357	0.0684	0.9642

INSIDE AXIAL STRESS FACTORS

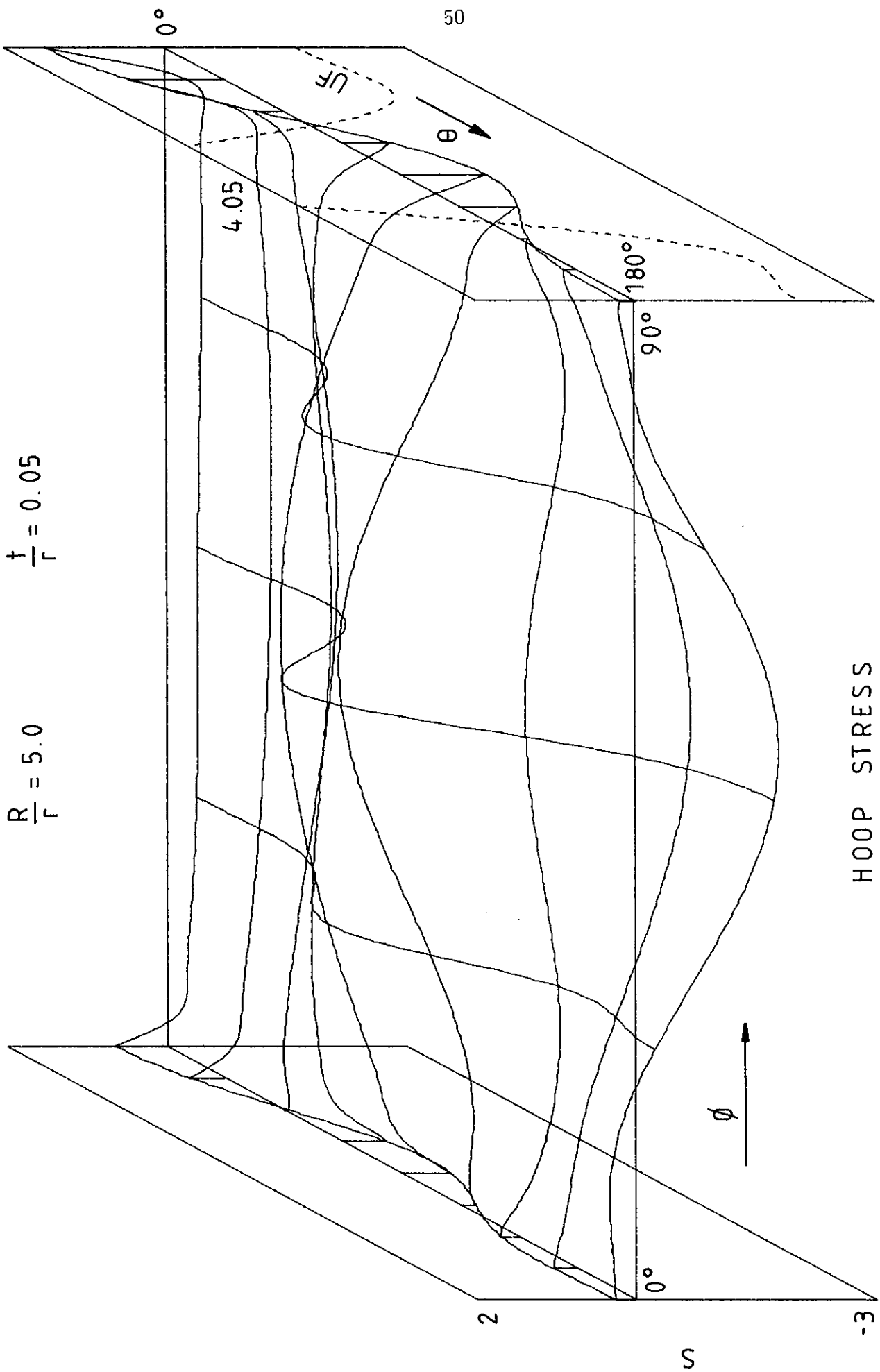
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
0.0	-0.2635	0.7699	0.4297	0.2559	0.1733	0.1474	0.1644	0.2246	0.3421	0.5491	0.9101	1.5535	-0.4223	-0.2585
22.5	-0.1434	0.6560	0.3995	0.2493	0.1681	0.1380	0.1515	0.2103	0.3270	0.5276	0.8563	1.3897	-0.2477	-0.0593
45.0	0.2041	0.3409	0.4292	0.4312	0.4037	0.3828	0.3936	0.4508	0.5562	0.6974	0.8444	0.9320	0.2511	1.6561
67.5	0.4102	-0.3451	0.2135	0.5473	0.7405	0.8496	0.9180	0.9648	0.9717	0.8819	0.6019	-0.0195	0.6471	2.9207
90.0	-0.2814	-1.2297	-0.8217	-0.4493	-0.1065	0.1734	0.3319	0.3236	0.1411	-0.2012	-0.7090	-1.4341	-0.1116	-1.9357
112.5	-0.9254	-0.9350	-1.0460	-1.0438	-0.9770	-0.8941	-0.8562	-0.9069	-1.0520	-1.2607	-1.4904	-1.6798	-1.2964	-4.1620
135.0	-0.1028	0.1220	-0.0794	-0.2055	-0.3961	-0.6328	-0.8052	-0.8408	-0.7809	-0.7380	-0.7558	-0.6822	-0.8411	-0.0424
157.5	0.6678	0.5753	0.3230	0.0846	-0.1382	-0.3370	-0.4918	-0.5833	-0.5976	-0.5277	-0.3625	-0.0808	0.0409	0.9611
180.0	0.7524	0.6642	0.3527	-0.0246	-0.2489	-0.3316	-0.4098	-0.5623	-0.7121	-0.6757	-0.3558	0.0653	0.2280	0.5535

