

EFFECT OF ENVIRONMENT ON FATIGUE CRACK PROPAGATION IN ALUMINIUM ALLOY SHEET AND PLATE

1. NOTATION

a	crack length or crack half-length	m	in
C	coefficient in simple crack growth rate equation, $da/dN = C(\Delta K)^n$	$m(m^{3/2}/N)^n$	$in(in^{3/2}/lbf)^n$
f_p	0.2 per cent proof stress of material	N/m ²	lbf/in ²
f_t	tensile strength of material	N/m ²	lbf/in ²
K	stress intensity factor defined as $S(\pi a)^{1/2}\alpha$	N/m ^{3/2}	lbf/in ^{3/2}
K_c	critical value of stress intensity factor (also plane stress fracture toughness)	N/m ^{3/2}	lbf/in ^{3/2}
K_{Ic}	plane strain fracture toughness in Mode I	N/m ^{3/2}	lbf/in ^{3/2}
ΔK	stress intensity factor range	N/m ^{3/2}	lbf/in ^{3/2}
ΔK_{TH}	threshold value of ΔK	N/m ^{3/2}	lbf/in ^{3/2}
N	number of load cycles		
n	index in simple crack growth rate equation, $da/dN = C(\Delta K)^n$		
R	S_{min}/S_{max}		
S	stress based upon gross cross-sectional area	N/m ²	lbf/in ²
S_{max}	maximum value of S in fatigue cycle	N/m ²	lbf/in ²
S_{min}	minimum value of S in fatigue cycle	N/m ²	lbf/in ²
α	geometrical factor in stress intensity factor expression, see Equation (2.1)		

1.1 Additional Notation for Test Specimens

CN	centre notched
CT	compact tension

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<i>DCB</i>	double cantilever beam
<i>SEN</i>	single edge notched
<i>SSCH</i>	single side cracked hole

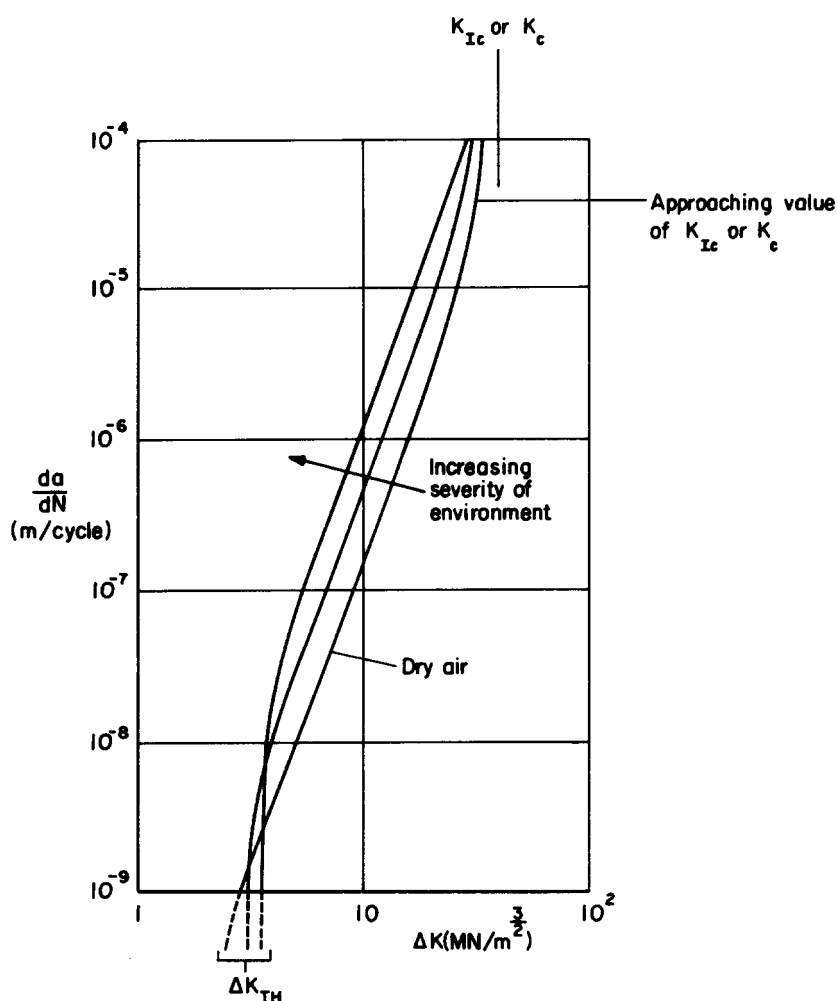
1.2 Conversion Factors

Both SI and British units are quoted in the notation. Stress intensity factors may be converted into lbf in units using the following conversion factor.

$$1.0 \text{ MN/m}^{3/2} = 0.91 \times 10^3 \text{ lbf/in}^{3/2}.$$

2. NOTES

2.1 General



Sketch 2.1 The effect of environment at a particular frequency and stress ratio, *R*

This Data Item presents fatigue crack propagation rate data on aluminium alloys in a variety of environmental conditions. Linear elastic fracture mechanics behaviour is assumed, as described in Data Item No. 80036*. Most of the data presented refer to aluminium alloy sheet and plate. Some data on forgings have also been presented. The most common test environments for which data are provided are salt water, humid air and dry air. A small range of other environments have been included for some alloys. A complete list of all the materials and environments for which data are presented and their location is given in Table 6.1.

The figures show that, all other factors being constant, fatigue crack propagation rates are generally increased by environments containing water or other corrosive substances. The increased growth rate is a function of the alloy type and its heat treatment as well as the environment and the frequency of loading. Above $\Delta K = 30 \text{ MN/m}^{3/2} (27.3 \times 10^3 \text{ lbf/in}^{3/2})$ environmental conditions have a negligible effect on crack growth rates and mechanical conditions are dominant. Corrosive environments can increase the threshold value of the stress intensity factor. The general effect of environment is shown in Sketch 2.1.

