WRDC-TR-90-4113

THE MECHANICAL PROPERTY DATA BASE FROM AN AIR FORCE/INDUSTRY COOPERATIVE TEST PROGRAM ON ADVANCED ALUMINUM ALLOYS (8090 EXTRUSION)

MARY ANN PHILLIPS and STEVEN R. THOMPSON
Materials Engineering Branch
Systems Support Division

November 1990

Interim Report for Period February 1986 - January 1990

Approved for public release; distribution unlimited.

MATERIALS LABORATORY
WRIGHT RESEARCH AND DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6533

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States Government incurs no responsibility or any obligation whatsoever. The fact that the government may have formulated or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder, or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This report is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

Mary Ann Phillips

MARY ANN PHILLIPS, Project Engineer
Engineering and Design Data
Materials Engineering Branch

Steven R Thompson

STEVEN R THOMPSON, Project Engineer
Engineering and Design Data
Materials Engineering Branch

FOR THE COMMANDER

Clayton L Harmsworth

CLAYTON L HARMSWORTH, Tech. Mgr.
Engineering and Design Data
Materials Engineering Branch

Theodore J Reinhart

THEODORE J REINHART, Chief
Materials Engineering Branch
Systems Support Division
Materials Laboratory

If your address has changed, if you wish to be removed from our mailing list, or if the addressee is no longer employed by your organization please notify WRDC/MLSE, WPAFB, OH 45433-6533 to help us maintain a current mailing list.

Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704 0188

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S) WRDC-TR-90-4113	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Materials Laboratory Wright-Patterson 6b OFFICE SYMBOL (If applicable) WRDC/MLSE	7a NAME OF MONITORING ORGANIZATION
6c ADDRESS (City, State, and ZIP Code) Wright-Patterson AFB OH 45433-6533	7b ADDRESS (City, State, and ZIP Code)
8a NAME OF FUNDING SPONSORING ORGANIZATION 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State, and ZIP Code)	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO: 62102F; PROJECT NO: 2418; TASK NO: 07; WORK UNIT ACCESSION NO: 03

11 TITLE (Include Security Classification)
The Mechanical Property Data Base From an Air Force/Industry Cooperative Test Program on Advanced Aluminum Alloys (8090 Extrusion)

12 PERSONAL AUTHOR(S)
Mary Ann Phillips Steven R Thompson

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Interim	FROM 2/86 TO 1/90	1990, November	80

16 SUPPLEMENTARY NOTATION

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)			
FIELD	GROUP	SUB-GROUP	Aluminum-Lithium	Al 905XL	Compression	Fracture Toughness
11	04		2091	CW67	Bearing	Fatigue Crack Growth
			8090	7064	Shear	P/M
			IN905XL	Tensile	Spectrum	

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

Development of mechanical property data base on Alcan aluminum-lithium structural alloys is detailed. Aluminum-lithium alloy tested was 8090-T651 Extrusions. Basic mechanical property data consist of tension, compression, bearing, shear, and fracture toughness. Fatigue data were developed for both smooth and notched specimens. Constant amplitude fatigue crack growth rate data and spectrum test data were generated. Corrosion characteristics were also obtained. All other data developed by the participants are documented.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	UNCLASSIFIED
22a NAME OF RESPONSIBLE INDIVIDUAL Mary Ann Phillips	22b TELEPHONE (Include Area Code) (513) 255-5063
	22c OFFICE SYMBOL WRDC/MLSE

PREFACE

This report was prepared by the Materials Engineering Branch (WRDC/MLSE), Systems Support Division, Materials Laboratory, Wright Research and Development Center, Wright-Patterson Air Force Base, Ohio, under Project 2418, "Metallic Structural Materials," Task 241807, "Systems Support," Work Unit 24180703, "Engineering and Design Data."

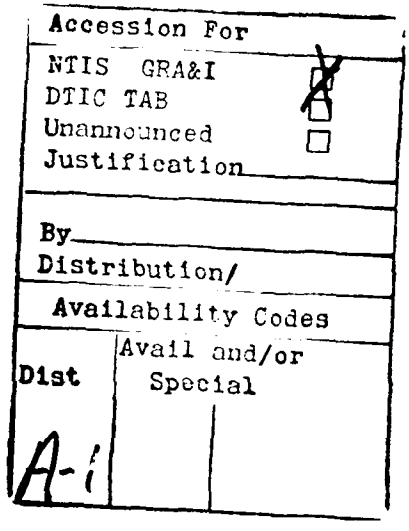

TABLE OF CONTENTS

Section		Page
I	INTRODUCTION	1
II	MATERIALS AND TESTS	3
III	PRESENTATION	4
IV	RESULTS AND DISCUSSION	5
V	CONCLUSIONS	6
	APPENDIX	7

LIST OF ILLUSTRATIONS

Figure		Page
A1	Fatigue Results for 8090-T651 1" x 4" Extrusion ($R=0.1$, $K_t=1.0$, Longitudinal)	29
A2	Fatigue Results for 8090-T651 1" x 4" Extrusion ($R=0.1$, $K_t=3.0$, Longitudinal)	30
A3	Fatigue Crack Growth Rate Data for Alcan 8090-T8 1" x 4" Extrusion (L-T Orientation). Grumman	31
A4	Fatigue Crack Growth Rate Data for Alcan 8090-T8 1" x 4" Extrusion (T-L Orientation). Grumman	34
A5	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Orientation). Northrop	37
A6	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). Northrop	39
A7	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Orientation). U.S. Air Force	41
A8	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Orientation). U.S. Air Force	43
A9	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Orientation). U. S. Air Force	45
A10	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). U.S. Air Force	47
A11	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). U.S. Air Force	49
A12	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). U.S. Air Force	51
A13	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Orientation). NASA-Langley	53
A14	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Orientation). NASA-Langley	56
A15	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). NASA-Langley	59
A16	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). NASA-Langley	62

Figure		Page
A17	Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). NASA-Langley	65
A18	FALSTAFF Spectrum Results for 8090-T651 Extrusion	68
A19	Crack Length Versus Flights for 8090-T651 Extrusion Under FALSTAFF Loading, Max Stress = 30 KSI	69
A20	Crack Length Versus Flights for 8090-T651 Extrusion Under Mini-TWIST Loading, Max Stress = 17 KSI	69
A21	Crack Length Versus Flights for 8090-T651 Extrusion Under Mini-TWIST Loading, Max Stress = 26 KSI	70

LIST OF TABLES

Table		Page
A1	Tensile Results at t/2 Location for Alcan 8090-T651 Extrusion, Longitudinal Orientation	8
A2	Tensile Results at t/2 Location for Alcan 8090-T651 Extrusion, Longitudinal Orientation, Varying Test Temperatures	9
A3	Tensile Results at t/2 Location for Alcan 8090-T651 Extrusion, Long Transverse Orientation	10
A4	Tensile Results at t/2 Location for Alcan 8090-T651 Extrusion, Long Transverse Orientation, Varying Test Temperatures	11
A5	Tensile Results at t/2 Location for Alcan 8090-T651 Extrusion, Short Transverse Orientation	12
A6	Tensile Results at t/10 Location for Alcan 8090-T651 Extrusion, Longitudinal Orientation	13
A7	Tensile Results at t/10 Location for Alcan 8090-T651 Extrusion, Long Transverse Orientation	13
A8	Tensile Results at t/2 Location for Alcan 8090-T651 Extrusion, Aged 100 Hrs at 350°F	14
A9	Notch Tensile Results at t/2 Location for Alcan 8090-T651 Extrusion	15
A10	Compression Results for Alcan 8090-T651 Extrusion, Longitudinal Orientation	16
A11	Compression Results for Alcan 8090-T651 Extrusion, Long Transverse Orientation	16
A12	Rivet Shear Results for Alcan 8090-T651 Extrusion, L-S Orientation	17
A13	Rivet Shear Results for Alcan 8090-T651 Extrusion, T-S Orientation	17
A14	Amsler Double Shear Results for Alcan 8090-T651 Extrusion, L-S Orientation	18
A15	Amsler Double Shear Results for Alcan 8090-T651 Extrusion, T-S Orientation	18

Table		Page
A16	Bearing Results for Alcan 8090-T651 Extrusion, c/D=1.5, Longitudinal Orientation	19
A17	Bearing Results for Alcan 8090-T651 Extrusion, c/D=1.5, Long Transverse Orientation	19
A18	Bearing Results for Alcan 8090-T651 Extrusion, c/D=2.0, Longitudinal Orientation	20
A19	Bearing Results for Alcan 8090-T651 Extrusion, c/D=2.0, Long Transverse Orientation	20
A20	Fracture Toughness Results for Alcan 8090-T651 Extrusion L-T Orientation	21
A21	Fracture Toughness Results for Alcan 8090-T651 Extrusion T-L Orientation	22
A22	Stress Corrosion Cracking Results for Alcan 8090-T651 Extrusion T-L Orientation	23
A23	Fatigue Results for Alcan 8090-T651 Extrusion, R=0.1, K_t=1.0, Longitudinal Orientation	24
A24	Fatigue Results for Alcan 8090-T651 Extrusion, R=0.1, K_t=3.0, Longitudinal Orientation	25
A25	Tensile Results at t/2 Location for Alcan 8090-T8 Extrusion	26
A26	Compression Results at t/2 Location for Alcan 8090-T8 Extrusion	27
A27	Fracture Toughness Results for Alcan 8090-T8 Extrusion	28
A28	Fatigue Crack Growth Rate Data Associated with Figure A3	32
A29	Fatigue Crack Growth Rate Data Associated with Figure A3	33
A30	Fatigue Crack Growth Rate Data Associated with Figure A4	35
A31	Fatigue Crack Growth Rate Data Associated with Figure A4	36
A32	Fatigue Crack Growth Rate Data Associated with Figure A5	38
A33	Fatigue Crack Growth Rate Data Associated with Figure A6	40