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	0.0	0.0	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	0.3229	0.2346	0.1194	0.0592	0.0244	0.0010	-0.0195	-0.0431	-0.0771	-0.1332	-0.2339	-0.4266	-0.6078	0.0628
45.0	0.3585	0.3965	0.2407	0.1356	0.0617	0.0074	-0.0386	-0.0907	-0.1661	-0.2840	-0.4691	-0.7622	-0.8312	0.1876
67.5	-0.0823	0.2332	0.2478	0.2013	0.1277	0.0424	-0.0513	-0.1582	-0.2851	-0.4327	-0.5868	-0.7045	-0.3561	0.1531
90.0	-0.5995	-0.4253	-0.1316	0.0326	0.0851	0.0381	-0.0821	-0.2259	-0.3340	-0.3551	-0.2420	0.0721	0.4573	-0.3231
112.5	-0.5126	-0.7988	-0.6408	-0.4336	-0.2737	-0.1932	-0.1717	-0.1556	-0.0777	0.1175	0.4376	0.8037	0.6725	-0.5907
135.0	-0.1131	-0.3455	-0.5969	-0.7014	-0.6731	-0.5147	-0.2482	0.0655	0.3531	0.5630	0.6563	0.5683	0.3257	-0.2914
157.5	0.0341	0.0498	-0.2132	-0.4933	-0.5964	-0.4757	-0.1904	0.1547	0.4301	0.5082	0.3478	0.0994	0.0794	-0.0733
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