2.2 Presentation of Data

Data on 10 alloys subject to various environments are presented in Figures 1 to 20. In some cases the figures provide data on several heat treatment conditions of one alloy. The data are presented as curves of crack propagation rate versus stress intensity factor range, that is da/dN versus ΔK . The values of stress ratio, R , and frequency of loading have been noted. The tables accompanying each figure give information on the test conditions relevant to the use of the curves. The first table gives information on the material and environments. The second table gives values of C and n , in both SI and lbf in units, obtained from the mean crack propagation rate curves for various ranges of da/dN . These values have been calculated by constructing a 'least squares fit' straight line through the points within the given range. The range of da/dN was selected so that the correlation coefficient[†] for the fitted line was greater than 0.98. The stress intensity factor range is given by the equation

$$\Delta K = (S_{max} - S_{min})(\pi a)^{1/2} \alpha. \quad (2.1)$$

2.3 Test Conditions

The type of specimen used in each case is noted in the first table accompanying each figure. Most of the specimen shapes conform to ASTM E647 - 86a (Reference 27). In all cases the loading was sinusoidal. Specimens were pre-cracked and growing fatigue cracks were established before crack measurements commenced. All tests were performed at ambient temperature. The various environments are detailed in the tables accompanying each figure. In cases where full details of the test conditions were not given, blank spaces appear in the tables. Values of da/dN were not determined below $10^{-8} \text{ m/cycle} (3.9 \times 10^{-7} \text{ in/cycle})$ except for the data in Figures 1, 2 and 19.

3. DISCUSSION OF DATA

3.1 Effect of Environment on Crack Growth Rate

The principal test environments used were dry air, humid air, salt water and salt spray. The dry air is taken to have a relative humidity of less than 10 per cent and the humid air a relative humidity greater than 90

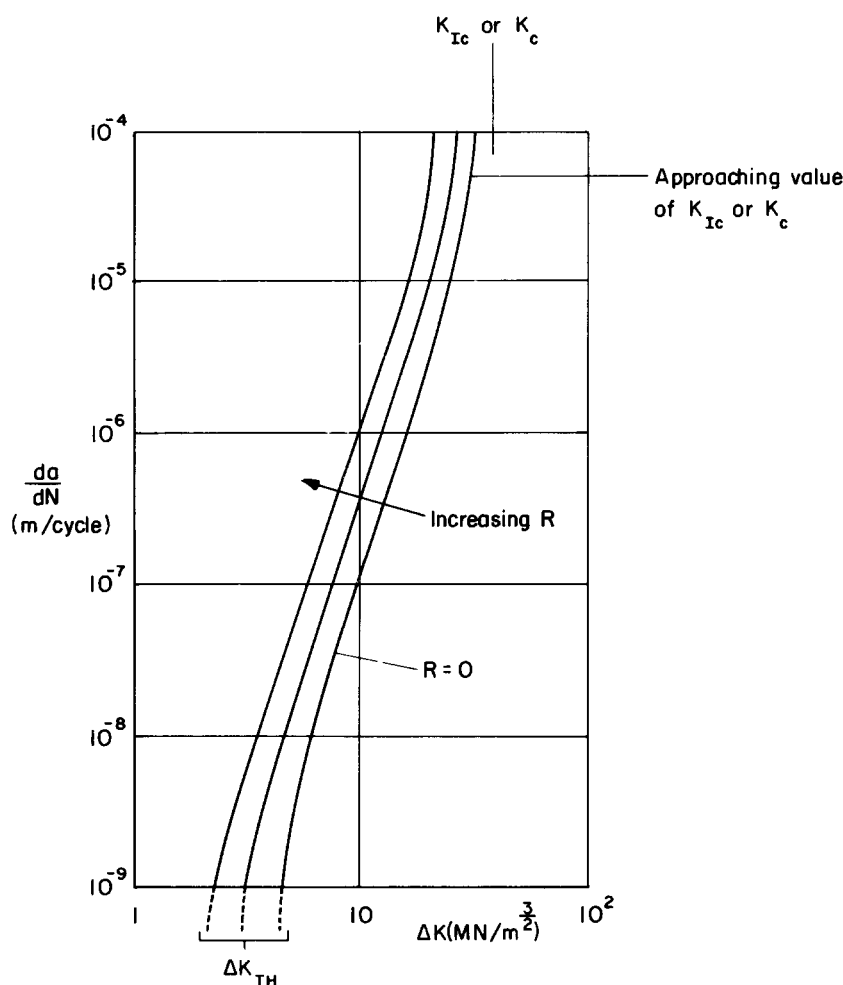
* Data Item No. 80036, 'Introduction to the use of linear elastic fracture mechanics in estimating fatigue crack growth rates and residual strength of components'.

† The correlation coefficient is a measure of how well the fitted line approximates the data. In this case 0 means no correlation and 1 means a perfect correlation.

per cent. The salt water consisted of a 3.5 per cent NaCl solution except where otherwise stated. The salt water spray consisted of a 20 second spray of a 3.5 per cent NaCl solution injected into the crack every 5 minutes. Both the humid air and salt water environments caused an increase in crack growth rate. Between ΔK values of 10 and 20 $\text{MN/m}^{3/2}$ (9.1×10^3 and 18.2×10^3 $\text{lbf/in}^{3/2}$) the crack growth rate for the aluminium copper alloys is increased by approximately 1.3 for humid air and 2 for the salt water. The effects of the environment are worse for the aluminium zinc alloys; humid air increases crack growth rate by 1.5 to 3.5 times that for dry air, while salt spray increases crack growth by 3 to 6 times that for dry air for ΔK between 10 and 20 $\text{MN/m}^{3/2}$. The large range of crack growth rates among the aluminium zinc alloys depends partly on the heat treatment condition. The T61 condition in the 7475 alloy has a 1.2 times higher crack growth rate in humid air and a 1.4 times higher crack growth rate in salt spray than the T761 condition, for ΔK between 10 and 20 $\text{MN/m}^{3/2}$. The aluminium copper alloys have better corrosion fatigue crack propagation resistance than the aluminium zinc alloys.

