SAE Aerospace
An SAE International Group

AEROSPACE INFORMATION REPORT

SAE AIR1418 | REV. A

Issued 1980-04
Revised 1996-08
Reaffirmed 2013-01

Superseding AIR1418

Flexure Fatigue Strength of Tube Fitting Joints

RATIONALE

AIR1418A has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

This SAE Aerospace Information Report (AIR) presents flexure fatigue strength of tube fitting joints in the form of graphs showing applied deflection D and total calculated axial stress S versus number of cycles to failure N. The graphs have been prepared from data obtained by actual testing conducted in accordance with ARP1185.

1.1 Purpose:

The accompanying D/N (deflection versus cycles) and S/N (stress versus cycles) curves for tube fitting joints are presented over the widest practical range to enable a designer to choose the optimum design for a particular application. Requirements may vary from missile applications with a very short cycle life to a commercial airplane application with a very long cycle life. S/N curves can predict a life for projected designs where given stresses are forecast. D/N curves can compare similar fittings used on different tubing with widely varying levels of elasticity. The curves may also be used as the base line for qualification testing of alternate fitting joint designs.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable is;'sue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

ARP1185 Flexure Testing of Hydraulic Tube Fitting Joints

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AIR1418A

3. INFORMATION:

The curve on the graph represents a minimum fatigue strength boundary. The apparent axial stress has been calculated using Equation 1:

$$S = e_{max} \cdot E + \frac{P\, d_i^2}{d_o^2 - d_i^2} \qquad \text{(Eq. 1)}$$

where:

S = Maximum apparent total axial stress
e_{max} = Maximum measured axial unit bending strain
E = Modulus of elasticity for the tube material
P = Internal pressure
d_o = Tube outside diameter
d_i = Tube inside diameter

The deflection has been calculated using Equation 2:

$$D = \frac{D_i\, L^2}{L_i^2} \qquad \text{(Eq. 2)}$$

where:

D = Double amplitude deflection at L
L = Length of tube per ARP1185
L_i = Measured length of tube
D_i = Measured double amplitude deflection at L_i

All measured and calculated data used in preparing the graphs is presented in Appendix A.