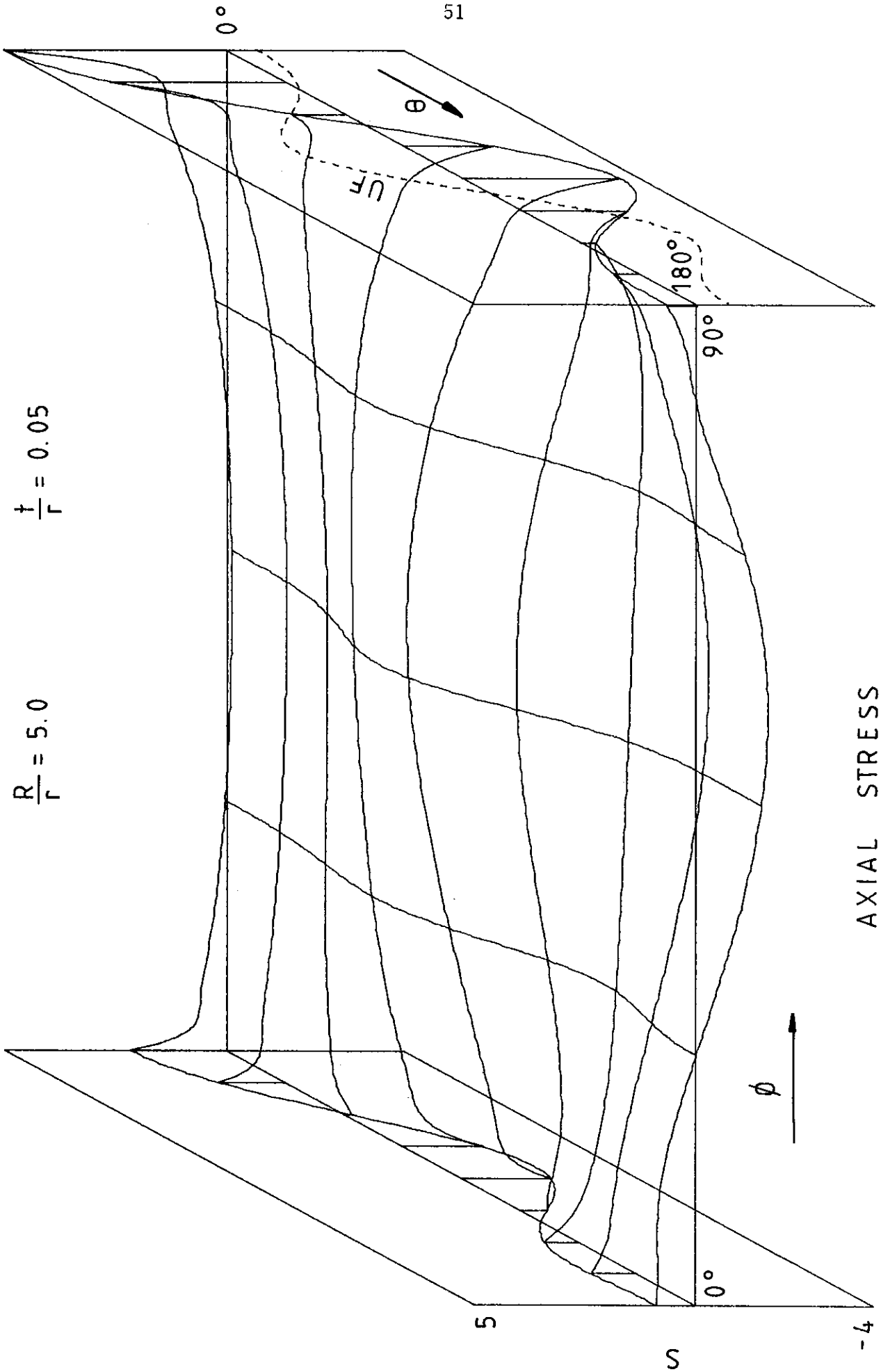
DIAMETER EXPANSION FACTORS

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
180.0	0.0	-2.971	-7.771	-16.801	-28.904	-40.177	-46.314	-44.854	-36.382	-24.344	-13.242	-5.746	0.0	-163.781



HOOP STRESS

FIGURE A21



AXIAL STRESS

FIGURE A22

TABLE A21

R/r = 5.0 t/r = 0.05

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	Unflanged x sin
0.0	0.6440	-0.2730	-0.3403	-0.3841	-0.4013	-0.4039	-0.4056	-0.4157	-0.4343	-0.4530	-0.4590	-0.4579	1.4957	-1.6114
22.5	0.4441	-0.2257	-0.3373	-0.4328	-0.5027	-0.5492	-0.5762	-0.5860	-0.5777	-0.5467	-0.4863	-0.4076	1.1824	-1.8095
45.0	-0.0600	-0.0221	-0.1405	-0.2939	-0.4532	-0.5872	-0.6670	-0.6740	-0.6060	-0.4770	-0.3127	-0.1538	0.3497	-1.2559
67.5	-0.5510	0.2780	0.3793	0.3775	0.3016	0.2071	0.1449	0.1454	0.2087	0.2998	0.3526	0.3037	-0.6066	1.4989
90.0	-0.6109	0.2602	0.6016	0.9269	1.1918	1.3839	1.4888	1.4944	1.3956	1.1877	0.8592	0.4405	-1.0588	4.0081
112.5	-0.1875	-0.1615	-0.0027	0.3714	0.8313	1.2410	1.4817	1.4792	1.2232	0.7783	0.2780	-0.0735	-0.7240	2.2327
135.0	0.2297	-0.2922	-0.4973	-0.4916	-0.3513	-0.1895	-0.0927	-0.1105	-0.2497	-0.4530	-0.5825	-0.4631	-0.1151	-1.3876
157.5	0.3037	0.0849	-0.1367	-0.4793	-0.8552	-1.1797	-1.3790	-1.4050	-1.2472	-0.9382	-0.5519	-0.1997	0.1718	-2.3723
180.0	0.2580	0.3321	0.2147	-0.2315	-0.8326	-1.3833	-1.7219	-1.7494	-1.4429	-0.8852	-0.2905	0.0544	0.2013	-2.0405

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	Unflanged x sin
0.0	2.1467	0.4662	0.1765	0.0128	-0.0796	-0.1216	-0.1193	-0.0691	0.0418	0.2414	0.5848	1.1929	4.9856	-0.6615
22.5	1.4802	0.4371	0.2362	0.1027	0.0125	-0.0380	-0.0429	0.0073	0.1236	0.3220	0.6336	1.1280	3.9413	-0.2504
45.0	-0.1999	0.3167	0.3996	0.4103	0.3892	0.3683	0.3740	0.4242	0.5232	0.6600	0.8060	0.9104	1.1656	1.1466
67.5	-1.8366	-0.0422	0.3989	0.6844	0.8793	1.0167	1.1078	1.1536	1.1479	1.0670	0.8466	0.3591	-2.0220	2.6083
90.0	-2.0364	-0.6593	-0.1749	0.2742	0.6786	1.0049	1.2025	1.2293	1.0657	0.7087	0.1436	-0.6639	-3.5292	1.6119
112.5	-0.6251	-0.9466	-0.8765	-0.6330	-0.3358	-0.0783	0.0695	0.0568	-0.1460	-0.5336	-1.0436	-1.5169	-2.4132	-1.4395
135.0	0.7657	-0.3767	-0.7036	-0.8645	-0.9625	-1.0483	-1.1243	-1.1903	-1.2640	-1.3602	-1.4271	-1.2880	-0.3837	-2.5896
157.5	1.0125	0.4876	0.1224	-0.3383	-0.8016	-1.2016	-1.4825	-1.6018	-1.5336	-1.2762	-0.8594	-0.3742	0.5725	-1.4577
180.0	0.8601	0.8466	0.5475	-0.0168	-0.6189	-1.1287	-1.4804	-1.6243	-1.5062	-1.0967	-0.4718	0.0841	0.6710	-0.7374