3.2 Effect of Stress Ratio, R , and Frequency

In both dry air and the other environments for which data are available increasing the stress ratio, R , increases the fatigue crack growth rate, for the same value of ΔK . Compare, for example Figures 8, 9 and 10. The general effect of increasing R is shown in Sketch 3.1. In corrosive environments decreasing the frequency increases the crack growth rate.



Sketch 3.1 The effect of increasing stress ratio, R , in a particular environment

3.3 Effect of Heat Treatment

Heat treatments that improve the resistance of the material to stress corrosion cracking also appear to improve its crack propagation resistance characteristics in humid air and salt water environments. The 7075 alloy in the T73 condition has a lower fatigue crack growth rate than it does in the T6 condition, in both humid air and salt water. Similarly, the T761 condition reduces fatigue crack growth rates in the 7475 alloy compared to the T61 condition, in humid air and salt water. Although the above heat treatments reduce crack growth rates, they also reduce the tensile and proof stresses of the alloys. Each table contains a summary of the applied heat treatments. A more detailed description of the temper designations can be found in References 26 and 28.

3.4 Effect of Specimen Type, Thickness and Orientation

There are insufficient data available to allow comparison among specimen thicknesses, types and orientations. For thick plates no information was available on where the specimens were cut from.

4. CALCULATION OF CRACK GROWTH

The growth of a crack over a number of cycles may be predicted by integrating the crack growth rate curves given in Figures 1 to 20. This may be easily done over the linear portion of the curve which may be represented by the Paris equation

$$\frac{da}{dN} = C(\Delta K)^n \quad (4.1)$$

Examples of the use of these curves are given in Data Item Nos. 82015, 84001 and 84003*. Since the curves are presented on a logarithmic scale, n represents the slope and C the ordinate intercept of the straight line. Equation (4.1) can be integrated analytically, using the method described in Data Item No. 80036, to obtain the total number of loading cycles required for a crack to grow from one length to another.

Difficulty may arise in relating these laboratory environments to real conditions. In many applications the given environments represent overly harsh conditions and so their use in design may underestimate crack growth life in service.

5. DERIVATION AND REFERENCES

Derivation

This Section lists selected sources that have assisted in the preparation of this Item.

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* Data Item No. 82015, 'Fatigue crack propagation rates and threshold stress intensity factor ranges for titanium alloy plate, bar and forgings'.

Data Item No. 84001, 'Growth of cracks under constant amplitude fatigue loading: example calculation'.

Data Item No. 84003, 'Fatigue crack propagation rates and threshold stress intensity factors in high alloy and corrosion resistant (stainless) steel'.

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SCHRA, L. Corrosion fatigue crack arrest in aluminium alloys. National Aerospace Laboratory, the Netherlands, NLR-TR-87128, July 1987.

References

This section gives recommended sources of information supplementary to that in this Item.

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28. USA, DoD USAF, MIL Handbook 5. Published by United States Air Force, Department of Defence, Wright Patterson AFB, Ohio.

6. TABLES AND FIGURES

TABLE 6.1 INDEX TO FIGURES AND TABLES

Material designation	Environment	From	Figure and Table No.
2024-T3	Air < 0.05% relative humidity Air at 100% relative humidity 3.5% NaCl solution Sump tank water	3.15 mm (0.124 in) Alclad sheet 1.6 mm (0.063 in) sheet 1 mm (0.039 in) Alclad sheet	Figs 1, 2 Tables 6.2 to 6.5
2124-T851	Air < 10% relative humidity Air > 90% relative humidity Salt spray	50 mm (2 in) plate 114 mm (4.488 in) plate	Fig. 3 Tables 6.6, 6.7
2219-T87	Laboratory air 3.5% NaCl solution	25.4 mm (1 in) plate	Fig. 4 Tables 6.8, 6.9
2618A-T651	Air at 95% relative humidity 3.0% NaCl solution	1.6 mm (0.063 in) sheet	Fig. 5 Tables 6.10, 6.11
5456-H117	Laboratory air/sea water	11 mm (0.433 in) plate	Fig. 6 Tables 6.12, 6.13
6061-T6	Air > 85% relative humidity Salt water	90 mm (3.543 in) extrusion	Fig. 7 Tables 6.14, 6.15
7050-T76 7050-T73651 7050-T7651 7050-T736	Air < 10% relative humidity Air > 90% relative humidity Salt spray Salt water	90 mm (3.543 in) plate 38.1 mm (1.5 in) forging 28.6 mm (1.125 in) plate 3.2 mm (0.125 in) Alclad sheet	Figs 8 to 12 Tables 6.16 to 6.25
7075-T6 7075-T651 7075-T73	Air < 10% relative humidity Air > 90% relative humidity 3.5% NaCl solution Water saturated fuel Distilled water Dye penetrant Sump tank water	15.9 mm (0.625 in) plate 4 mm (0.157 in) sheet 1.6 mm (0.063 in) sheet 1 mm (0.039 in) clad sheet	Figs 13 to 15 Tables 6.26 to 6.31
7178-T6	Air < 10% relative humidity Air > 90% relative humidity Distilled water 3.5% NaCl solution	4 mm (0.157 in) sheet	Fig. 16 Tables 6.32, 6.33
7475-T61 7475-T761 7475-T7651	Air < 10% relative humidity Air > 90% relative humidity Salt spray Sump tank water 3.5% NaCl solution	25.4 mm (1 in) plate 3.2 mm (0.125 in) sheet 2.9 mm (0.114 in) sheet 1 mm (0.039 in) sheet	Figs 17 to 20 Tables 6.34 to 6.41