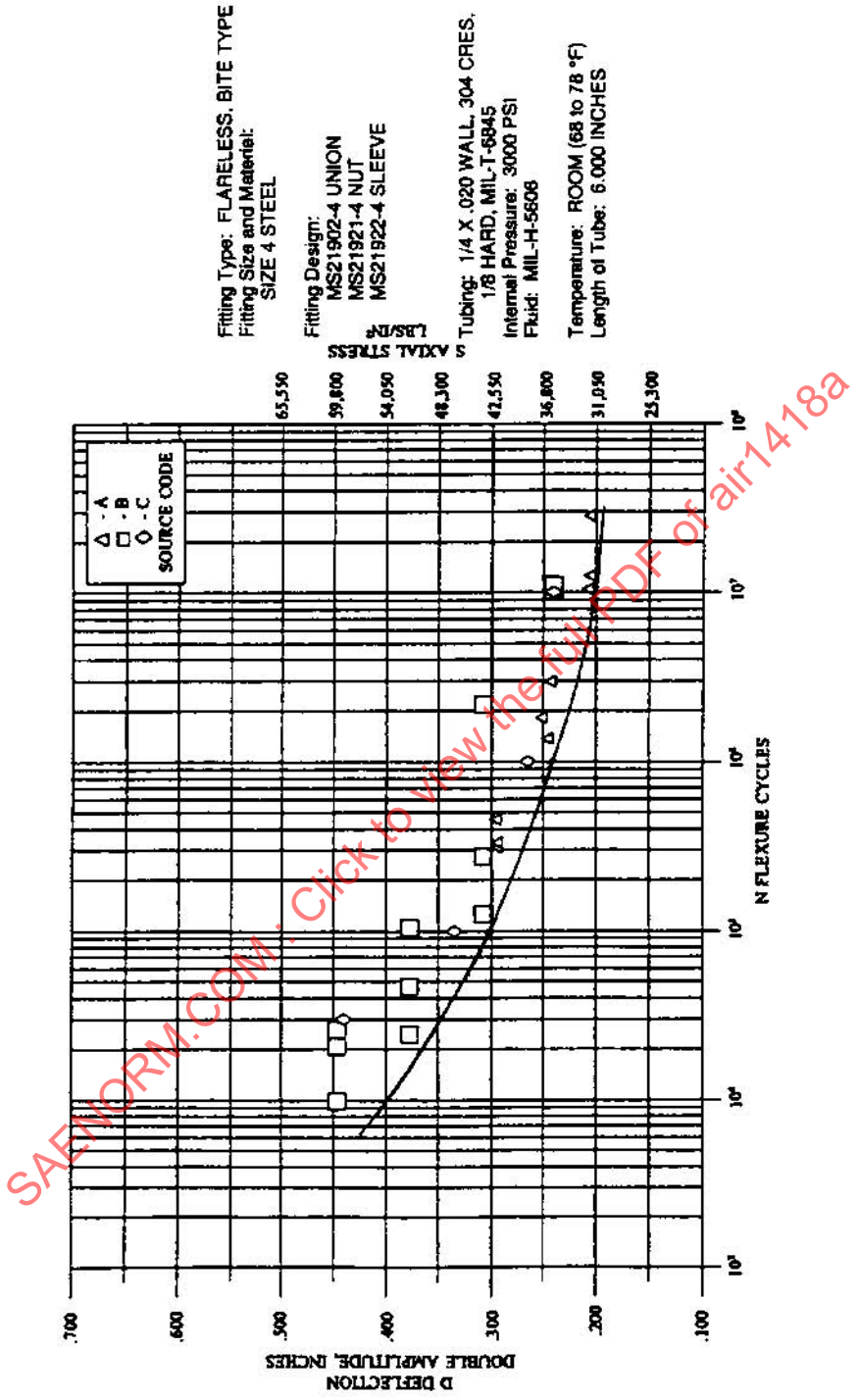

FIGURE 1

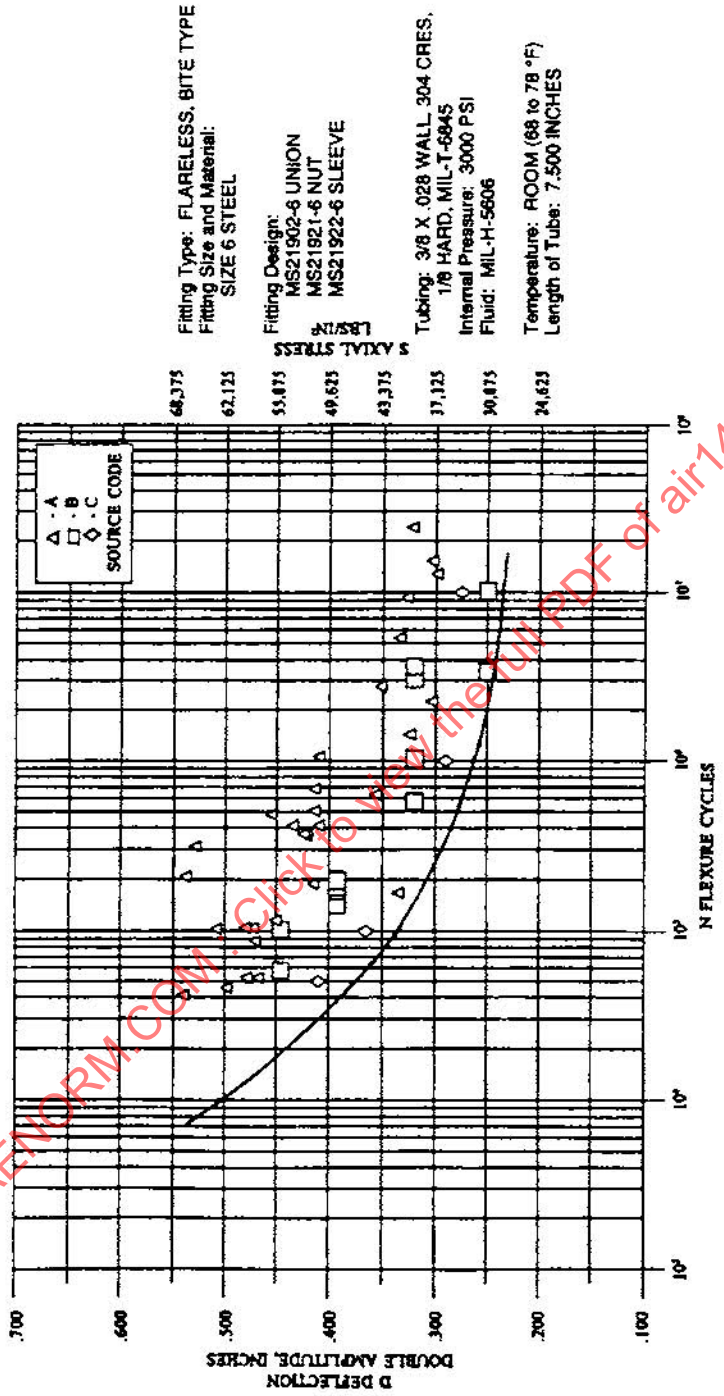