Table		Page
A34	Fatigue Crack Growth Rate Data Associated with Figure A7	42
A35	Fatigue Crack Growth Rate Data Associated with Figure A8	44
A36	Fatigue Crack Growth Rate Data Associated with Figure A9	46
A37	Fatigue Crack Growth Rate Data Associated with Figure A10	48
A38	Fatigue Crack Growth Rate Data Associated with Figure A11	50
A39	Fatigue Crack Growth Rate Data Associated with Figure A12	52
A40	Fatigue Crack Growth Rate Data Associated with Figure A13	54
A41	Fatigue Crack Growth Rate Data Associated with Figure A13	55
A42	Fatigue Crack Growth Rate Data Associated with Figure A14	57
A43	Fatigue Crack Growth Rate Data Associated with Figure A14	58
A44	Fatigue Crack Growth Rate Data Associated with Figure A15	60
A45	Fatigue Crack Growth Rate Data Associated with Figure A15	61
A46	Fatigue Crack Growth Rate Data Associated with Figure A16	63
A47	Fatigue Crack Growth Rate Data Associated with Figure A16	64
A48	Fatigue Crack Growth Rate Data Associated with Figure A17	66
A49	Fatigue Crack Growth Rate Data Associated with Figure A17	67

SECTION I

INTRODUCTION

High performance aerospace systems are dependent on materials that are lighter, have improved mechanical properties, and/or offer a cost savings. Aluminum alloys that met these criteria were the newly developed aluminum-lithium alloys and the second generation powder metallurgy alloys.

In 1985, the Air Force along with the aerospace community found it important to investigate the potential of these promising aluminum alloys. A cooperative program was formed by the WRDC Materials Laboratory, Systems Support Division, and a number of aerospace industries. The Air Force would obtain the test material from the producers, compile the test data, and submit reports to the participants. The participants agreed to support the program by performing mechanical property tests which include tension, compression, bearing, shear, fracture toughness, and fatigue related properties (S/N, da/dn). The Air Force elected to perform spectrum fatigue crack growth testing on most alloys. A list of participants is shown in the following table.

This interim report contains only the aluminum-lithium alloys produced by Alcan: 8090-T651 1.0-inch x 4.0-inch extrusion. Comparisons to other materials, and ranking of materials is generally avoided since each potential application may be biased on different evaluation criteria.

TABLE
Participants and Advanced Aluminum Alloys
in the Cooperative Test Program

PARTICIPANTS	ALUMINUM LITHIUM ALLOYS												P/M ALUMINUM ALLOYS					
	PECHINEY				ALCAN	IncoMAP		ALCOA					KAISER	ALCOA				
	2091-T3 Sheet (0.063"T)	2091-T351 Plate (0.420"T)	2091-T6 Forging	8090-T651 T-extrusion	8090-T651 Extrusion	PM IN905XL Forging	PM AL905XL Forging	2091-T3 Sheet (0.063"T)	2091-T3 Sheet (0.144"T)	2091-T8 Plate (0.50"T)	8090 Extrusion		7064-T7351 Extrusion	7064-T6 Forging	C467 Sheet (0.063"T)	C467 Plate (0.40"T)	C467 Extrusion	C467 Forging
AVCO, TN	X							X										
Wyman-Gordon							X											
Boeing, WA	X	X	X	X														
Douglas Aircraft, CA							X	X	X	X	X							
General Dynamics, CA	X	X						X	X	X								
General Dynamics, TX	X	X	X	X		X		X	X	X	X							
Grumman Aerospace, NY	X	X			X	X							X	X		X	X	
Lockheed, CA	X			X			X	X		X								
Lockheed, GA			X		X			X	X					X			X	
LTV, TX	X			X		X	X	X			X		X	X		X		
Martin Marietta, LA	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
McDonnell Douglas Astro, CA									X									
McDonnell Douglas Helicopter, AR							X											X
MCAIR, MO	X					X	X	X						X	X			X
NASA, VA					X	X	X											
Naval Air Development Center		X		X			X			X								X
Northrop, CA	X	X	X		X	X	X	X	X	X	X							
Sikorsky, CT						X		X						X		X		X
Jet Propulsion, CA							X											
Air Force WPAFB, OH		X			X		X	X	X	X	X		X	X	X	X	X	X

SECTION II

MATERIALS AND TESTS

The aluminum-lithium alloy tested was 8090 which is a damage tolerant, higher strength alloy.

Basic mechanical tests including fatigue, fatigue crack growth, spectrum fatigue, and stress corrosion tests were performed by the participants. ASTM standards were used for testing when applicable.

SECTION III

PRESENTATION

The purpose of this effort was to generate mechanical property data on newly developed aluminum alloys.

Each participant compiled a data package which contained the data they generated. Some of these data packages contain discussions, and in other cases, only the data were provided. The tensile, compression, bearing, shear, and fracture toughness data from each package were put in tabular form. Fatigue, fatigue crack growth, and spectrum fatigue crack growth data were placed in tabular and graphical form. Corrosion results were prepared in tabular and written descriptions.

Constant amplitude fatigue crack growth tests were conducted according to ASTM E647 Standard unless otherwise specified. The A-N data supplied were reduced using a seven-point incremental polynomial method. This involves fitting a second-order polynomial (parabola) to sets of seven successive data points. The most often used spectrums were FALSTAFF and Mini-TWIST. Corrosion results were documented almost exactly as they were received from the participants.

SECTION IV

RESULTS AND DISCUSSION

This interim report contains only the aluminum-lithium material produced by Alcan. The appendix contains the results for a specific alloy and product form. The following table lists the form and aluminum-lithium alloy in the appendix.

Table
Contents of Appendix

Form	Aluminum-Lithium Alloy
Extrusion	8090-T651 and 8090-T8

One group of the material was re-heat treated by the participant from the T651 condition to a temper that would give them the optimum properties of their interest. The procedures used for tempering are included on the second page of the appendix.

SECTION V

CONCLUSIONS

Five aerospace laboratories participated in generating data on the Alcan aluminum-lithium material for the cooperative test program. These data combined with future interim reports on the Air Force/Industry Cooperative Test Program on Advanced Aluminum Alloys will provide an extensive data base on aluminum-lithium alloys.

APPENDIX

ALCAN 8090-T651 AND 8090-T8 EXTRUSION (1.0" X 4.0")

INTRODUCTION

The Alcan 8090-T651 1-inch x 4-inch extrusion was received the first quarter of 1986. One participant heat treated the 8090-T651 to a T8 temper. Grumman -T8 condition was achieved by heating the material to 338°F for 24 hours. The other participants tested the material in the as-received condition (-T651).

TESTING

Basic mechanical properties (tension, compression, bearing, etc.) were tested according to ASTM standards, unless otherwise specified.

Constant amplitude fatigue crack growth tests were conducted according to ASTM E647 standard. The growth rate a-N data that were generated by the participants (Northrop, Grumman, and Air Force) were reduced using a seven-point incremental polynomial method. This involves fitting a second-order polynomial (parabola) to sets of seven successive data points. The data are also checked against size requirements per ASTM E647, Section 7.2. NASA-Langley performed constant amplitude fatigue crack growth tests using K-increasing (load increasing) and K-decreasing (load dereasing) methods.

Spectrum tests were performed by the Air Force using FALSTAFF (a severe fatigue environment) and Mini-TWIST (a moderately intense fatigue environment) spectrums.

TABLE A1

TENSILE RESULTS AT t/2 LOCATION FOR ALCAN

8090-T651 EXTRUSION (1" x 4")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
AIR FORCE	RT	LONG	72.7	62.9	5.3	13.0	
			76.1	64.2	5.3	6.0	
			77.0	65.2	6.1	9.9	
			76.6	65.2	5.3	9.9	
			74.2	62.2	5.7	8.5	
			76.8	64.9	5.6	7.0	
MARTIN MARIETTA	RT	LONG	81.0	76.8	4.9		11.3
			73.1	63.5	6.2		11.3
			81.1	77.2	7.9		11.2
NORTHROP	RT	LONG	73.7	65.6	4.0	19.6	11.8
			76.4	68.5	6.0	20.8	11.6
			79.9	76.5	4.0	19.4	11.7
			76.6	71.1	7.0		12.0
			73.1	64.8	7.0		12.5
			73.9	65.5	7.0		12.5
NASA LANGLEY	RT	LONG	77.1	67.9	5.0		11.4
			75.8	66.6	10.0		11.3
			76.4	67.5	9.0		11.4
			77.0	68.0	7.5		11.4
		AVERAGE	76.2	67.6	6.3	12.7	11.6
	STANDARD DEVIATION		2.5	4.6	1.6	5.8	0.4

TABLE A2

TENSILE RESULTS AT t/2 LOCATION FOR ALCAN

8090-T651 EXTRUSION (1" x 4")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
MARTIN	-423	LONG	103.9		22.0		13.1
MARIETTA			102.9	52.7	8.0		12.9
			99.8	62.0	16.0		12.3
			123.6		14.0		14.4
			107.0	71.3	20.0		13.4
	-320	LONG	89.4	64.4	12.0		14.9
			89.4	68.6	11.0		13.5
			89.1	64.5			13.5
	+200	LONG	68.3	65.6	16.0		11.0
			69.6	63.9	14.0		11.2
			69.3	66.0	18.0		12.4
	+350	LONG	55.3	55.2	36.0		10.5
			55.6	55.5	26.0		10.5
			55.7	55.6	30.0		10.7