TABLE 6.2

ALLOY TYPE SPECIFICATION ENVIRONMENT				2024-T3 L109 Dry air/Humid air/Salt water/Sump tank water								TABLE 6.2 FIGURE 1
COMPOSITION				4.4Cu - 1.5Mg - 0.6Mn								
HEAT TREATMENT				T3 - solution treated and cold worked								
Curve No.	Derivation Nos	Test Freq. (Hz)	R	Spec. Type	Spec. Thickness (mm) (in)	Orientation	Material Form	f_t		f_p		ENVIRONMENT
								MN/m ²	lbf/in ²	MN/m ²	lbf/in ²	
1	1	0.4	0.1	CN	1 (0.039)	L-T	1 mm Alclad sheet	459	66 600	353	51 200	Air at 100% relative humidity
2	1	57	0.1	CN	1 (0.039)	L-T	1 mm Alclad sheet	459	66 600	353	51 200	Air at 100% relative humidity
3	2	2-5 (a)	0.1	SEN	1.6 (0.063)	L-T	1.6 mm sheet	470	68 200	356	51 600	3.5% NaCl solution
4	1	0.4	0.1	CN	1 (0.039)	L-T	1 mm Alclad sheet	459	66 600	353	51 200	Air < 0.05% relative humidity
5	12	13	0.1	SSCH	3.15 (0.124)	L-T	3.15 mm Alclad sheet	475	68 900	349	50 600	Air at 50%±10% relative humidity
6	12	13	0.1	SSCH	3.15 (0.124)	L-T	3.15 mm Alclad sheet	475	68 900	349	50 600	Sump tank water (b)
7	12	13	0.1	SSCH	3.15 (0.124)	L-T	3.15 mm Alclad sheet	475	68 900	349	50 600	Artificial seawater (c)

Notes

(a) Frequency maintained at 5 Hz up to a crack growth rate of 2×10^{-6} m/cycle (8×10^{-5} in/cycle); thereafter it is maintained at 2 Hz.

(b) Sump tank water consists of the following in g/litre of deionised water:

NaCl - 0.100, MgCl₂ - 0.050, CaCl₂ - 0.050, CdCl₂ - 1.000, ZnCl₂ - 0.010, FeCl₃ - 0.005,

MnCl₂.4H₂O - 0.005, PbCl₂ - 0.001, CrCl₃.6H₂O - 0.001, CuCl₃.2H₂O - 0.001, NiCl₂.6H₂O - 0.001.

(c) Seawater conforms to ASTM D1141-75.