FIGURE 2

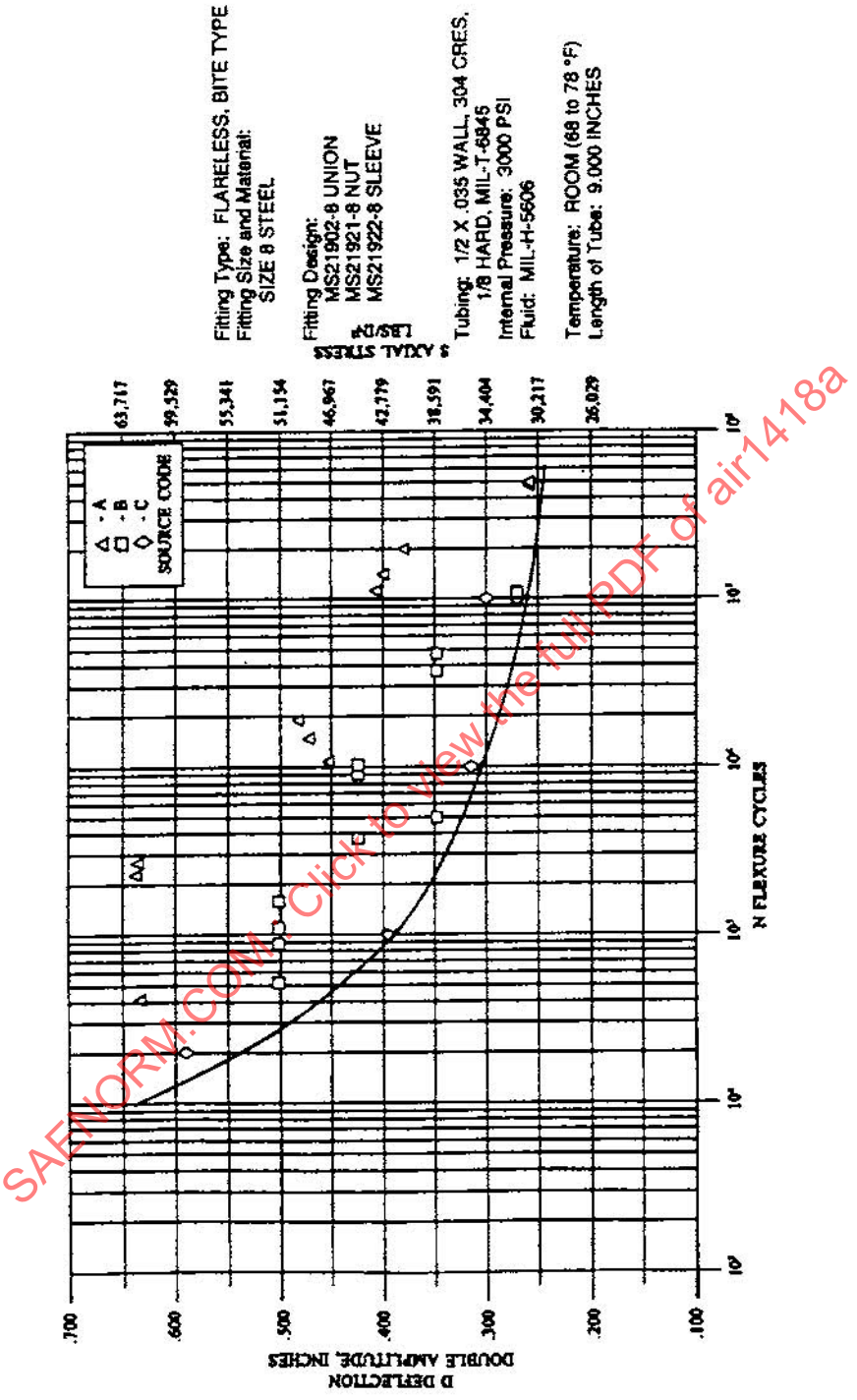

FIGURE 3

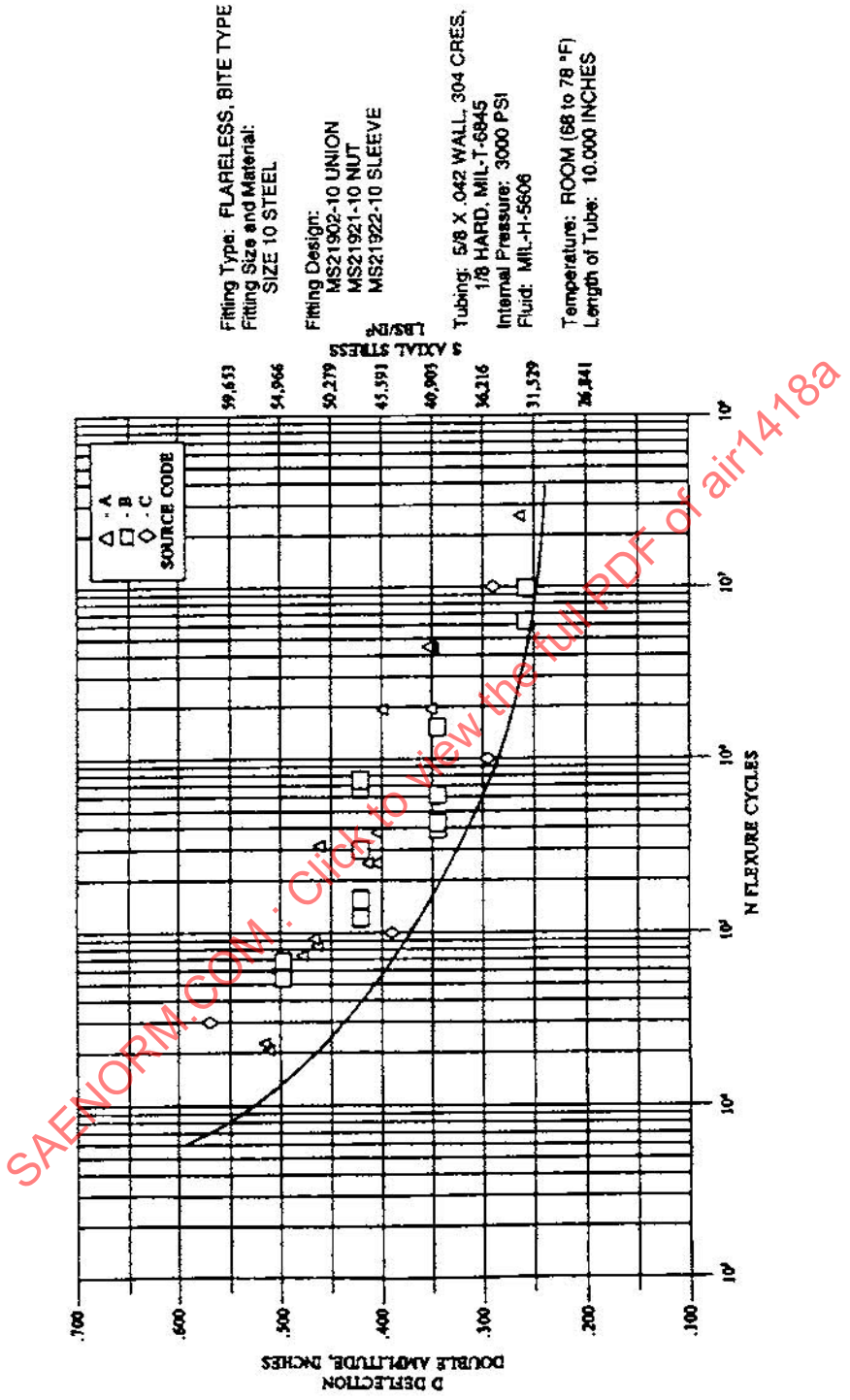