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	Unflanged x cos
0.0	0.0	0.0	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	0.1401	0.0938	0.0466	0.0297	0.0192	0.0056	-0.0140	-0.0391	-0.0692	-0.1076	-0.1668	-0.2829	-0.3902	-0.0725
45.0	0.1079	0.0656	0.0119	-0.0026	-0.0093	-0.0208	-0.0414	-0.0708	-0.1081	-0.1569	-0.2333	-0.3857	-0.5005	-0.2112
67.5	-0.1240	-0.0970	-0.1237	-0.1304	-0.1253	-0.1121	-0.0954	-0.0825	-0.0814	-0.0992	-0.1443	-0.2369	-0.2254	-0.3645
90.0	-0.3626	-0.2507	-0.2511	-0.2702	-0.2675	-0.2286	-0.1597	-0.0810	-0.0176	0.0124	0.0121	0.0215	0.2211	-0.3400
112.5	-0.3758	-0.2825	-0.2512	-0.2624	-0.2627	-0.2334	-0.1769	-0.1051	-0.0340	0.0233	0.0773	0.1943	0.4583	-0.0806
135.0	-0.1962	-0.2533	-0.1839	-0.1188	-0.0850	-0.0899	-0.1217	-0.1524	-0.1481	-0.0805	0.0618	0.2652	0.3697	0.1409
157.5	-0.0449	-0.1759	-0.1170	-0.0143	0.0421	0.0246	-0.0481	-0.1316	-0.1699	-0.1127	0.0460	0.2171	0.1653	0.1307
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

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
90.0	0.0	4.102	10.091	16.922	23.442	28.608	31.501	31.522	28.534	22.884	15.340	7.180	0.0	78.377

TABLE A22

R/r = 5.0 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	-0.0967	0.1044	0.2566	0.3353	0.3676	0.3728	0.3676	0.3605	0.3481	0.3132	0.2259	0.0238	-0.2013	1.6412
22.5	-0.0435	0.0954	0.2685	0.3939	0.4790	0.5301	0.5520	0.5462	0.5085	0.4281	0.2863	0.0469	-0.1185	1.8453
45.0	0.0741	-0.0300	0.0892	0.2573	0.4324	0.5777	0.6592	0.6545	0.5604	0.3918	0.1776	-0.0383	0.0798	1.2251
67.5	0.1303	-0.2885	-0.4560	-0.4660	-0.3816	-0.2734	-0.2040	-0.2107	-0.2931	-0.4069	-0.4674	-0.3606	0.2241	-1.7994
90.0	0.0127	-0.2920	-0.7171	-1.0822	-1.3677	-1.5699	-1.6794	-1.6866	-1.5867	-1.3705	-1.0128	-0.4942	0.1124	-4.5970
112.5	-0.1636	0.1108	-0.0812	-0.5005	-1.0194	-1.4855	-1.7616	-1.7624	-1.4805	-0.9952	-0.4611	-0.0742	-0.1888	-2.7342
135.0	-0.1385	0.3028	0.4908	0.4363	0.2163	-0.0275	-0.1829	-0.1855	-0.0282	0.2135	0.3655	0.2461	-0.3206	1.1952
157.5	0.0674	0.0646	0.1782	0.4240	0.7191	0.9764	1.1174	1.0937	0.9028	0.5926	0.2525	0.0138	-0.1805	2.3072
180.0	0.1807	-0.1007	-0.1594	0.1519	0.6746	1.1743	1.4605	1.4224	1.0494	0.4647	-0.0586	-0.1965	-0.0701	1.9753