TABLE A3

TENSILE RESULTS AT t/2 LOCATION FOR ALCAN

8090-T651 EXTRUSION (1" x 4")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
AIR FORCE	RT	L TRANS	67.4	54.7	7.8	16.0	
			68.2	54.0	0.0	15.9	
			69.6	55.0	8.6	21.8	
NORTHROP	RT	L TRANS	68.6	58.4	7.0	19.6	11.8
			68.3	58.1	7.0	20.8	11.6
			68.2	58.0	7.0	19.4	11.7
			68.0	58.0	8.0		12.3
			67.8	57.2	8.0		12.5
			68.2	58.2	9.0		12.2
MARTIN MARIETTA	RT	L TRANS	67.9	56.1	8.0		11.1
			68.2	56.8	9.5		11.1
			68.5	56.5	9.5		11.5
NASA LANGLEY	RT	L TRANS	70.5	57.8	10.0		11.4
			70.1	57.7	11.0		11.4
			70.8	58.3	10.0		11.4
			70.7	57.8	10.0		11.4
		AVERAGE	68.8	57.0	8.2	18.9	11.6
	STANDARD DEVIATION		1.1	1.4	2.5	2.5	0.4

TABLE A4

TENSILE RESULTS AT t/2 LOCATION FOR ALCAN

8090-T651 EXTRUSION (1" x 4")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
MARTIN	-423	L TRANS	86.9	62.6	8.0		12.5
MARIETTA			81.8	72.0			12.5
			87.9	62.5	9.0		13.1
	-320	L TRANS	78.9	60.6	5.0		13.6
			79.3	60.2	8.0		13.5
			77.3	60.1			13.2
	+200	L TRANS	63.5	56.1	12.3		9.0
			63.6	56.5	13.3		10.6
			63.6	56.7	12.5		10.8
	+350	L TRANS	50.7	50.6	22.0		10.4
			51.4	51.2	18.0		10.0
			58.5	56.3	18.0		10.0

TABLE A5

TENSILE RESULTS AT t/2 LOCATION FOR ALCAN

8090-T651 EXTRUSION (1" x 4")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
NORTHROP	RT	S TRANS	69.4	55.9	8.0	7.8	11.1
			68.0	52 4	4.0	3.1	11.3
			66.5	51.6	4.0	3.1	11.2
		AVERAGE	68.0	53.3	5.3	4.7	11.2
	STANDARD DEVIATION		1.5	2.3	2.3	2.7	0.1

TABLE A6

TENSILE RESULTS AT t/10 LOCATION FOR ALCAN

8090-T651 EXTRUSION (1" x 4")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
NORTHROP	RT	LONG	77.9	69.0	6.0		12.0
			75.7	66.8	5.0		12.2
			74.1	65.1	5.0		11.9
		AVERAGE	75.9	67.0	5.3		12.0
		STANDARD DEVIATION	1.9	2.0	0.6		0.2

TABLE A7

TENSILE RESULTS AT t/10 LOCATION FOR ALCAN

8090-T651 EXTRUSION (1" x 4")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
NORTHROP	RT	L TRANS	72.4	63.4	9.0		12.4
			72.2	63.1	9.0		12.2
			72.3	63.0	9.0		12.2
		AVERAGE	72.3	63.2	9.0		12.3
		STANDARD DEVIATION	0.1	0.2	0.0		0.1

TABLE A8

TENSILE RESULTS AT t/2 LOCATION FOR ALCAN

8090-T651 EXTRUSION (1" x 4") AFTER 100 HRS AT 350F

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
NORTHROP	RT	LONG	78.0	72.1	7.0	14.5	11.6
			73.6	66.8	7.0	12.3	12.5
			72.3	65.0	7.0	10.9	11.8
		AVERAGE	74.6	68.0	7.0	12.6	12.0
		STANDARD DEVIATION	3.0	3.7	0.0	1.8	0.5
	RT	L TRANS	68.1	60.4	6.0	13.8	11.5
			68.2	60.4	6.0	13.8	12.3
			68.1	60.5	6.0	13.8	12.9
		AVERAGE	68.1	60.4	6.0	13.8	12.2
		STANDARD DEVIATION	0.1	0.1	0.0	0.0	0.7
	RT	S TRANS	67.2	56.9	4.0	6.2	11.3
			64.8	55.8	2.0	2.5	10.8
			67.1	55.2	2.0	4.7	10.8
		AVERAGE	66.4	56.0	2.7	4.5	11.0
		STANDARD DEVIATION	1.4	0.9	1.2	1.9	0.3

TABLE A9

NOTCH TENSILE RESULTS AT t/2 LOCATION FOR ALCAN

8090-T651 EXTRUSION (1" x 4")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	NTS (KSI)	NTS/TYS
NORTHROP	RT	LONG	82.7	1.2
			78.1	1.1
			85.0	1.2
		AVERAGE	81.9	1.2
		STANDARD DEVIATION	3.5	0.1
	RT	L TRANS	60.5	1.0
			54.1	0.9
			50.3	0.9
		AVERAGE	55.0	0.9
		STANDARD DEVIATION	5.2	0.0

TABLE A10

COMPRESSION RESULTS FOR ALCAN

8090-T651 EXTRUSION (1" x 4")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (MSI)
AIR FORCE	RT	LONG	69.1	
			69.4	
			69.0	
NORTHROP	RT	LONG	74.6	12.0
			71.9	12.0
			71.8	11.9
NASA LANGLEY	RT	LONG	67.4	11.7
			66.9	11.7
			66.9	11.7
		AVERAGE	69.7	11.8
		STANDARD DEVIATION	2.6	0.2

TABLE A11

COMPRESSION RESULTS FOR ALCAN

8090-T651 EXTRUSION (1" x 4")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
AIR FORCE	RT	L TRANS	65.5	
			64.5	
			65.2	
NORTHROP	RT	L TRANS	64.9	12.1
			65.3	11.9
			62.5	12.3
NASA LANGLEY	RT	L TRANS	63.2	11.8
			63.1	11.5
			63.9	11.8
			63.4	11.8
		AVERAGE	64.2	11.9
		STANDARD DEVIATION	1.1	0.3

TABLE A12

RIVET SHEAR RESULTS FOR ALCAN

8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
NORTHROP	L - S	36.9
		37.4
		37.1
	AVERAGE	37.1
	STANDARD DEVIATION	0.3

TABLE A13

RIVET SHEAR RESULTS FOR ALCAN

8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
NORTHROP	T - S	34.5
		34.6
		36.6
	AVERAGE	35.2
	STANDARD DEVIATION	1.2

TABLE A14

AMSLER DOUBLE SHEAR RESULTS FOR

ALCAN 8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
AIR FORCE	L - S	36.5
		34.9
		34.7
NASA - LANGLEY	L - S	36.7
		36.7
		36.4
		37.0
	AVERAGE	36.1
	STANDARD DEVIATION	1.0

TABLE A15

AMSLER DOUBLE SHEAR RESULTS FOR

ALCAN 8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
AIR FORCE	T - S	36.5
		36.6
		34.6
NASA - LANGLEY	T - S	35.4
		35.1
		35.0
		34.8
	AVERAGE	35.4
	STANDARD DEVIATION	0.8

TABLE A16

BEARING RESULTS FOR ALCAN

8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
AIR FORCE	LONG	1.5	94.2	74.3
			100.6	82.7
			100.4	79.3
NORTHROP	LONG	1.5	101.0	84.4
			99.4	77.7
			100.0	81.5
NASA LANGLEY	LONG	1.5	104.5	86.1
			103.2	85.5
			101.9	82.4
			103.5	84.3
		AVERAGE	100.9	81.8
		STANDARD DEVIATION	2.9	3.7

TABLE A17

BEARING RESULTS FOR ALCAN

8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
AIR FORCE	L TRANS	1.5	88.3	79.4
			80.0	71.8
			87.4	78.2
NORTHROP	L TRANS	1.5	87.7	79.5
			88.3	80.1
			86.3	78.9
		AVERAGE	86.3	78.0
		STANDARD DEVIATION	3.2	3.1

TABLE A18

BEARING RESULTS FOR ALCAN

8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
AIR FORCE	LONG	2.0	123.0	
			126.0	
			116.7	87.0
NORTHROP	LONG	2.0	126.0	98.3
			125.0	94.8
			128.0	97.1
NASA LANGLEY	LONG	2.0	131.4	100.0
			131.0	97.4
			127.0	98.1
			132.4	97.4
		AVERAGE	126.7	96.3
		STANDARD DEVIATION	4.6	4.0

TABLE A19

BEARING RESULTS FOR ALCAN

8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
AIR FORCE	L TRANS	2.0	116.0	98.0
			115.1	90.3
			104.7	86.6
NORTHROP	L TRANS	2.0	116.0	98.3
			115.0	98.3
		AVERAGE	113.4	94.3
		STANDARD DEVIATION	4.9	5.5

TABLE A20

FRACTURE TOUGHNESS RESULTS FOR

ALCAN 8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	KIC (KSI in^0.5)	Kq (KSI in^0.5)	COMMENT
AIR FORCE	L - T		25.2	INVALID(1)
		25.8		VALID
			27.8	INVALID(1,2)
NORTHROP	L - T	26.2		(3)
		28.3		(3)
		28.4		(3)
NASA LANGLEY	L - T		25.3	INVALID(1,2)
			28.1	INVALID(1,2)
			27.4	INVALID(1,2)
			28.9	INVALID(1,2)
	AVERAGE	27.2	27.1	
	STANDARD DEVIATION	1.4	1.5	

(1): Pmax/Pq was greater than 1.10

(2): The difference between the two surface crack length measurements exceed 10% of the average crack length.