FIGURE 4

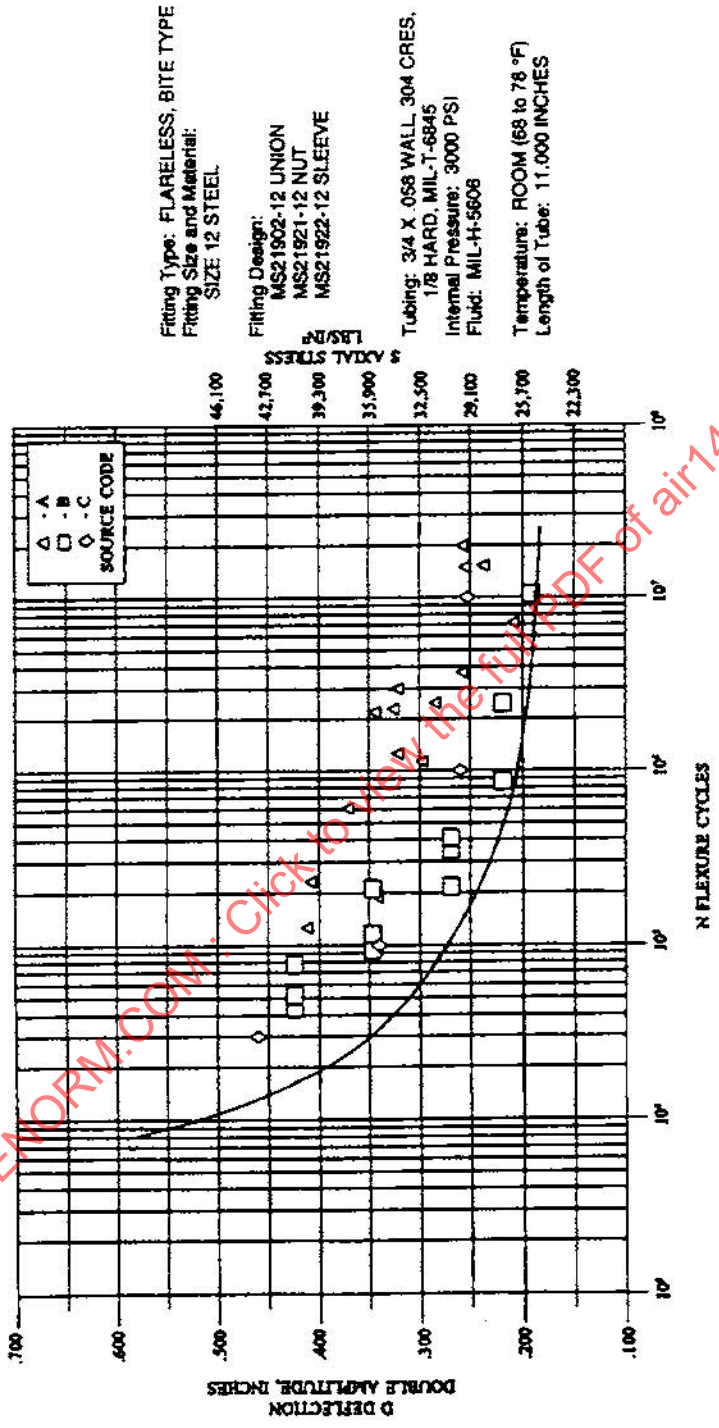

FIGURE 5