INSIDE AXIAL STRESS FACTORS

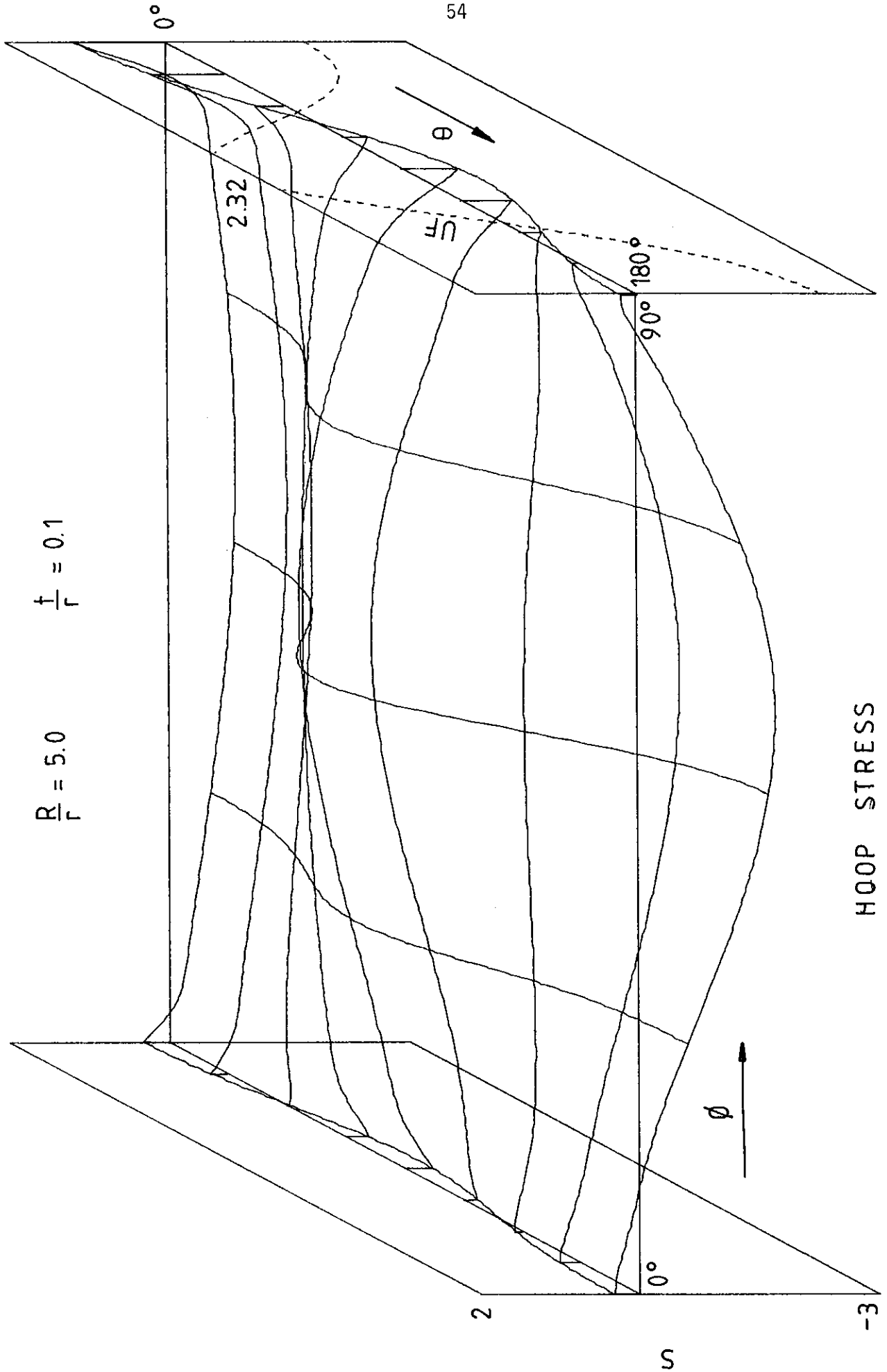
Theta	Phi=0.0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0	Unflanged x sin
0.0	-0.3222	0.5153	0.3097	0.1859	0.1089	0.0698	0.0719	0.1238	0.2371	0.4306	0.7427	1.2502	-0.6711	0.0950
22.5	-0.1450	0.4537	0.3500	0.2844	0.2424	0.2240	0.2361	0.2878	0.3882	0.5487	0.7904	1.1529	-0.3949	0.5533
45.0	0.2471	0.2115	0.3497	0.4422	0.5143	0.5750	0.6286	0.6778	0.7248	0.7688	0.7998	0.7799	0.2661	1.3887
67.5	0.4342	-0.2609	0.0386	0.2666	0.4632	0.6243	0.7321	0.7709	0.7334	0.6165	0.4029	0.0109	0.7470	1.0258
90.0	0.0422	-0.6851	-0.5028	-0.3497	-0.2073	-0.0877	-0.0107	0.0044	-0.0574	-0.2074	-0.4610	-0.8835	0.3746	-1.1072
112.5	-0.5454	-0.5760	-0.6231	-0.6862	-0.7770	-0.8698	-0.9334	-0.9534	-0.9454	-0.9520	-1.0234	-1.1944	-0.6294	-2.3715
135.0	-0.4615	-0.0424	-0.1874	-0.3467	-0.5487	-0.7490	-0.8958	-0.9581	-0.9391	-0.8786	-0.8315	-0.7956	-1.0687	-1.0720
157.5	0.2247	0.3415	0.1442	0.0106	-0.0855	-0.1664	-0.2545	-0.3580	-0.4632	-0.5340	-0.5223	-0.3600	-0.6017	0.5214
180.0	0.6023	0.4362	0.1955	0.0793	0.0676	0.0846	0.0518	-0.0703	-0.2603	-0.4308	-0.4563	-0.2292	-0.2336	0.9677

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	0.0	0.0	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	0.1333	0.1979	0.1205	0.0736	0.0408	0.0140	-0.0118	-0.0413	-0.0808	-0.1399	-0.2355	-0.4002	-0.3712	0.0915
45.0	0.1026	0.2805	0.2047	0.1492	0.0992	0.0449	-0.0187	-0.0932	-0.1815	-0.2917	-0.4416	-0.6614	-0.4761	0.1367
67.5	-0.1179	0.1052	0.1456	0.1496	0.1211	0.0585	-0.0344	-0.1472	-0.2668	-0.3821	-0.4859	-0.5643	-0.2144	0.0287
90.0	-0.3449	-0.3034	-0.1391	-0.0504	-0.0224	-0.0416	-0.0937	-0.1625	-0.2266	-0.2553	-0.2069	-0.0278	0.2103	-0.2489
112.5	-0.3575	-0.5775	-0.4824	-0.4045	-0.3410	-0.2750	-0.1971	-0.1088	-0.0106	0.1112	0.2888	0.5487	0.4360	-0.4477
135.0	-0.1867	-0.4293	-0.5676	-0.6128	-0.5687	-0.4451	-0.2581	-0.0291	0.2133	0.4331	0.5883	0.6363	0.3516	-0.3573
157.5	-0.0427	-0.1309	-0.3442	-0.4487	-0.4367	-0.3399	-0.1856	0.0083	0.2174	0.3899	0.4444	0.3239	0.1572	-0.1446
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