(3): Fractured parallel to load line

TABLE A21

FRACTURE TOUGHNESS RESULTS FOR

ALCAN 8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	KIC (KSI in^0.5)	Kq (KSI in^0.5)	COMMENT
AIR FORCE	T - L	16.1		VALID
		16.3		VALID
		15.9		VALID
NORTHROP	T - L	15.1		VALID
		14.9		VALID
		15.3		VALID
NASA LANGLEY	T - L		5.4	INVALID(1,2)
			6.8	INVALID(1,3)
			17.1	INVALID(1)
			17.9	INVALID(1)
	AVERAGE	15.6	11.8	
	STANDARD DEVIATION	0.6		

(1): Kmax > 0.6 Kq
(2): Pmax / Pq = 3.6
(3): Pmax / Pq = 2.6

TABLE A22

STRESS CORROSION CRACKING RESULTS FOR

ALCAN 8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	STRESS APPLIED (KSI in^0.5)	% OF T-L KIC (KSI in^0.5)	COMMENT
AIR FORCE	T-L	12.0	75.0	DID NOT FAIL
		14.0	87.0	DID NOT FAIL

NOTE: TESTING DISCONTINUED AFTER SPECIMEN WAS LOADED TO 87% OF T-L KIC AND DID NOT FAIL AFTER 2000 HRS.

TABLE A23

FATIGUE RESULTS WITH R=0.1 AND Kt=1.0 FOR

ALCAN 8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
NORTHROP	LONG	80.0	98
		70.0	18,793
		60.0	28,082
		50.0	57,511
		45.0	362,662
		42.5	642,818
		40.0	4,000,000 *
		37.5	5,000,000 *
NASA - LANGLEY	LONG	60.0	29,100
		50.0	43,000
		45.0	55,600
		40.0	549,000
		38.0	2,472,100
		36.0	10,557,700 *
		36.0	139,300
		36.0	317,600
		30.0	12,900,000 *

(*): INDICATES RUN-OUT TEST

TABLE A24

FATIGUE RESULTS WITH R=0.1 AND Kt=3.0 FOR

ALCAN 8090-T651 EXTRUSION (1" X 4")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
NORTHROP	LONG	55.0	4,413
		50.0	6,373
		40.0	13,431
		35.0	35,620
		30.0	115,117
		27.5	210,968
		27.5	150,596
		25.0	5,000,000 *
NASA - LANGLEY	LONG	35.0	20,400
		30.0	47,600
		25.0	462,400
		23.0	1,785,300
		22.0	1,169,200
		22.0	725,500
		22.0	12,300,000 *
		21.0	10,908,100 *
		20.0	10,045,000 *

(*): INDICATES RUN-OUT TEST

NOTE: NASA-LANGLEY SPECIMENS HAD A Ktg=3.01 AND A Ktn=2.88

TABLE A25

TENSILE RESULTS AT t/2 LOCATION FOR ALCAN

8090-T8 [338F FOR 24 HRS] EXTRUSION (1" x 4")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATF STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
GRUMMAN	RT	LONG	80.9	78.0	3.5	4.8	12.3
			80.1	77.5	4.0	5.9	11.6
			80.9	76.8	4.0	7.5	11.2
		AVERAGE	80.6	77.4	3.8	6.1	11.7
	STANDARD DEVIATION		0.5	0.6	0.3	1.4	0.6
GRUMMAN	RT	45	67.9	57.3	10.0	32.8	10.1
			67.6	57.6	10.0	30.4	11.4
			67.1	56.2	10.0	31.2	11.2
		AVERAGE	67.5	57.0	10.0	31.5	10.9
	STANDARD DEVIATION		0.4	0.7	0.0	1.2	0.7
GRUMMAN	RT	L TRANS	71.9	64.0	7.5	13.4	11.8
			70.8	62.7	7.0	18.9	11.3
			70.5	61.6	7.0	19.4	11.1
		AVERAGE	71.1	62.8	7.2	17.2	11.4
	STANDARD DEVIATION		0.7	1.2	0.3	3.3	0.4

TABLE A26

COMPRESSION RESULTS FOR ALCAN

8090-T8 [338F FOR 24 HRS] EXTRUSION (1" x 4")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (MSI)
GRUMMAN	RT	LONG	78.4	12.1
			77.7	12.1
			68.6	12.0
		AVERAGE	74.9	12.1
		STANDARD DEVIATION	5.5	0.1
GRUMMAN	RT	45	60.3	11.8
			60.3	11.8
			60.1	11.7
		AVERAGE	60.2	11.8
		STANDARD DEVIATION	0.1	0.1
GRUMMAN	RT	L TRANS	67.9	11.9
			67.4	12.1
			67.4	12.1
		AVERAGE	67.6	12.0
		STANDARD DEVIATION	0.3	0.1

TABLE A27

FRACTURE TOUGHNESS RESULTS FOR ALCAN

8090-T8 [338F FOR 24 HRS] EXTRUSION (1" x 4")

COMPANY	ORIENTATION	KIC (KSI in^0.5)	Kq (KSI in^0.5)	COMMENT
GRUMMAN	L - T		33.3	INVALID(1),(2)
			27.6	INVALID(2),(3)
	AVERAGE		30.5	
	STANDARD DEVIATION		4.0	
GRUMMAN	T - L	14.6		VALID
	AVERAGE	14.6		
	STANDARD DEVIATION	0.0		

(1) 1.08 greater than B

(2) Angle of fracture greater than 5 degrees

(3) Pmax/Pq greater than 1.10

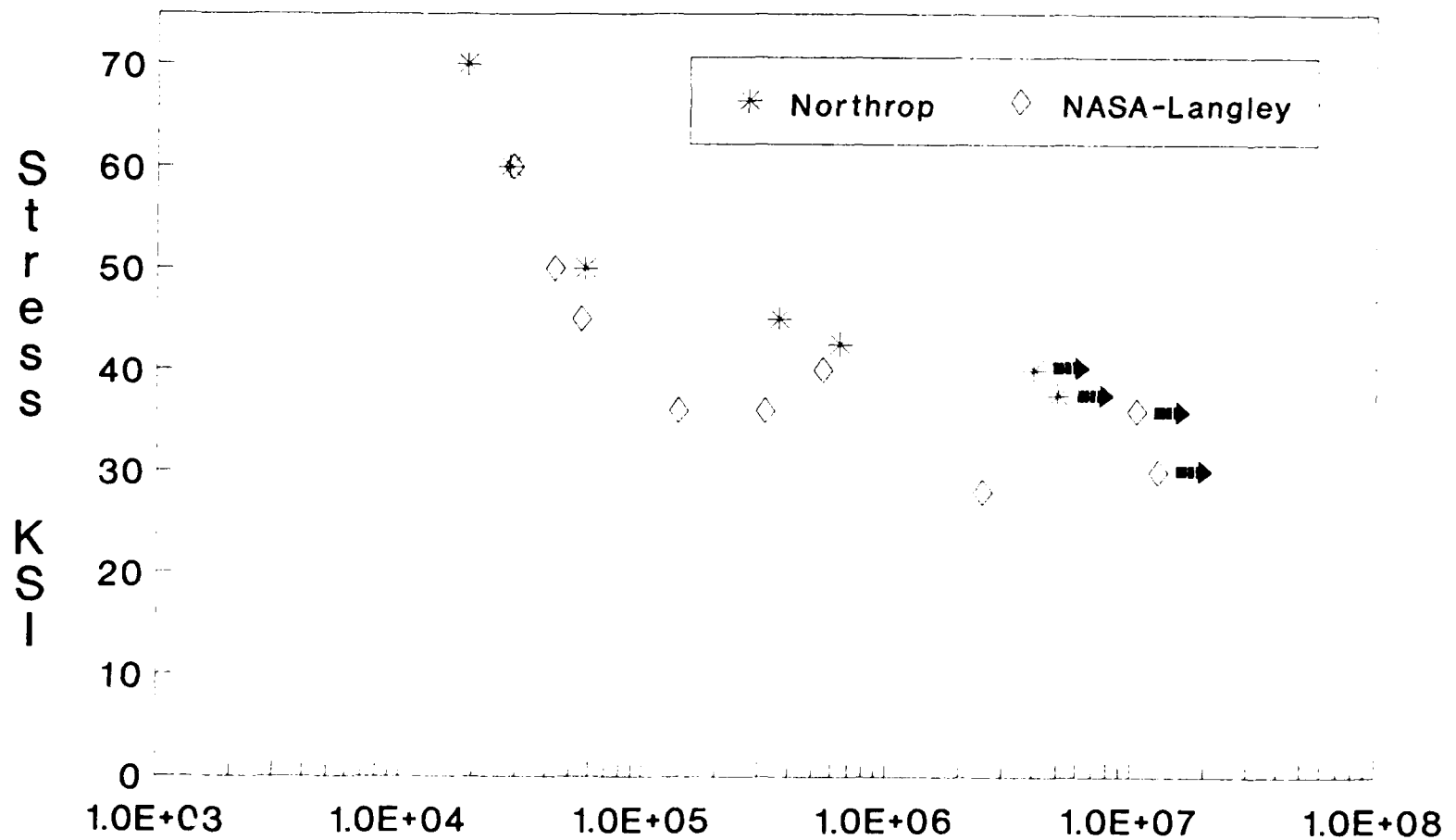

Figure A1. Fatigue Results for 8090-T651 1" x 4" Extrusion (R=0.1, K_t=1.0, Longitudinal).