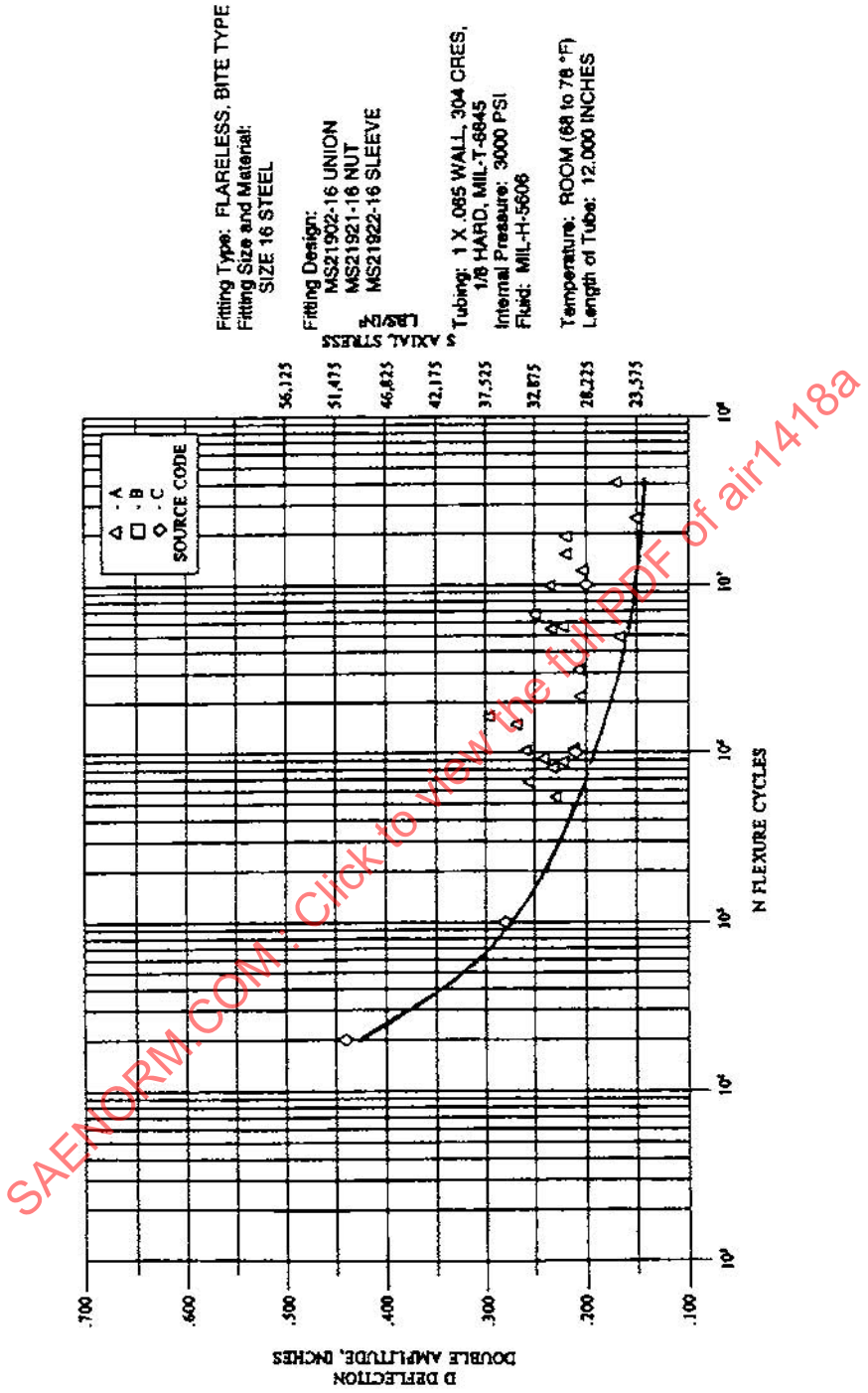

FIGURE 6

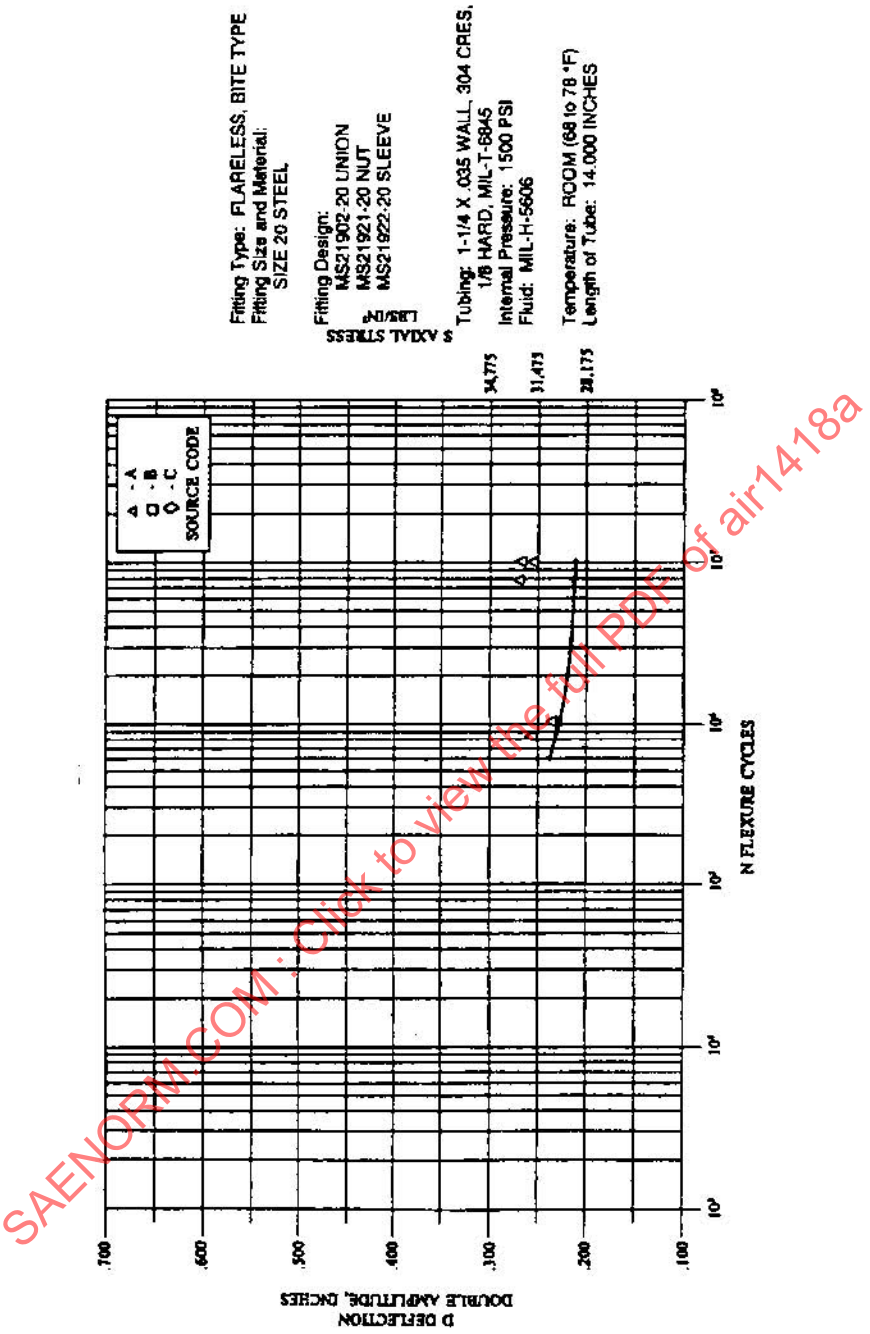

FIGURE 7