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
180.0	0.0	-2.730	-7.280	-13.524	-20.147	-25.662	-28.813	-28.816	-25.521	-19.540	-12.255	-5.531	0.0	-66.568



HOOP STRESS

FIGURE A23

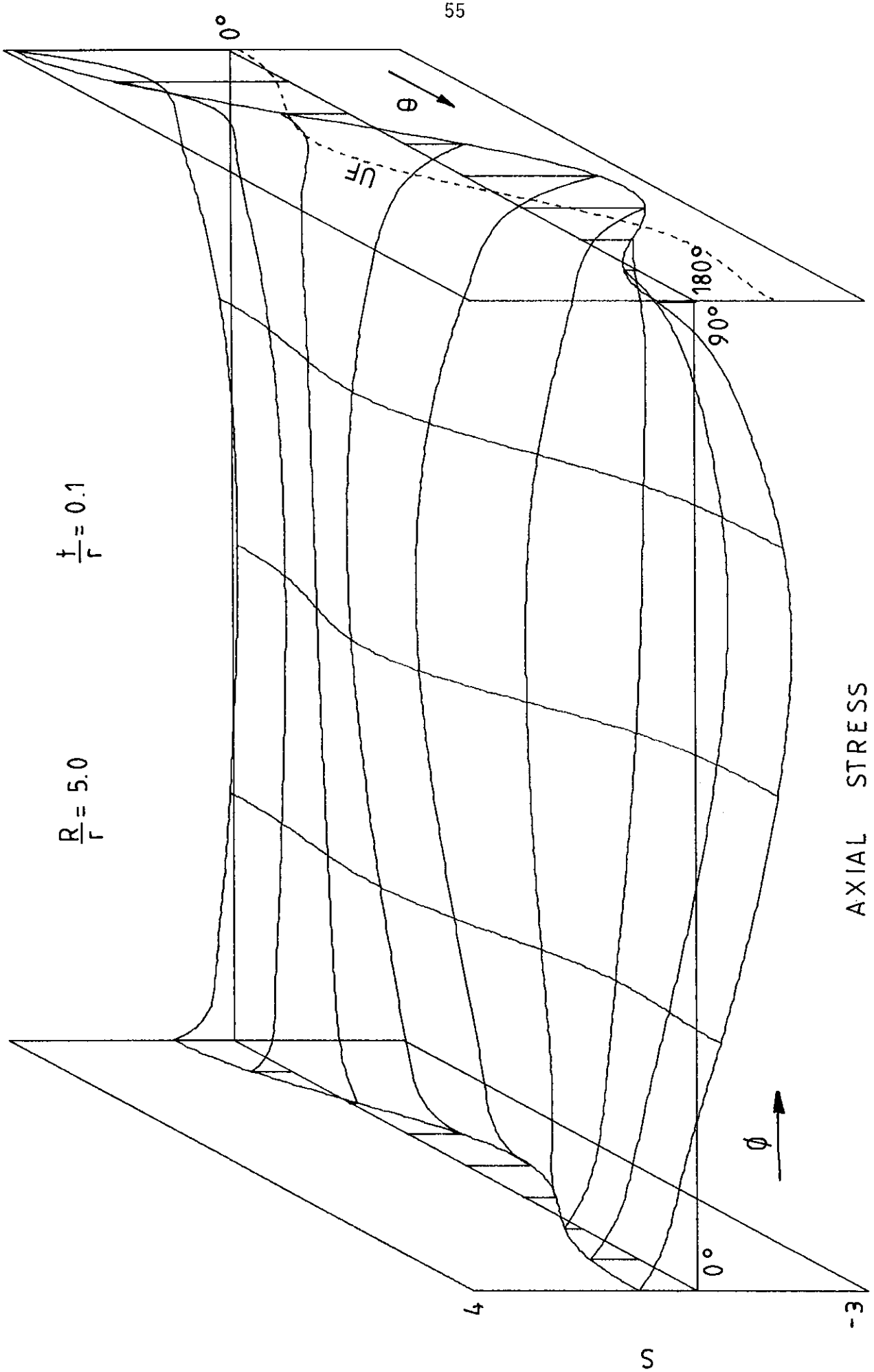


FIGURE A24

TABLE A23

R/r = 5.0 t/r = 0.1

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	Unflanged x sin
0.0	0.3199	-0.2392	-0.3869	-0.5333	-0.6624	-0.7646	-0.8299	-0.8506	-0.8244	-0.7530	-0.6377	-0.5246	1.1474	-1.7145
22.5	0.2151	-0.1696	-0.2986	-0.4368	-0.5653	-0.6702	-0.7381	-0.7592	-0.7293	-0.6502	-0.5281	-0.4120	0.9239	-1.4259
45.0	-0.0392	0.0069	-0.0366	-0.1116	-0.1955	-0.2703	-0.3213	-0.3376	-0.3132	-0.2501	-0.1624	-0.1036	0.3485	-0.4101
67.5	-0.2833	0.1705	0.2908	0.3796	0.4452	0.4911	0.5163	0.5194	0.5011	0.4605	0.3876	0.2446	-0.3106	1.2123
90.0	-0.3422	0.1619	0.4041	0.6709	0.9263	1.1363	1.2691	1.2997	1.2150	1.0155	0.7178	0.3469	-0.7101	2.3004
112.5	-0.1677	-0.0095	0.1538	0.4154	0.6962	0.9375	1.0938	1.1304	1.0247	0.7771	0.4314	0.0886	-0.6546	1.6041
135.0	0.0950	-0.1083	-0.1748	-0.1572	-0.1136	-0.0703	-0.0433	-0.0440	-0.0821	-0.1575	-0.2407	-0.2397	-0.2815	-0.3462
157.5	0.2646	-0.0161	-0.2557	-0.5262	-0.8017	-1.0366	-1.1965	-1.2539	-1.1898	-1.0005	-0.7104	-0.3370	0.0750	-1.8394
180.0	0.3100	0.0685	-0.2184	-0.6076	-1.0239	-1.3837	-1.6287	-1.7130	-1.6022	-1.2897	-0.8315	-0.3143	0.2061	-2.2729

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	Unflanged x sin
0.0	1.0663	0.2943	0.1611	0.0576	-0.0219	-0.0753	-0.0917	-0.0577	0.0404	0.2195	0.5121	0.9159	3.8247	-0.1238
22.5	0.7170	0.2874	0.2173	0.1609	0.1183	0.0930	0.0938	0.1311	0.2170	0.3656	0.6005	0.9049	3.0797	0.2277
45.0	-0.1305	0.2203	0.3127	0.3884	0.4553	0.5164	0.5707	0.6187	0.6649	0.7161	0.7747	0.7993	1.1618	1.0429