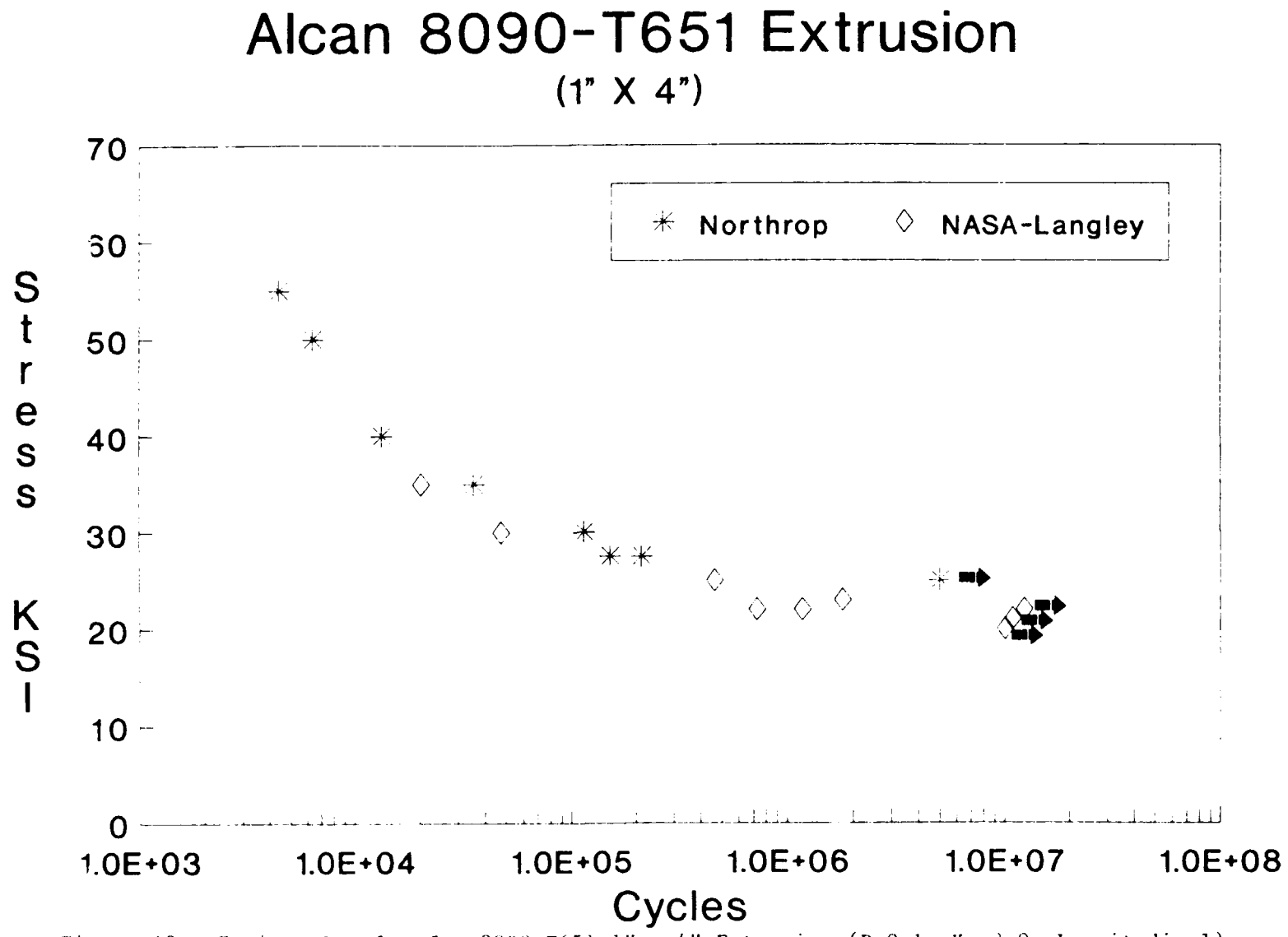

Figure A2. Fatigue Results for 8090-T651 1" x 4" Extrusion (R=0.1, K_t=3.0, Longitudinal).

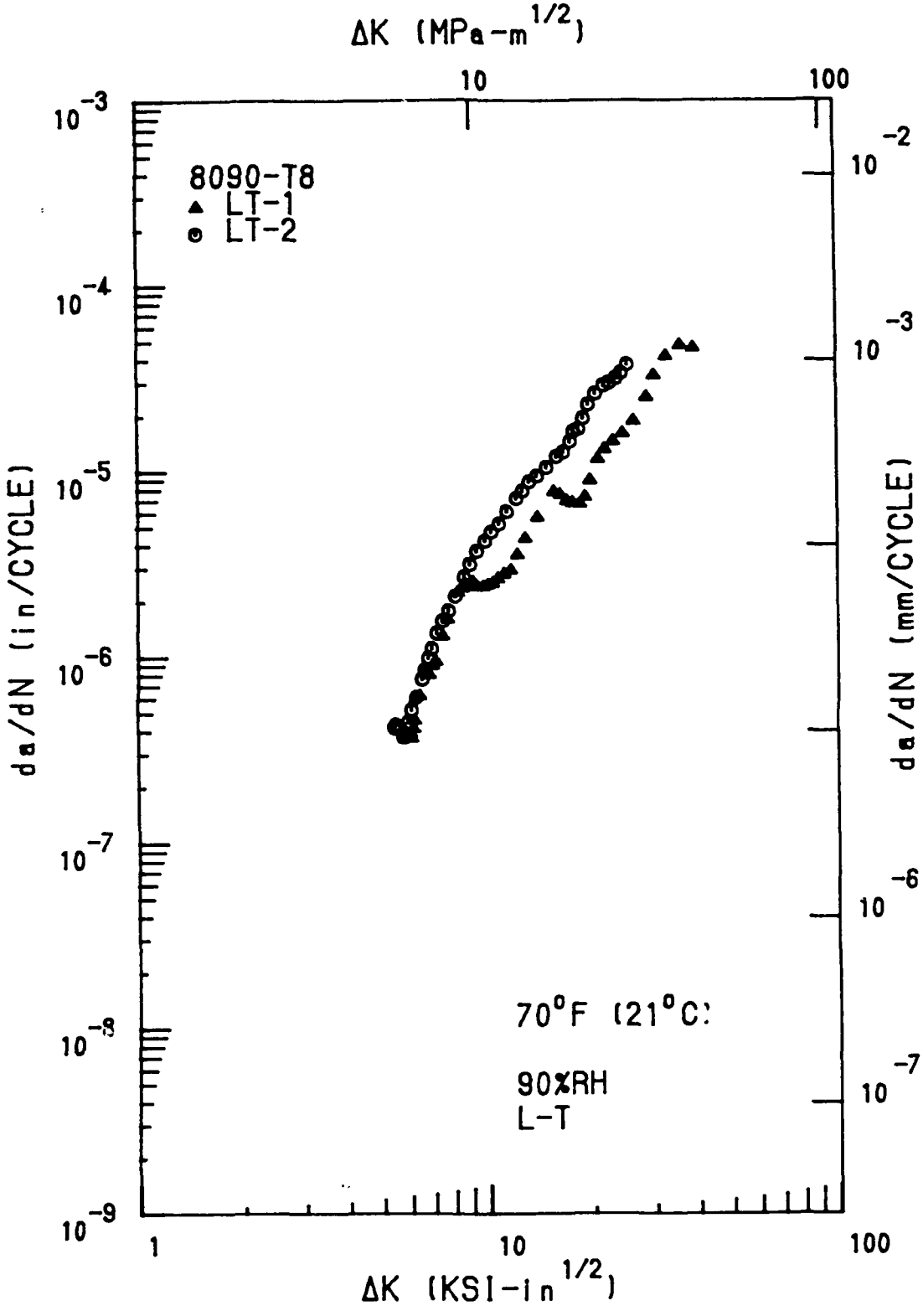

Figure A3. Fatigue Crack Growth Rate Data for Alcan 8090-T8 1" x 4" Extrusion (L-T Orientation). Grumman.

Table A28

Fatigue Crack Growth Rate Data Associated with Figure A3

Seven Point Incremental Polynomial Method per ASTM E647

00-00-1980

Specimen Number: LT-1 Specimen Type: CT

B= 0.2560 in W= 2.4950 in An= 0.0000

Pmax= 480.0 lbs Pmin= 0.0 lbs

R= 0.00 Frequency= 8.00 hz.