APPENDIX A

TABLE A1

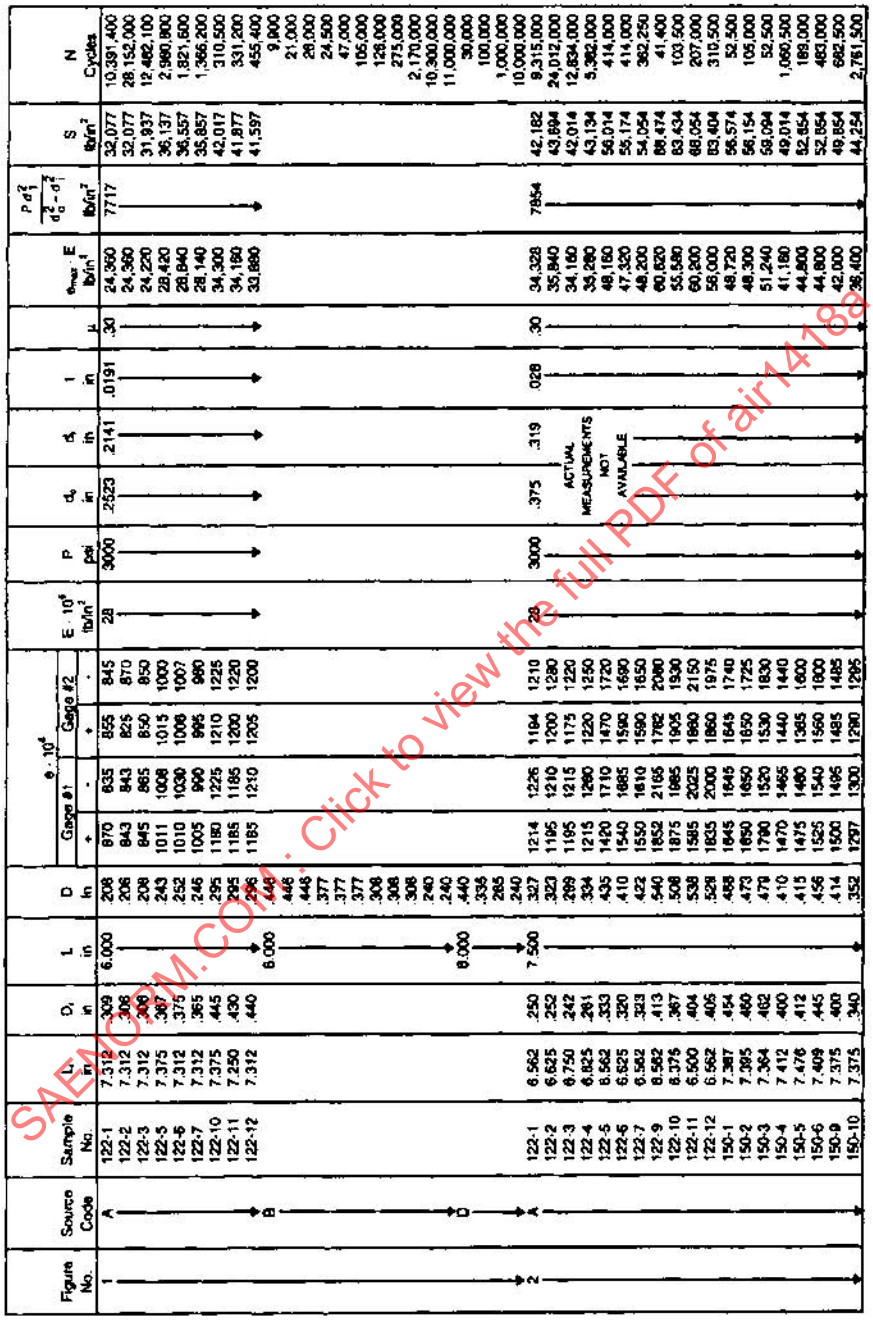

TABLE A1 (Continued)