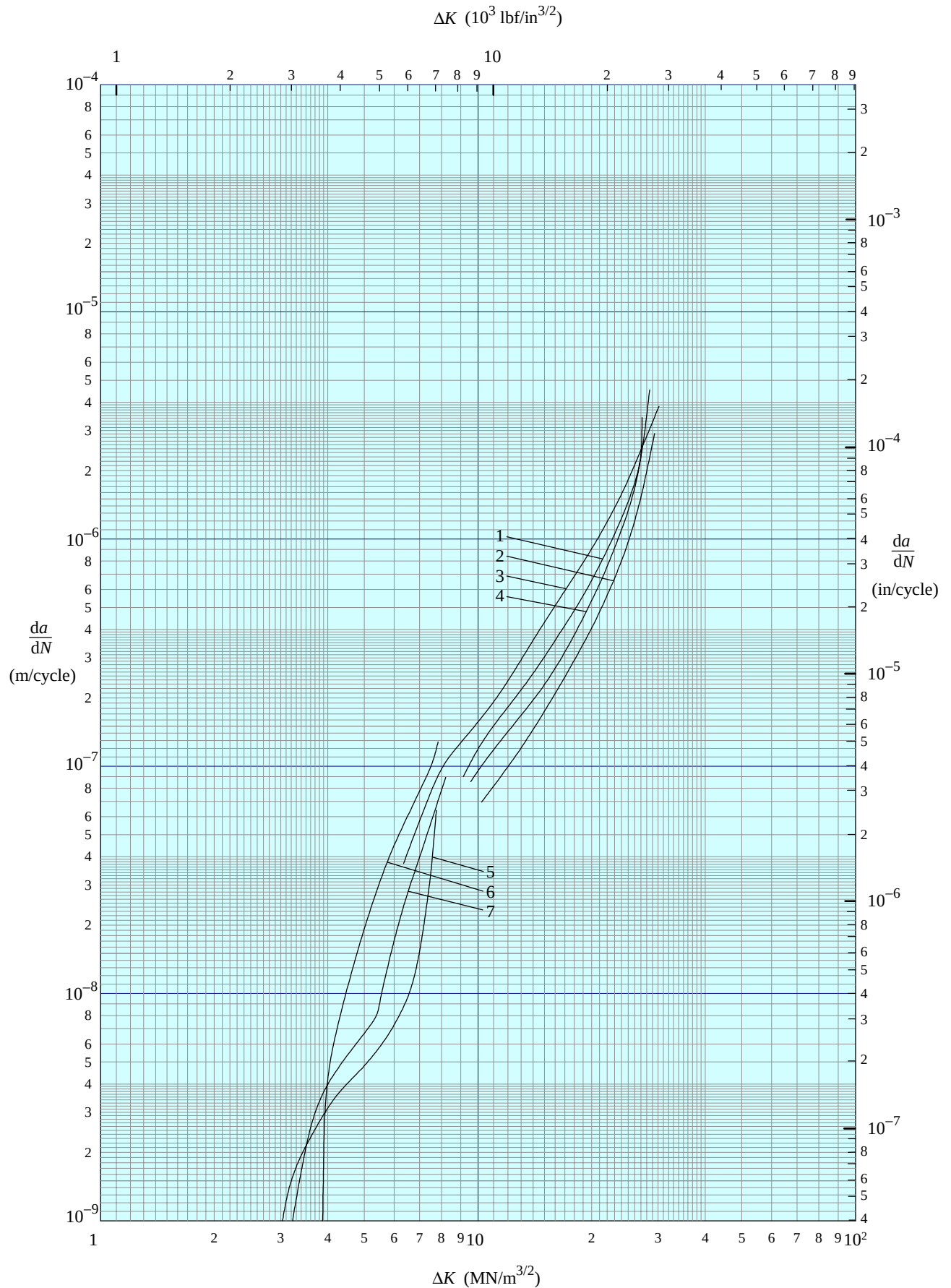


FIGURE 1 2024 – T3

TABLE 6.3

ALLOY TYPE		2024 - T3					TABLE 6.3	
ENVIRONMENT		Dry air/Humid air/Salt water/Sump tank water					FIGURE 1	
Curve No.	K_{IC}	K_Q	ΔK_{TH}	Range of da/dN		n	C	
	MN/m ^{3/2}	MN/m ^{3/2}	MN/m ^{3/2}	m/cycle	in/cycle		$m\left(\frac{m^{3/2}}{MN}\right)^n$	$in\left(\frac{in^{3/2}}{10^3 \text{ lbf}}\right)^n$
1				10^{-7} to 10^{-6}	3.9×10^{-6} to 3.9×10^{-5}	2.3	5.9×10^{-10}	2.9×10^{-8}
2				10^{-7} to 10^{-6}	3.9×10^{-6} to 3.9×10^{-5}	2.7	1.5×10^{-10}	7.6×10^{-9}
3				4×10^{-8} to 3×10^{-6}	1.6×10^{-6} to 1.2×10^{-4}	2.6	4.1×10^{-10}	2.1×10^{-8}
4				8×10^{-8} to 1×10^{-6}	3.1×10^{-6} to 3.9×10^{-5}	2.5	2.7×10^{-10}	1.4×10^{-8}
5			2.7	2×10^{-9} to 9×10^{-9}	7.9×10^{-8} to 3.5×10^{-7}	2.3	1.3×10^{-10}	6.3×10^{-9}
6			3.6	10^{-8} to 10^{-7}	3.9×10^{-7} to 3.9×10^{-6}	4.4	1.6×10^{-11}	9.8×10^{-10}
7			3.0	7×10^{-9} to 8×10^{-8}	2.8×10^{-7} to 3.1×10^{-6}	5.2	1.8×10^{-12}	1.1×10^{-10}



TABLE 6.4

ALLOY TYPE SPECIFICATION ENVIRONMENT				2024-T3 L109/AMS 4041 Laboratory Air/Sump tank water								TABLE 6.4 FIGURE 2
COMPOSITION				4.4Cu - 1.5Mg - 0.6Mn								
HEAT TREATMENT				T3 - solution treated and cold worked								
Curve No.	Derivation Nos	Test Freq. (Hz)	R	Spec. Type	Spec. Thickness (mm) (in)	Orientation	Material Form	f_t		f_p		ENVIRONMENT
								MN/m ²	lbf/in ²	MN/m ²	lbf/in ²	
1	12	13	0.5	SSCH	3.15 (0.124)	L-T	3.15 mm Alclad sheet	475	68 900	349	50 600	Air at 50%±10% relative humidity
2	12	13	0.5	SSCH	3.15 (0.124)	L-T	3.15 mm Alclad sheet	475	68 900	349	50 600	Sump tank water (a)

Notes

- (a) Sump tank water consists of the following in g/litre of deionised water:
NaCl - 0.100, MgCl₂ - 0.050, CaCl₂ - 0.050, CdCl₂ - 1.000, ZnCl₂ - 0.010, FeCl₃ - 0.005, MnCl₂.4H₂O - 0.005, PbCl₂ - 0.001,
CrCl₃.6H₂O - 0.001, CuCl₃.2H₂O - 0.001, NiCl₂.6H₂O - 0.001.