Test Temperature= 70 F Environment= 90%RH

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	0.00	0.5980				
2	25.00	0.6130				
3	50.00	0.6280				
4	100.00	0.6430	0.6465	0.992786	5.99	.3852E-06
5	125.00	0.6580	0.6536	0.989967	6.04	.3635E-06
6	175.00	0.6680	0.6688	0.983831	6.14	.4107E-06
7	200.00	0.6780	0.6765	0.990650	6.19	.4544E-06
8	250.00	0.6980	0.7015	0.997999	6.35	.6158E-06
9	300.00	0.7380	0.7373	0.998490	6.60	.8390E-06
10	325.00	0.7630	0.7615	0.989195	6.76	.7990E-06
11	350.00	0.7830	0.7840	0.992244	6.92	.8977E-06
12	375.00	0.8130	0.8041	0.990920	7.07	.9396E-06
13	425.00	0.8430	0.8499	0.976600	7.41	.1297E-05
14	450.00	0.8830	0.8814	0.983424	7.65	.1594E-05
15	487.50	0.9330	0.9484	0.988987	8.20	.2224E-05
16	500.00	0.9930	0.9779	0.987482	8.46	.2342E-05
17	512.50	1.0080	1.0082	0.983903	8.73	.2414E-05
18	525.00	1.0430	1.0447	0.988006	9.08	.2546E-05
19	537.50	1.0730	1.0713	0.997122	9.35	.2380E-05
20	550.00	1.1030	1.1054	0.998239	9.71	.2380E-05
21	562.50	1.1350	1.1321	0.992729	10.01	.2437E-05
22	575.00	1.1660	1.1624	0.993274	10.36	.2491E-05
23	587.50	1.1830	1.1929	0.994186	10.73	.2626E-05
24	600.00	1.2330	1.2260	0.995332	11.17	.2789E-05
25	612.50	1.2610	1.2635	0.994958	11.70	.2931E-05
26	625.00	1.3030	1.2984	0.983871	12.23	.3549E-05
27	637.50	1.3430	1.3388	0.987280	12.89	.4348E-05
28	650.00	1.3780	1.3961	0.989989	13.95	.5650E-05
29	662.50	1.4730	1.4727	0.994114	15.61	.7767E-05
30	666.00	1.5110	1.4985	0.986456	16.25	.7511E-05
31	669.00	1.5250	1.5268	0.997082	17.00	.6931E-05
32	672.00	1.5510	1.5492	0.995583	17.64	.6758E-05
33	677.00	1.5780	1.5770	0.993047	18.49	.6631E-05
34	680.00	1.5960	1.5968	0.992844	19.14	.7256E-05
35	683.00	1.6130	1.6171	0.993428	19.84	.8873E-05
36	686.00	1.6460	1.6435	0.996741	20.83	.1156E-04
37	688.00	1.6630	1.6679	0.996796	21.82	.1308E-04
38	690.00	1.6980	1.6974	0.996613	23.12	.1443E-04
39	692.00	1.7330	1.7284	0.996695	24.62	.1587E-04
40	694.00	1.7610	1.7620	0.990631	26.45	.1862E-04
41	696.00	1.7930	1.7991	0.985648	28.75	.2511E-04
42	697.00	1.8160	1.8218	0.993901	30.31	.3269E-04
43	698.00	1.8530	1.8547	0.999340	32.84	.4133E-04
44	698.80	1.8910	1.8898	0.998392	35.95	.4729E-04
45	699.40	1.9230	1.9207	0.995375	39.09	.4570E-04
46	699.80	1.9430				
47	700.20	1.9610				
48	700.60	1.9710				

* - DATA VIOLATED SIZE REQUIREMENTS

Table A29

Fatigue Crack Growth Rate Data Associated with Figure A3

Seven Point Incremental Polynomial Method per ASTM E647

00-00-1980

Specimen Number: LT-2 Specimen Type: CT

B= 0.2540 in W= 2.5030 in An= 0.0000

Pmax= 860.0 lbs Pmin= 430.0 lbs

R= 0.50 Frequency= 10.00 hz.

Test Temperature= 70 F Environment= 90%RH

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN	
1	0.00	0.5880					
2	50.00	0.6050					
3	100.00	0.6230					
4	150.00	0.6500	0.6486	0.994447	5.40	.4139E-06	
5	175.00	0.6630	0.6595	0.995871	5.46	.4296E-06	
6	225.00	0.6800	0.6820	0.995346	5.60	.4103E-06	
7	275.00	0.6980	0.7006	0.995525	5.71	.3684E-06	
8	325.00	0.7230	0.7169	0.991691	5.81	.3714E-06	
9	375.00	0.7330	0.7327	0.980207	5.90	.4443E-06	
10	425.00	0.7500	0.7546	0.987226	6.04	.5169E-06	
11	475.00	0.7780	0.7809	0.988072	6.20	.6013E-06	
12	525.00	0.8250	0.8155	0.989223	6.43	.7565E-06	
13	550.00	0.8350	0.8360	0.989073	6.56	.8486E-06	
14	575.00	0.8480	0.8571	0.987310	6.71	.9852E-06	
15	600.00	0.8830	0.8787	0.997161	6.86	.1110E-05	
16	625.00	0.9100	0.9109	0.998400	7.09	.1341E-05	
17	650.00	0.9480	0.9479	0.999300	7.37	.1556E-05	
18	675.00	0.9880	0.9870	0.999463	7.67	.1767E-05	
19	700.00	1.0330	1.0337	0.998417	8.06	.2105E-05	
20	725.00	1.0850	1.0888	0.997831	8.56	.2672E-05	
21	737.50	1.1200	1.1218	0.998699	8.88	.3144E-05	
22	750.00	1.1600	1.1617	0.999831	9.29	.3684E-05	
23	762.50	1.2100	1.2107	0.999723	9.84	.4200E-05	
24	770.00	1.2450	1.2431	0.999107	10.23	.4697E-05	
25	778.00	1.2830	1.2822	0.998981	10.74	.5203E-05	
26	786.00	1.3200	1.3238	0.997747	11.33	.6050E-05	
27	794.00	1.3750	1.3742	0.998760	12.12	.7137E-05	
28	798.00	1.4000	1.4031	0.999068	12.62	.7846E-05	
29	802.00	1.4400	1.4361	0.998728	13.23	.8776E-05	
30	806.00	1.4700	1.4720	0.998515	13.95	.9445E-05	
31	810.00	1.5100	1.5118	0.998265	14.84	.1048E-04	
32	814.00	1.5580	1.5543	0.998819	15.90	.1194E-04	
33	816.00	1.5750	1.5793	0.998547	16.59	.1264E-04	
34	818.00	1.6050	1.6056	0.996442	17.36	.1445E-04	
35	819.00	1.6200	1.6186	0.998317	17.77	.1631E-04	
36	820.00	1.6330	1.6365	0.996747	18.35	.1682E-04	
37	821.00	1.6550	1.6522	0.991442	18.90	.1921E-04	
38	822.00	1.6750	1.6714	0.991259	19.60	.2290E-04	
39	823.00	1.6880	1.6961	0.990776	20.56	.2606E-04	
40	824.00	1.7250	1.7231	0.989739	21.71	.2875E-04	
41	824.60	1.7480	1.7418	0.989447	22.57	.2988E-04	
42	825.20	1.7600	1.7624	0.995519	23.58	.3169E-04	*
43	825.80	1.7780	1.7782	0.994257	24.40	.3369E-04	*
44	826.40	1.7980	1.7976	0.998909	25.49	.3747E-04	*
45	827.00	1.8200					
46	827.60	1.8530					
47	827.90	1.8650					

* - DATA VIOLATES SIZE REQUIREMENTS

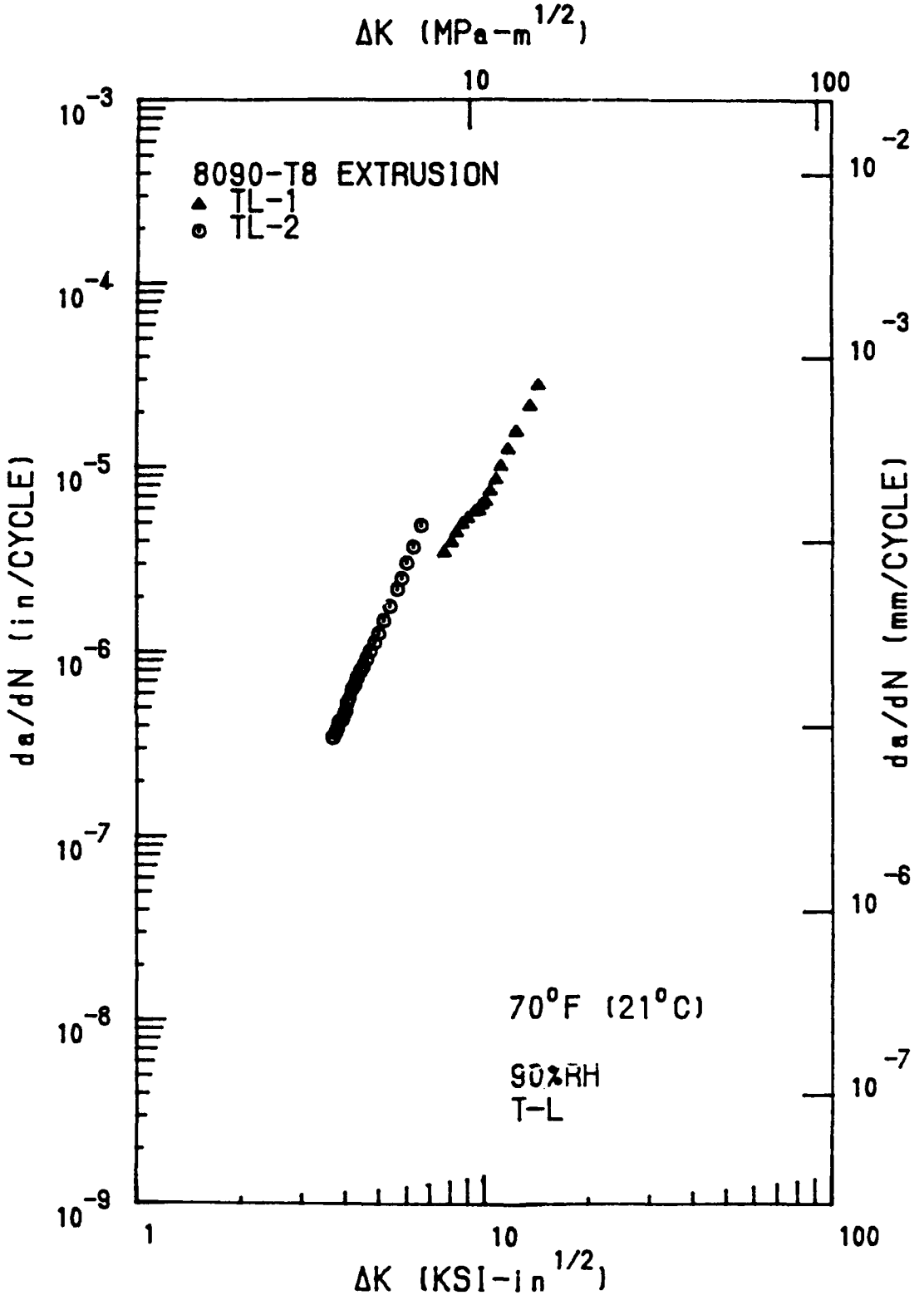

Figure A4. Fatigue Crack Growth Rate Data for Alcan 8090-T8 1" x 4" Extrusion (T-L Orientation). Grumman.