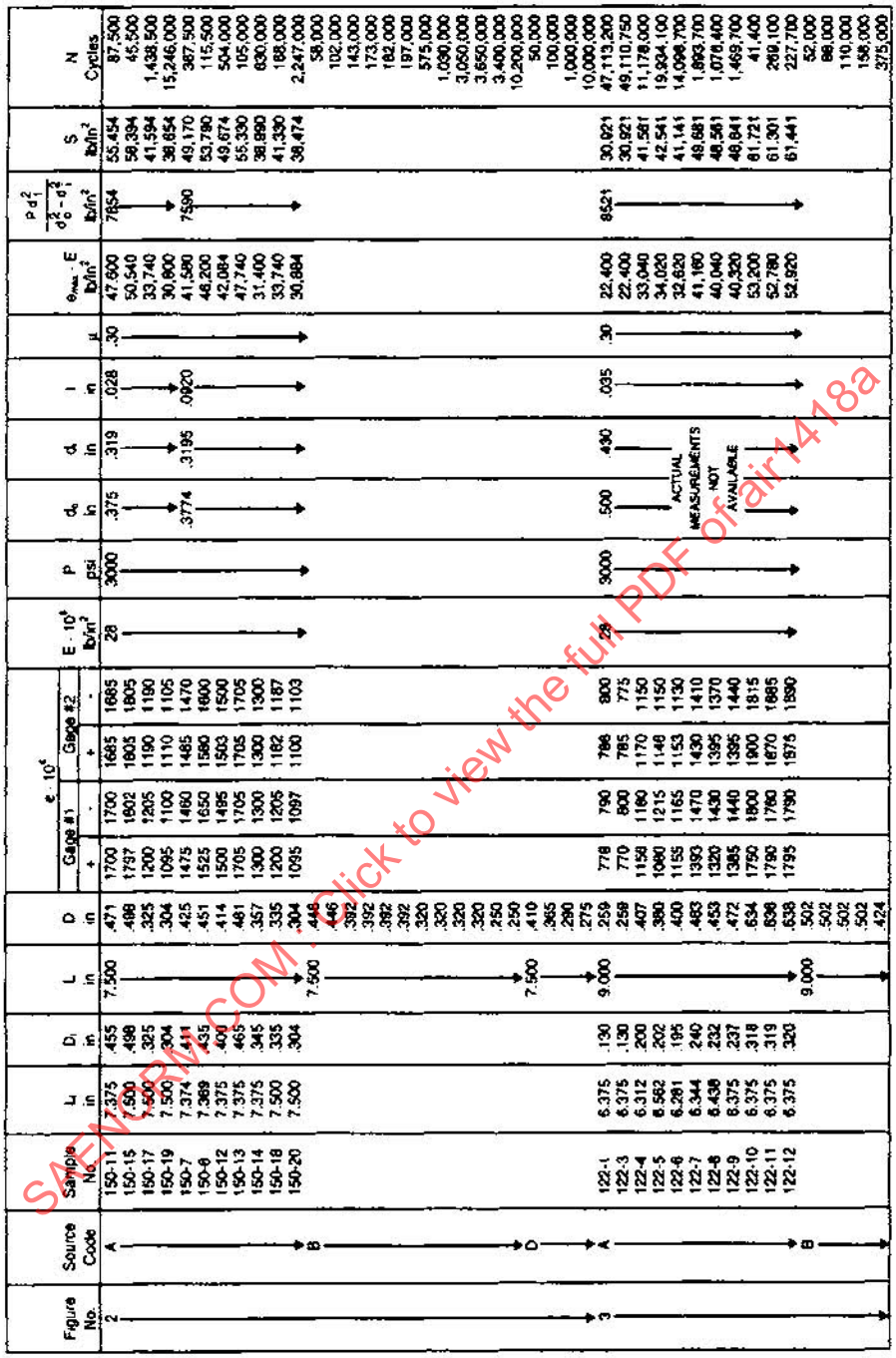

Figure No.	Source Code	Sample No.	L_i in	D_i in	L in	D in	$\epsilon \cdot 10^4$ Gage #1 +	Gage #1 −	Gage #2 +	Gage #2 −	$E \cdot 10^4$ lb/in²	P psi	d_o in	d_i in	l in	μ	$\epsilon_{max} \cdot E$ lb/in²	$\frac{P d_i^2}{d_o^2 - d_i^2}$ lb/in²	S lb/in²	N Cycles
2	A	150-11	7.375	.455	7.500	.471	1700	1700	1685	1685	28	3000	.375	.319	.028	.30	47,600	7854	55,454	87,500
		150-15	7.500	.499		.498	1737	1802	1805	1805							50,540		58,394	45,500
		150-17	7.500	.325		.325	1200	1205	1190	1190							33,740		41,594	1,438,500
		150-19	7.500	.304		.304	1095	1100	1110	1105							30,800		38,654	15,246,000
		150-7	7.374	.411		.425	1475	1460	1485	1470			.3774	.3195	.0920		41,580	7590	49,170	387,500
		150-6	7.369	.435		.451	1525	1550	1560	1600							48,200		53,790	115,500
		150-12	7.375	.400		.414	1500	1495	1503	1500							42,084		49,674	504,000
		150-13	7.375	.465		.481	1705	1705	1705	1705							47,740		55,330	105,000
		150-14	7.375	.345		.357	1300	1300	1300	1300							31,400		38,990	630,000
		150-18	7.500	.335		.335	1200	1205	1182	1187							33,740		41,330	188,000
		150-20	7.500	.304		.304	1095	1097	1100	1103							30,884		38,474	2,247,000
	B					.446														58,000
						.446														102,000
						.392														143,000
						.392														173,000
						.392														182,000
						.320														197,000
						.320														575,000
						.320														1,050,000
						.320														3,050,000
						.250														3,650,000
						.250														3,400,000
						.250														10,200,000
	D				7.500	.410														50,000
						.365														100,000
						.290														1,000,000
						.275														10,000,000
3	A	122-1	6.375	.130	9.000	.259	778	790	786	800	28	3000	.500	.430	.035	.30	22,400	8521	30,921	47,113,200
		122-3	6.375	.130		.259	770	800	785	775							22,400		30,921	49,110,750
		122-4	6.312	.200		.407	1158	1180	1170	1150							33,040		41,561	11,178,000
		122-5	6.562	.202		.380	1060	1215	1148	1150							34,020		42,541	19,934,100
		122-6	6.281	.195		.400	1155	1165	1153	1130							32,620		41,141	14,096,700
		122-7	6.344	.240		.463	1393	1470	1430	1410							41,160		48,681	1,863,700
		122-8	6.438	.232		.453	1320	1430	1395	1370							40,040		48,561	1,078,400
		122-9	6.375	.237		.472	1385	1440	1395	1440							40,320		48,841	1,469,700
		122-10	6.375	.318		.634	1790	1800	1800	1815							53,200		61,721	41,400
		122-11	6.375	.319		.636	1790	1760	1670	1685							52,780		61,301	269,100
		122-12	6.375	.320		.638	1795	1790	1975	1990							52,920		61,441	227,700
	B				9.000	.502														52,000
						.502														88,000
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						.424														375,000

TABLE A1 (Continued)