67.5	-0.9445	0.0057	0.2583	0.4886	0.6942	0.8680	0.9933	1.0544	1.0414	0.9476	0.7557	0.4300	-1.0352	1.5510
90.0	-1.1405	-0.3268	-0.0645	0.2105	0.4625	0.6731	0.8194	0.8768	0.8198	0.6231	0.2582	-0.2556	-2.3671	0.8993
112.5	-0.5590	-0.5142	-0.4390	-0.3146	-0.2023	-0.1145	-0.0575	-0.0440	-0.1012	-0.2669	-0.5725	-0.9347	-2.1820	-0.6506
135.0	0.3166	-0.2979	-0.4717	-0.6114	-0.7499	-0.8786	-0.9818	-1.0502	-1.0897	-1.1196	-1.1572	-1.1178	-0.9382	-1.6963
157.5	0.8819	0.1674	-0.1643	-0.5227	-0.8603	-1.1528	-1.3843	-1.5348	-1.5779	-1.4824	-1.2306	-0.8098	0.2499	-1.6431
180.0	1.0334	0.4068	0.0303	-0.4086	-0.8148	-1.1599	-1.4351	-1.6202	-1.6727	-1.5314	-1.1576	-0.5870	0.6871	-1.3992

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	Unflanged x cos
0.0	0.0	0.0	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	0.0127	-0.0136	-0.0319	-0.0358	-0.0341	-0.0301	-0.0260	-0.0244	-0.0282	-0.0411	-0.0704	-0.1369	-0.1980	-0.1014
45.0	-0.0322	-0.0645	-0.0943	-0.1025	-0.0976	-0.0838	-0.0650	-0.0474	-0.0386	-0.0473	-0.0866	-0.1814	-0.2562	-0.2092
67.5	-0.1392	-0.1445	-0.1780	-0.1918	-0.1841	-0.1570	-0.1161	-0.0707	-0.0331	-0.0176	-0.0406	-0.1132	-0.1242	-0.2863
90.0	-0.2451	-0.2016	-0.2255	-0.2390	-0.2312	-0.2016	-0.1550	-0.0990	-0.0442	-0.0045	0.0069	-0.0038	0.1134	-0.2609
112.5	-0.2705	-0.2028	-0.1888	-0.1793	-0.1706	-0.1606	-0.1481	-0.1303	-0.1037	-0.0665	-0.0144	0.0632	0.2926	-0.1159
135.0	-0.2015	-0.1673	-0.1003	-0.0501	-0.0360	-0.0541	-0.0944	-0.1410	-0.1726	-0.1616	-0.0773	0.0789	0.3075	0.0417
157.5	-0.0961	-0.1036	-0.0322	0.0246	0.0392	0.0152	-0.0357	-0.0974	-0.1472	-0.1532	-0.0808	0.0591	0.1830	0.0806
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

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
90.0	0.0	1.885	4.717	8.000	11.220	13.886	15.566	15.930	14.796	12.186	8.385	3.949	0.0	27.849