Table A30

Fatigue Crack Growth Rate Data Associated with Figure A4

Seven Point Incremental Polynomial Method per ASTM E647

00-00-1980

Specimen Number: TL-1 Specimen Type: CT

B= 0.2550 in W= 2.5070 in An= 0.0000

Pmax= 550.0 lbs Pmin= 0.0 lbs

R= 0.00 Frequency= 8.00 hz.

Test Temperature= 70 F Environment= 90%RH

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	0.00	0.6080				
2	25.00	0.6510				
3	50.00	0.7080				
4	62.50	0.7530	0.7527	0.999068	7.66	.3437E-05
5	75.00	0.8030	0.7983	0.998952	8.03	.3907E-05
6	83.00	0.8310	0.8314	0.997178	8.31	.4417E-05
7	91.00	0.8630	0.8662	0.997815	8.61	.4915E-05
8	99.00	0.9030	0.9058	0.995832	8.96	.5276E-05
9	107.00	0.9560	0.9513	0.995779	9.40	.5717E-05
10	111.00	0.9810	0.9761	0.996393	9.64	.5758E-05
11	115.00	0.9930	0.9994	0.992221	9.88	.6240E-05
12	119.00	1.0230	1.0214	0.996427	10.11	.6500E-05
13	123.00	1.0460	1.0475	0.997810	10.40	.7420E-05
14	127.00	1.0830	1.0808	0.998724	10.78	.8500E-05
15	131.00	1.1130	1.1134	0.996337	11.17	.1003E-04
16	135.00	1.1580	1.1547	0.994956	11.71	.1241E-04
17	139.00	1.1980	1.2055	0.997596	12.42	.1549E-04
18	143.00	1.2710	1.2745	0.995119	13.51	.2137E-04
19	145.00	1.3180	1.3190	0.997238	14.29	.2781E-04
20	146.00	1.3380				
21	147.00	1.3810				
22	148.00	1.4180				

* - DATA VIOLATES SIZE REQUIREMENTS

Table A31

Fatigue Crack Growth Rate Data Associated with Figure A4

Seven Point Incremental Polynomial Method per ASTM E647

00-00-1980

Specimen Number: TL-2 Specimen Type: CT

B= 0.2550 in W= 2.5110 in An= 0.0000

Pmax= 600.0 lbs Pmin= 300.0 lbs

R= 0.50 Frequency= 10.00 hz.

Test Temperature= 70 F Environment= 90%RH

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	0.00	0.5880				
2	25.00	0.6030				
3	75.00	0.6160				
4	125.00	0.6260	0.6295	0.988706	3.66	.3423E-06
5	175.00	0.6460	0.6465	0.995210	3.73	.3640E-06
6	200.00	0.6580	0.6561	0.995339	3.77	.3834E-06
7	225.00	0.6680	0.6670	0.998161	3.81	.4163E-06
8	275.00	0.6860	0.6877	0.998106	3.90	.4291E-06
9	300.00	0.6980	0.6979	0.998922	3.94	.4562E-06
10	325.00	0.7110	0.7097	0.998759	3.99	.4773E-06
11	350.00	0.7210	0.7219	0.997145	4.04	.5300E-06
12	375.00	0.7360	0.7355	0.997345	4.10	.5571E-06
13	400.00	0.7480	0.7491	0.996883	4.16	.6243E-06
14	425.00	0.7680	0.7666	0.994725	4.23	.6629E-06
15	450.00	0.7810	0.7831	0.994470	4.30	.7257E-06
16	475.00	0.8060	0.8022	0.995387	4.39	.7900E-06
17	500.00	0.8180	0.8222	0.996129	4.48	.8329E-06
18	525.00	0.8460	0.8440	0.996755	4.58	.9143E-06
19	550.00	0.8680	0.8660	0.997543	4.68	.1010E-05
20	575.00	0.8910	0.8939	0.998083	4.82	.1124E-05
21	600.00	0.9210	0.9210	0.998491	4.96	.1261E-05
22	625.00	0.9580	0.9538	0.997981	5.13	.1485E-05
23	650.00	0.9880	0.9930	0.997847	5.34	.1766E-05
24	675.00	1.0380	1.0395	0.998241	5.61	.2189E-05
25	687.50	1.0680	1.0663	0.999737	5.77	.2505E-05
26	700.00	1.0980	1.0989	0.996707	5.98	.3025E-05
27	712.50	1.1360	1.1344	0.996212	6.22	.3703E-05
28	725.00	1.1780	1.1820	0.996408	6.57	.4842E-05
29	737.50	1.2430				
30	746.00	1.3030				
31	750.00	1.3430				

* - DATA VIOLATES SIZE REQUIREMENTS

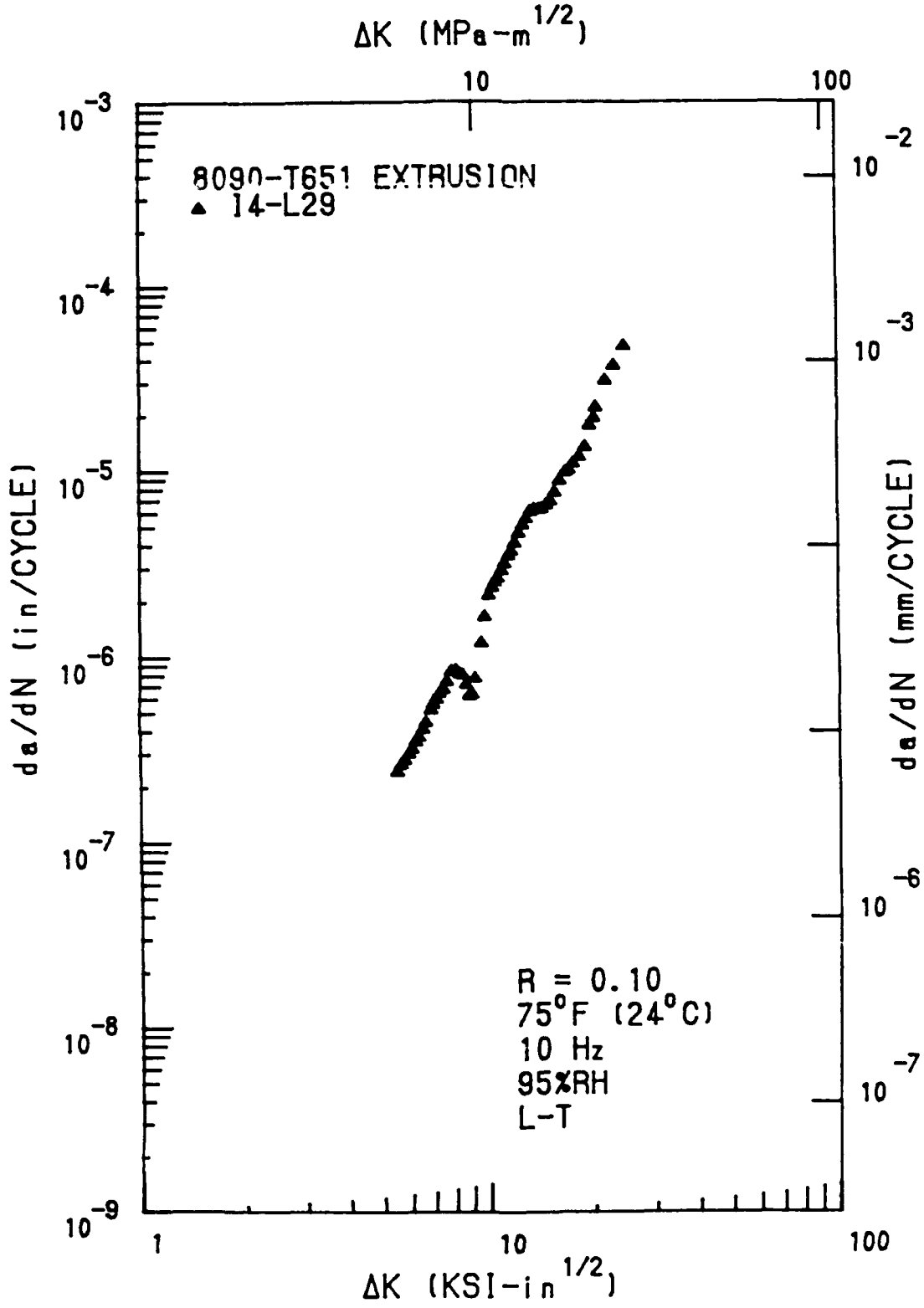

Figure A5. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Orientation). Northrop.