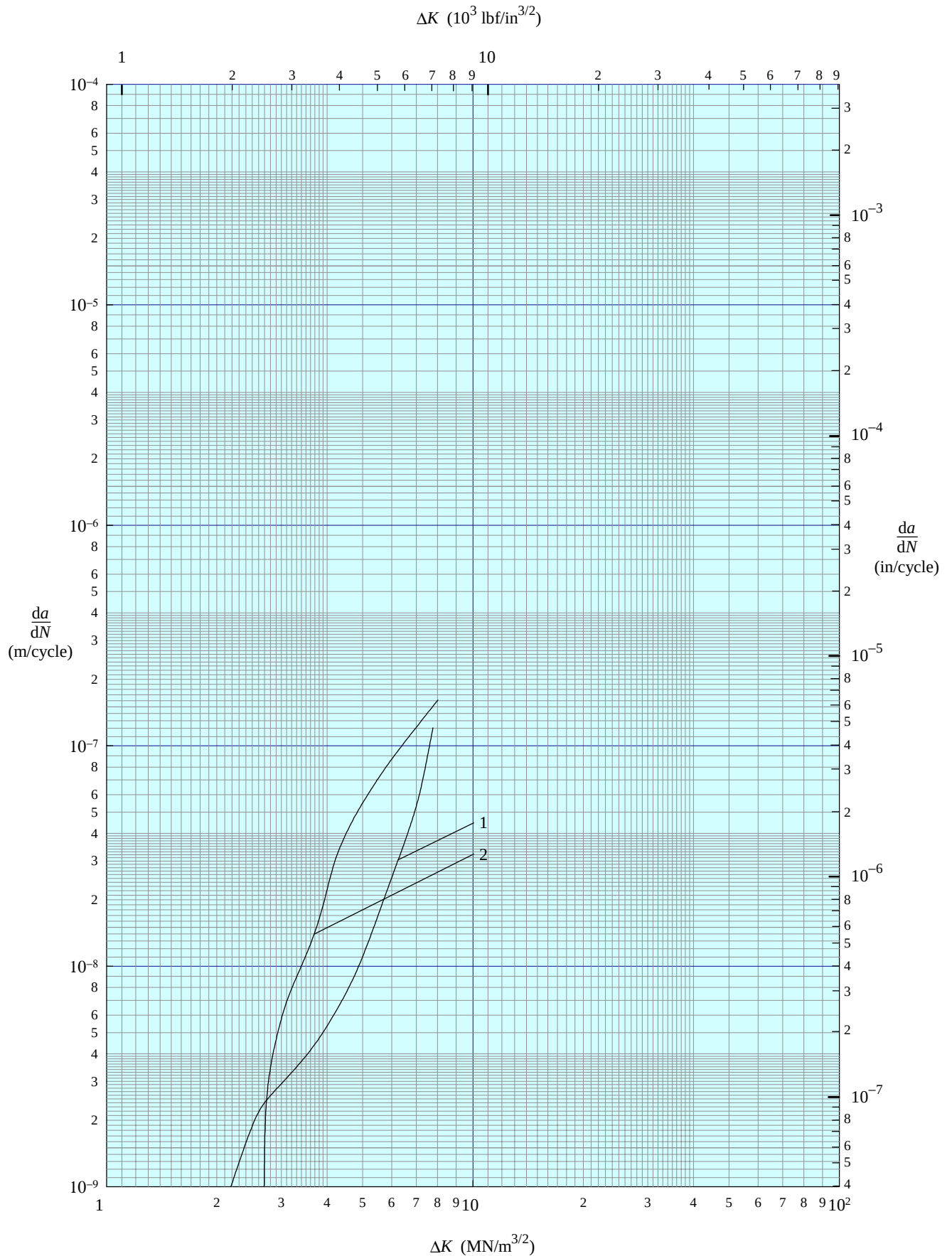


FIGURE 2 2024 – T3

TABLE 6.5

ALLOY TYPE		2024 - T3					TABLE 6.5	
ENVIRONMENT		Laboratory air/Sump tank water					FIGURE 2	
Curve No.	K_{IC}	K_Q	ΔK_{TH}	Range of da/dN		n	C	
	$\text{MN/m}^{3/2}$	$\text{MN/m}^{3/2}$	$\text{MN/m}^{3/2}$	m/cycle	in/cycle		$m\left(\frac{\text{m}^{3/2}}{\text{MN}}\right)^n$	$\text{in}\left(\frac{\text{in}^{3/2}}{10^3 \text{ lbf}}\right)^n$
1			1.9	6×10^{-9} to 3×10^{-8}	2.4×10^{-7} to 1.2×10^{-6}	3.9	2.1×10^{-11}	1.2×10^{-9}
2			2.5	5×10^{-8} to 1.5×10^{-7}	2.0×10^{-6} to 5.9×10^{-6}	2.0	2.3×10^{-9}	1.1×10^{-7}
				4×10^{-9} to 5×10^{-8}	1.6×10^{-7} to 2×10^{-6}	4.9	2.6×10^{-11}	1.6×10^{-9}



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TABLE 6.6

ALLOY TYPE SPECIFICATION ENVIRONMENT				2124 - T851 L97/AMS 4101 Dry air/Humid air/Salt spray								TABLE 6.6 FIGURE 3
COMPOSITION												
NOMINAL ACTUAL				4.4Cu - 1.5Mg - 0.6Mn 4.08Cu - 1.39Mg - 0.55Mn - 0.14Fe - 0.05Si - 0.32Zn - 0.02Ti								
HEAT TREATMENT				T851 - Solution treated, stress relieved by stretching, cold worked and artificially aged								
Curve No.	Derivation Nos	Test Freq. (Hz)	R	Spec. Type	Spec. Thickness (mm) (in)	Orientation	Material Form	f_t		f_p		ENVIRONMENT
								MN/m ²	lbf/in ²	MN/m ²	lbf/in ²	
1	7	13.3	0.33	CN	19 (0.748)	T-L	50 mm plate	493	71 500	456	66 200	Air <10% relative humidity
2	7	13.3	0.33	CN	19 (0.748)	T-L	50 mm plate	493	71 500	456	66 200	Air >90% relative humidity
3	7	13.3	0.33	CN	19 (0.748)	T-L	50 mm plate	493	71 500	456	66 200	Salt spray
4	7	13.3	0.33	CN	19 (0.748)	L-T	114 mm plate	493	71 500	456	66 200	Air <10% relative humidity
5	7	13.3	0.33	CN	19 (0.748)	L-T	114 mm plate	493	71 500	456	66 200	Air >90% relative humidity
6	7	13.3	0.33	CN	19 (0.748)	L-T	114 mm plate	493	71 500	456	66 200	Salt spray