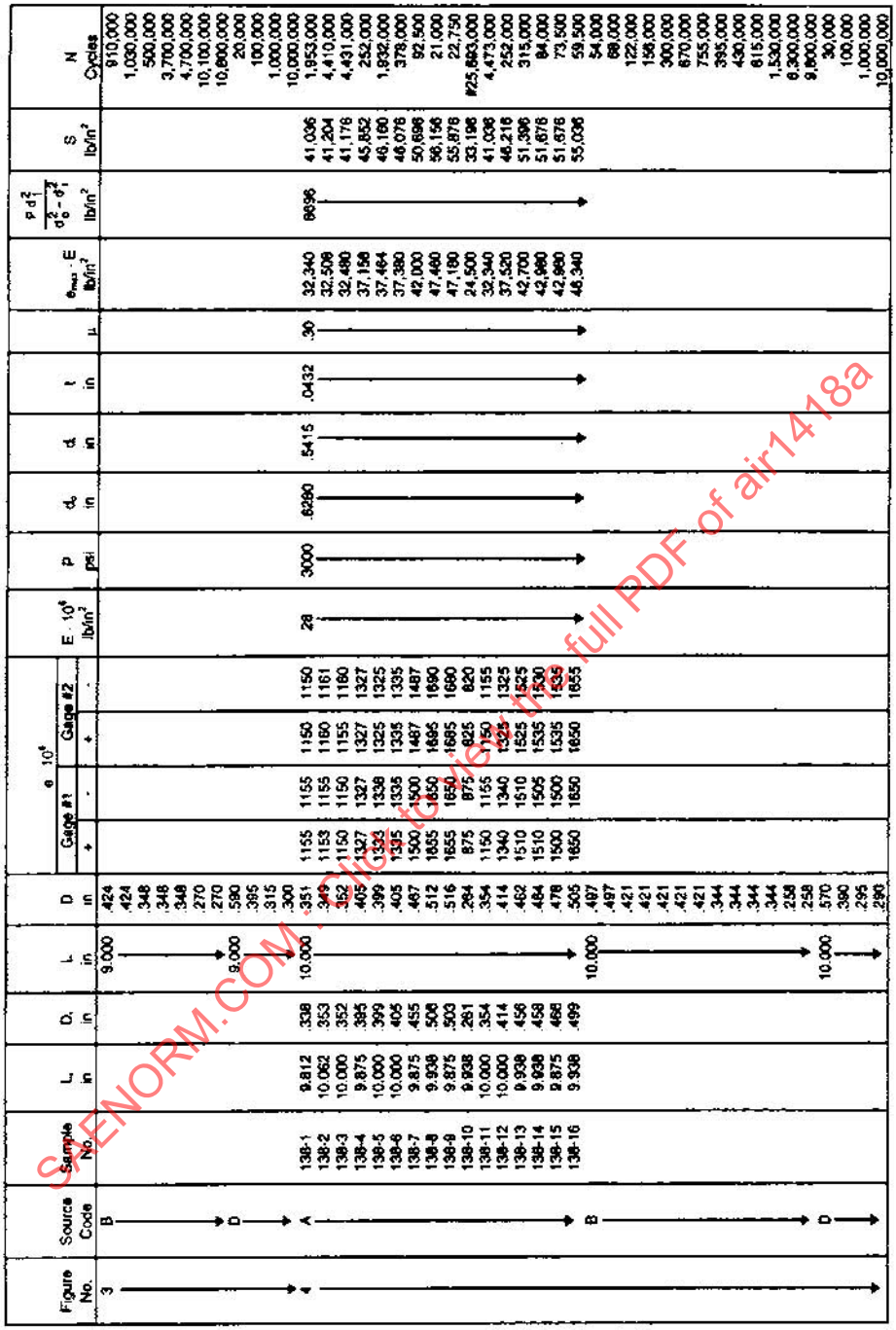

Figure No.	Source Code	Sample No.	L, in	D_i, in	L, in	D, in	$\epsilon \cdot 10^4$ Gage #1 +	$\epsilon \cdot 10^4$ Gage #1 -	$\epsilon \cdot 10^4$ Gage #2 +	$\epsilon \cdot 10^4$ Gage #2 -	$E \cdot 10^6$ lb/in²	p psi	d_o in	d_i in	t in	μ	$\epsilon_{max} \cdot E$ lb/in²	$\frac{p\,d_i^2}{d_o^2 - d_i^2}$ lb/in²	S lb/in²	N Cycles
3	B	138-1	9.812	.338	9.000	.424	1155	1155	1150	1150	28	3000	.6260	.5415	.0432	.30	32,340	8696	41,036	910,000
		138-2	10.062	.353		.424	1153	1155	1160	1161							32,508		41,204	1,030,000
		138-3	10.000	.352		.348	1150	1150	1155	1160							32,480		41,176	500,000
		138-4	9.875	.385		.348	1327	1327	1327	1327							37,156		45,852	3,700,000
		138-5	10.000	.399		.348	1334	1338	1325	1325							37,464		46,160	4,700,000
		138-6	10.000	.405		.270	1335	1335	1335	1335							37,380		46,076	10,100,000
		138-7	9.875	.455		.270	1500	1500	1495	1487							42,000		50,696	10,800,000
		138-8	9.938	.506		.590	1655	1650	1695	1690							47,460		56,156	20,000
		138-9	9.875	.503		.395	1655	1655	1695	1690							47,180		55,876	100,000
		138-10	9.938	.281		.315	875	875	825	820							24,500		33,196	1,000,000
		138-11	10.000	.354		.300	1150	1155	1150	1155							32,340		41,036	10,000,000
		138-12	10.000	.414		.351	1340	1340	1325	1325							37,520		46,216	#25,883,000
		138-13	9.938	.456		.349	1510	1510	1525	1525							42,700		51,396	4,473,000
		138-14	9.938	.458		.152	1510	1505	1535	1530							42,980		51,676	252,000
		138-15	9.875	.468		.405	1500	1500	1535	1535							42,980		51,676	315,000
		138-16	9.938	.499		.399	1650	1650	1650	1655							46,340		55,036	84,000
					10.000	.405														73,500
						.467														59,500
						.512														54,000
						.516														68,000
						.284														122,000
						.354														158,000
						.414														300,000
						.462														670,000
						.484														755,000
						.478														395,000
						.505														430,000
					10.000	.497														615,000
						.497														1,530,000
						.421														6,300,000
						.421														9,800,000
						.421														30,000
						.421														100,000
						.344														1,000,000
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						.344														
						.344														
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						.258														
	D				10.000	.570														
						.390														
						.295														
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