TABLE A24

R/r = 5.0 t/r = 0.1

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	-0.0480	0.1557	0.3502	0.5178	0.6587	0.7656	0.8274	0.8347	0.7819	0.6656	0.4768	0.1952	-0.1900	1.7487
22.5	-0.0150	0.0955	0.2593	0.4160	0.5571	0.6686	0.7352	0.7445	0.6893	0.5676	0.3791	0.1208	-0.1179	1.4381
45.0	0.0557	-0.0638	-0.0170	0.0639	0.1567	0.2382	0.2902	0.2987	0.2550	0.1598	0.0306	-0.1024	0.0510	0.3212
67.5	0.0946	-0.2179	-0.3712	-0.4812	-0.5585	-0.6125	-0.6435	-0.6514	-0.6381	-0.6027	-0.5253	-0.3806	0.1910	-1.5039
90.0	0.0471	-0.2007	-0.4943	-0.8146	-1.1180	-1.3677	-1.5260	-1.5633	-1.4648	-1.2325	-0.8785	-0.4649	0.1707	-2.7713
112.5	-0.0543	-0.0004	-0.2120	-0.5408	-0.8958	-1.2029	-1.4043	-1.4563	-1.3315	-1.0325	-0.6123	-0.2333	-0.0208	-2.0468
135.0	-0.1014	0.1468	0.1528	0.0797	-0.0292	-0.1325	-0.2071	-0.2359	-0.2037	-0.1093	0.0092	0.0432	-0.2328	0.0967
157.5	-0.0539	0.0989	0.2284	0.4586	0.7015	0.9061	1.0309	1.0451	0.9314	0.6943	0.3752	0.0850	-0.3259	1.7321
180.0	-0.0119	0.0320	0.1763	0.5300	0.9315	1.2779	1.4959	1.5310	1.3481	0.9524	0.4346	0.0374	-0.3352	2.1989

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	-0.1601	0.3547	0.3071	0.3015	0.3067	0.3208	0.3471	0.3919	0.4652	0.5815	0.7628	1.1401	-0.6333	0.6968
22.5	-0.0500	0.2929	0.2951	0.3219	0.3551	0.3917	0.4320	0.4792	0.5402	0.6268	0.7555	1.0244	-0.3930	0.7985
45.0	0.1856	0.1070	0.2109	0.3018	0.3901	0.4708	0.5381	0.5882	0.6205	0.6382	0.6447	0.6571	0.1698	0.8350
67.5	0.3154	-0.1580	-0.0075	0.0989	0.1962	0.2815	0.3489	0.3910	0.3998	0.3661	0.2758	0.0614	0.6365	0.3125
90.0	0.1570	-0.3521	-0.2730	-0.2498	-0.2396	-0.2329	-0.2233	-0.2107	-0.2044	-0.2243	-0.3022	-0.5547	0.5691	-0.7191
112.5	-0.1809	-0.3165	-0.3638	-0.4586	-0.5679	-0.6691	-0.7416	-0.7744	-0.7698	-0.7479	-0.7452	-0.8731	-0.0694	-1.3662
135.0	-0.3382	-0.0872	-0.2096	-0.3405	-0.4739	-0.5981	-0.7002	-0.7710	-0.8066	-0.8111	-0.7938	-0.8047	-0.7761	-0.9545
157.5	-0.1798	0.1308	-0.0032	-0.0805	-0.1331	-0.1847	-0.2501	-0.3370	-0.4420	-0.5478	-0.6118	-0.5962	-1.0864	-0.0296
180.0	-0.0395	0.2085	0.0775	0.0389	0.0406	0.0386	0.0018	-0.0875	-0.2281	-0.3928	-0.5116	-0.5025	-1.1172	0.4110

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	0.0	0.0	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	0.0115	0.1162	0.0851	0.0701	0.0544	0.0323	0.0021	-0.0359	-0.0811	-0.1357	-0.2088	-0.3364	-0.1792	0.0536
45.0	-0.0291	0.1445	0.1196	0.1051	0.0825	0.0463	-0.0053	-0.0717	-0.1513	-0.2450	-0.3597	-0.5353	-0.2318	0.0553
67.5	-0.1260	0.0221	0.0463	0.0514	0.0378	0.0072	-0.0400	-0.1034	-0.1820	-0.2721	-0.3650	-0.4628	-0.1123	-0.0378
90.0	-0.2218	-0.2206	-0.1528	-0.1251	-0.1156	-0.1133	-0.1155	-0.1241	-0.1405	-0.1590	-0.1569	-0.0921	0.1026	-0.2100
112.5	-0.2447	-0.4233	-0.3847	-0.3575	-0.3235	-0.2745	-0.2087	-0.1287	-0.0376	0.0650	0.1904	0.3698	0.2647	-0.3508
135.0	-0.1823	-0.4242	-0.4737	-0.4717	-0.4284	-0.3531	-0.2484	-0.1130	0.0535	0.2431	0.4326	0.5860	0.2782	-0.3427
157.5	-0.0869	-0.2407	-0.3216	-0.3355	-0.3055	-0.2497	-0.1724	-0.0694	0.0632	0.2167	0.3548	0.4133	0.1655	-0.1950
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

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
180.0	0.0	-1.686	-4.387	-7.631	-10.867	-13.565	-15.280	-15.675	-14.556	-11.944	-8.169	-3.929	0.0	-26.780