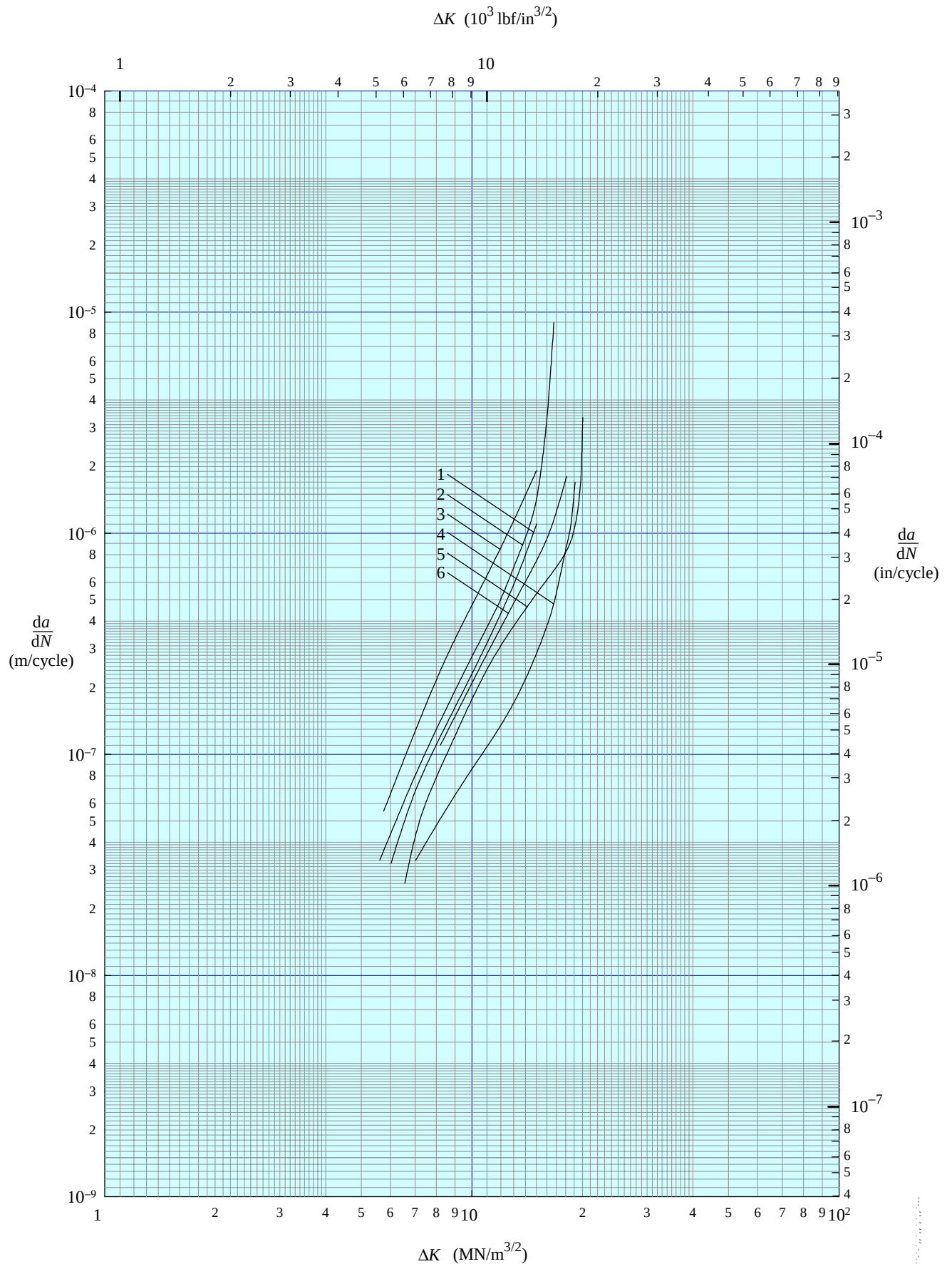


FIGURE 3 2124 – T851

TABLE 6.7

ALLOY TYPE		2124 - T851					TABLE 6.7	
ENVIRONMENT		Dry air/Humid air/Salt spray					FIGURE 3	
Curve No.	K_{IC}	K_Q	ΔK_{TH}	Range of da/dN		n	C	
	MN/m ^{3/2}	MN/m ^{3/2}	MN/m ^{3/2}	m/cycle	in/cycle		$m\left(\frac{m^{3/2}}{MN}\right)^n$	$in\left(\frac{in^{3/2}}{10^3 \text{ lbf}}\right)^n$
1				3×10^{-8} to 9×10^{-7}	1.2×10^{-6} to 3.5×10^{-5}	3.5	6.5×10^{-11}	3.6×10^{-9}
2				3×10^{-8} to 6×10^{-7}	1.2×10^{-6} to 2.4×10^{-5}	3.3	1.1×10^{-10}	5.9×10^{-9}
3				6×10^{-8} to 1.7×10^{-6}	2.4×10^{-6} to 6.7×10^{-5}	3.5	1.4×10^{-10}	7.8×10^{-9}
4				2×10^{-8} to 2×10^{-7}	7.9×10^{-7} to 7.9×10^{-6}	2.7	1.7×10^{-10}	8.8×10^{-9}
5				5×10^{-8} to 7×10^{-7}	2×10^{-6} to 2.8×10^{-5}	2.8	2.3×10^{-10}	1.2×10^{-8}
6				9×10^{-8} to 1.5×10^{-6}	3.5×10^{-6} to 5.9×10^{-5}	3.3	9.9×10^{-11}	5.3×10^{-9}



TABLE 6.8

ALLOY TYPE SPECIFICATION ENVIRONMENT				2219-T87 – Salt water/Laboratory air								TABLE 6.8 FIGURE 4
COMPOSITION NOMINAL ACTUAL				6.3Cu - 0.3Mn - 0.18Zr - 0.10V - 0.06Ti _____								
HEAT TREATMENT				T87 - Solution treated, cold worked and artificially aged								
Curve No.	Derivation Nos	Test Freq. (Hz)	R	Spec. Type	Spec. Thickness (mm) (in)	Orientation	Material Form	f_t		f_p		ENVIRONMENT
								MN/m ²	lbf/in ²	MN/m ²	lbf/in ²	
1	3	0.1	0	SEN	12.7 (0.5)	T-L	25.4 mm plate	496	72 000	379	55 000	3.5% NaCl solution
2	3	0.1	0	SEN	12.7 (0.5)	T-L	25.4 mm plate	496	72 000	379	55 000	Air at 50%±10% relative humidity

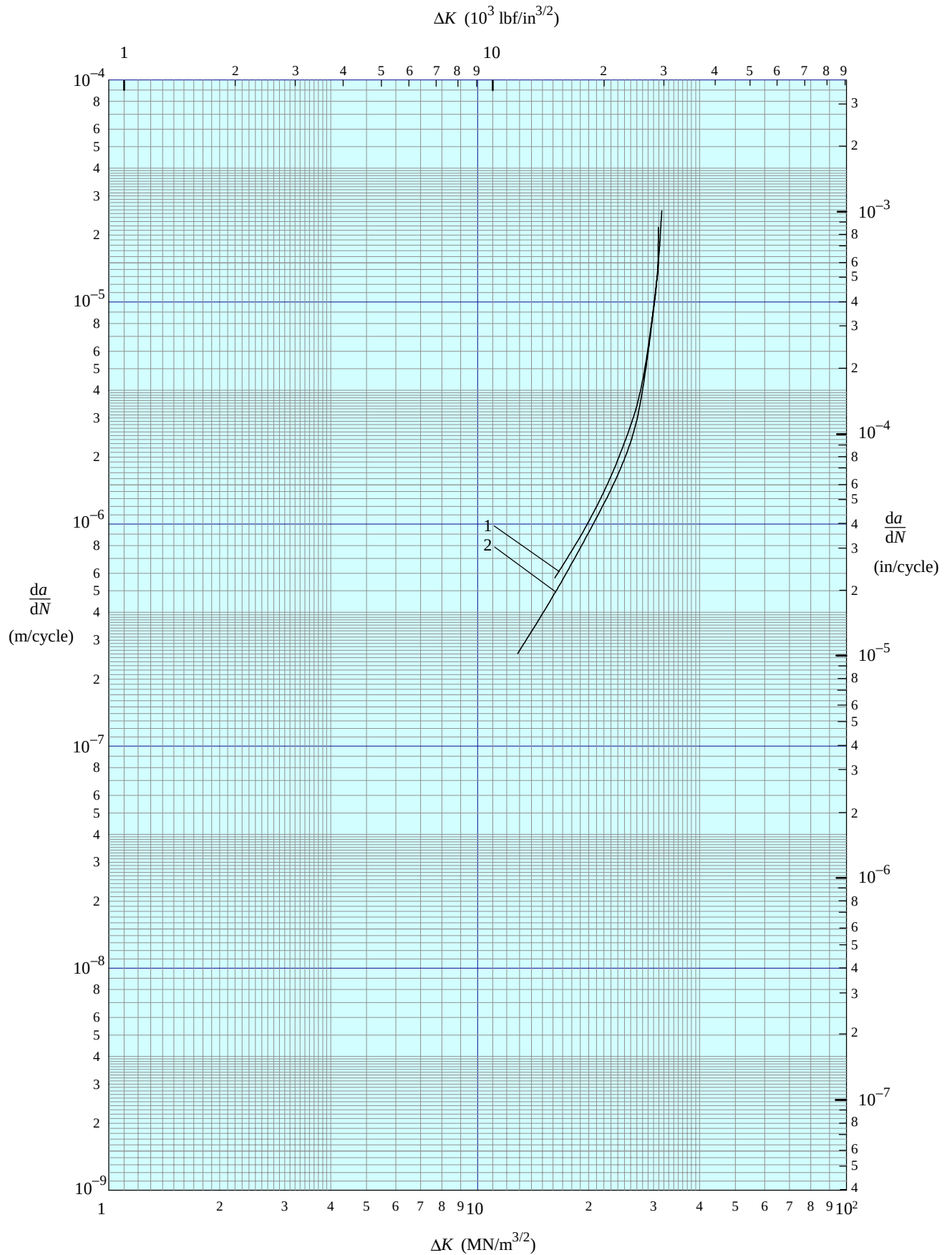


FIGURE 4 2219 – T87

TABLE 6.9

ALLOY TYPE		2219 - T87					TABLE 6.9	
ENVIRONMENT		Salt water/Laboratory air					FIGURE 4	
Curve No.	K_{IC}	K_Q	ΔK_{TH}	Range of da/dN		n	C	
	$MN/m^{3/2}$	$MN/m^{3/2}$	$MN/m^{3/2}$	m/cycle	in/cycle		$m\left(\frac{m^{3/2}}{MN}\right)^n$	$in\left(\frac{in^{3/2}}{10^3 \text{ lbf}}\right)^n$
1				6×10^{-7} to 2×10^{-6}	2.4×10^{-5} to 7.9×10^{-5}	3.2	6.3×10^{-11}	3.4×10^{-9}
1				3×10^{-6} to 3×10^{-5}	1.2×10^{-4} to 1.2×10^{-3}	11.1	4.4×10^{-22}	4.9×10^{-20}
2				2×10^{-7} to 2×10^{-6}	7.9×10^{-6} to 7.9×10^{-5}	3.0	1.1×10^{-10}	5.5×10^{-9}
2				2×10^{-6} to 2×10^{-5}	7.9×10^{-5} to 7.9×10^{-4}	11.7	6.7×10^{-23}	7.9×10^{-21}



TABLE 6.10

ALLOY TYPE SPECIFICATION ENVIRONMENT				2618A -T651 DTD 5070 B Humid air/Salt water								TABLE 6.10 FIGURE 5
COMPOSITION												
HEAT TREATMENT				T851 - Solution treated, stress relieved by stretching.								
Curve No.	Derivation Nos	Test Freq. (Hz)	R	Spec. Type	Spec. Thickness (mm) (in)	Orientation	Material Form	f_t		f_p		ENVIRONMENT
								MN/m ²	lbf/in ²	MN/m ²	lbf/in ²	
1	4	1	0.01	CN	1.6 (0.063)	T-L	1.6 mm sheet	460	66 700	417	60 500	Air at 95% relative humidity
2	4	1	0.01	CN	1.6 (0.063)	T-L	1.6 mm sheet	460	66 700	417	60 500	3.0% NaCl solution