Table A32

Fatigue Crack Growth Rate Data Associated with Figure A5

Seven Point Incremental Polynomial Method per ASTM E647

01-12-1990

Specimen Number: 14-129 Specimen Type: CT

B= 0.2510 in W= 3.0040 in An= 0.0000

Pmax= 540.0 lbs Pmin= 54.0 lbs

R= 0.10 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 95%RH

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	0.00	0.6640				
2	109.70	0.6820				
3	255.00	0.7130				
4	380.00	0.7390	0.7403	0.999781	5.45	.2405E-06
5	480.90	0.7665	0.7657	0.999793	5.58	.2620E-06
6	589.00	0.7950	0.7953	0.999688	5.72	.2769E-06
7	688.00	0.8240	0.8240	0.999316	5.87	.2986E-06
8	763.00	0.8480	0.8462	0.999204	5.99	.3171E-06
9	850.00	0.8715	0.8741	0.999018	6.13	.3470E-06
10	927.10	0.9015	0.9017	0.998950	6.28	.3673E-06
11	1000.90	0.9300	0.9294	0.998735	6.43	.4062E-06
12	1053.00	0.9535	0.9516	0.998046	6.56	.4411E-06
13	1140.00	0.9865	0.9910	0.997809	6.78	.5162E-06
14	1180.00	1.0125	1.0115	0.998781	6.90	.5545E-06
15	1221.00	1.0350	1.0349	0.998287	7.04	.5915E-06
16	1258.50	1.0610	1.0598	0.999682	7.19	.6341E-06
17	1306.00	1.0895	1.0895	0.999540	7.38	.6677E-06
18	1344.00	1.1150	1.1140	0.996577	7.52	.7360E-06
19	1392.00	1.1480	1.1500	0.997946	7.77	.8026E-06
20	1430.00	1.1795	1.1840	0.997980	8.01	.8477E-06
21	1455.00	1.2125	1.2079	0.990967	8.18	.8098E-06
22	1484.70	1.2375	1.2344	0.996142	8.37	.8002E-06
23	1521.00	1.2610	1.2610	0.994721	8.57	.7111E-06
24	1562.00	1.2835	1.2845	0.998497	8.76	.6178E-06
25	1599.00	1.3060	1.3043	0.997690	8.92	.6275E-06
26	1639.00	1.3280	1.3268	0.981045	9.10	.7681E-06
27	1690.00	1.3590	1.3694	0.980576	9.47	.1191E-05
28	1712.00	1.3885	1.3949	0.990621	9.71	.1646E-05
29	1730.00	1.4255	1.4252	0.999619	9.99	.2148E-05
30	1740.00	1.4490	1.4477	0.999407	10.22	.2346E-05
31	1748.00	1.4685	1.4679	0.999651	10.42	.2527E-05
32	1755.00	1.4850	1.4858	0.999670	10.61	.2652E-05
33	1763.30	1.5075	1.5079	0.999112	10.86	.2914E-05
34	1769.80	1.5285	1.5272	0.999214	11.07	.3167E-05
35	1777.50	1.5505	1.5528	0.999326	11.38	.3490E-05
36	1782.10	1.5705	1.5692	0.999224	11.58	.3704E-05
37	1788.20	1.5930	1.5923	0.999191	11.87	.4077E-05
38	1793.40	1.6135	1.6139	0.998187	12.16	.4592E-05
39	1798.40	1.6360	1.6371	0.999495	12.48	.5077E-05
40	1802.50	1.6580	1.6588	0.999422	12.79	.5511E-05
41	1806.65	1.6850	1.6831	0.999505	13.16	.5965E-05
42	1810.34	1.7060	1.7067	0.999528	13.52	.6156E-05
43	1814.10	1.7300	1.7306	0.999644	13.93	.6176E-05
44	1817.10	1.7505	1.7488	0.999494	14.25	.6207E-05
45	1820.90	1.7725	1.7721	0.998410	14.67	.6497E-05
46	1824.40	1.7970	1.7942	0.998871	15.13	.6846E-05
47	1827.80	1.8165	1.8172	0.999468	15.55	.7597E-05
48	1830.90	1.8425	1.8413	0.999010	16.06	.8838E-05
49	1833.70	1.8650	1.8673	0.998938	16.65	.9811E-05
50	1835.40	1.8840	1.8849	0.998107	17.06	.1012E-04
51	1837.30	1.9080	1.9047	0.997516	17.55	.1092E-04
52	1839.80	1.9335	1.9336	0.997367	18.20	.1191E-04
53	1841.80	1.9535	1.9574	0.995869	18.97	.1247E-04
54	1843.30	1.9780	1.9773	0.995373	19.56	.1754E-04
55	1844.30	1.9915	1.9944	0.997171	20.09	.1929E-04
56	1844.80	2.0040	2.0021	0.990264	20.33	.2197E-04
57	1846.50	2.0475	2.0425	0.994776	21.71	.3072E-04
58	1847.50	2.0665	2.0760	0.995647	22.98	.3708E-04
59	1848.50	2.1205	2.1154	0.995913	24.63	.4686E-04
60	1849.50	2.1475				
61	1850.00	2.1885				
62	1851.00	2.2660				

* - DATA VIOLATES SIZE REQUIREMENTS

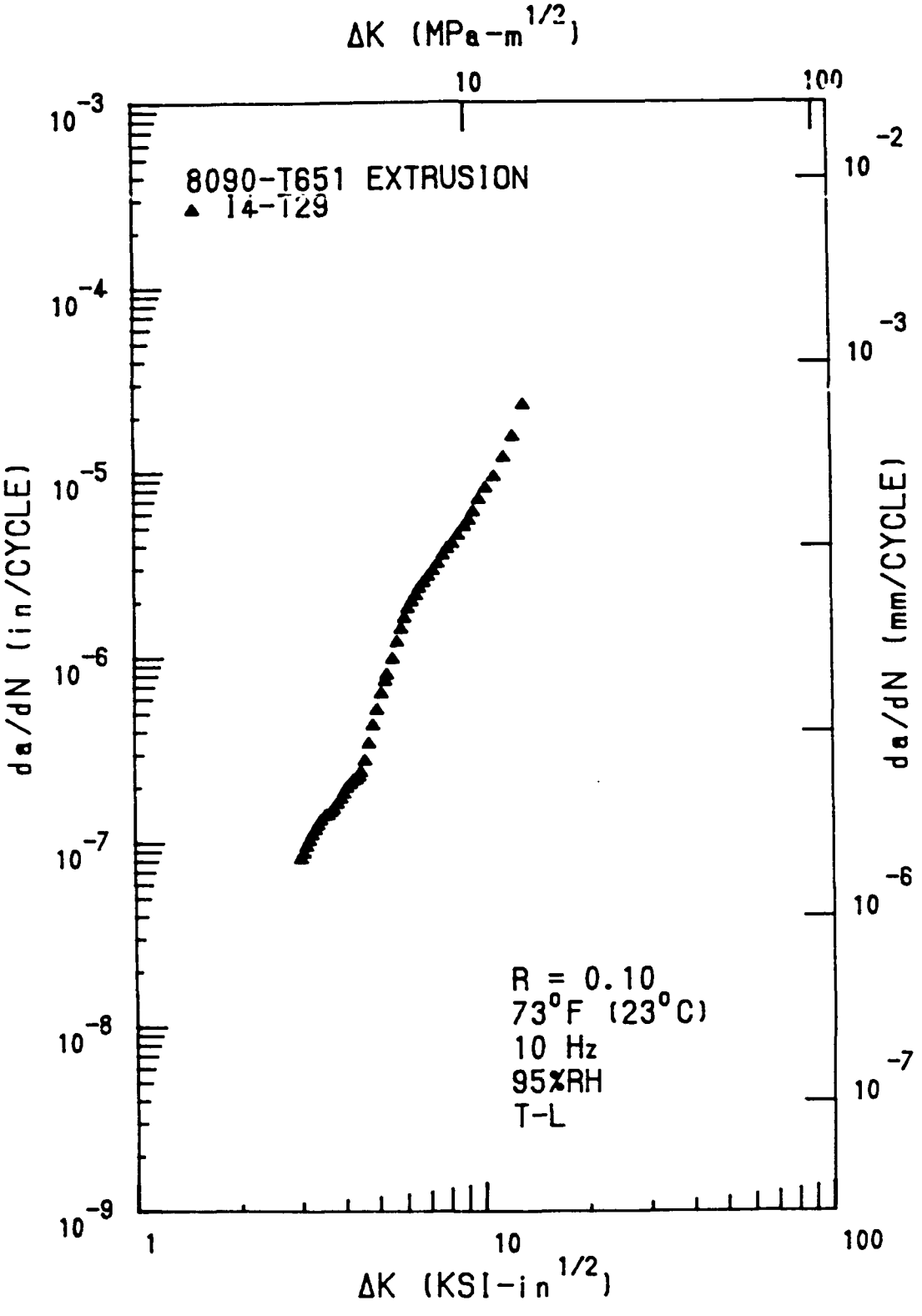

Figure A6. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). Northrop.

Table A33

Fatigue Crack Growth Rate Data Associated with Figure A6

Seven Point Incremental Polynomial Method per ASTM E647

01-12-1990

Specimen Number: I4-T29 Specimen Type: CT

B= 0.2540 in W= 3.0060 in An= 0.0000

Pmax= 280.0 lbs Pmin= 28.0 lbs

R= 0.10 Frequency= 10.00 hz.

Test Temperature= 73 F Environment= 95%RH

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	0.00	0.7620				
2	1500.00	0.7805				
3	1800.00	0.8010				
4	2100.00	0.8250	0.8230	0.998548	3.00	.8111E-07
5	2320.00	0.8440	0.8440	0.999677	3.06	.3727E-07
6	2570.00	0.8665	0.8666	0.999425	3.12	.9482E-07
7	2790.00	0.8890	0.8877	0.999370	3.18	.1018E-06
8	3000.00	0.9075	0.9096	0.999445	3.24	.1091E-06
9	3190.00	0.9315	0.9309	0.999540	3.30	.1161E-06
10	3370.00	0.9530	0.9524	0.999578	3.36	.1230E-06
11	3520.00	0.9715	0.9717	0.999795	3.42	.1307E-06
12	3800.00	1.0090	1.0094	0.999760	3.53	.1383E-06
13	3940.00	1.0290	1.0297	0.999439	3.59	.1387E-06
14	4100.00	1.0540	1.0520	0.998855	3.66	.1448E-06
15	4250.00	1.0[illegible]	1.0733	0.998486	3.72	.1504E-06
16	4450.00	1.1005	1.1037	0.998628	3.82	.1599E-06
17	4600.00	1.1290	1.1275	0.999415	3.90	.1707E-06
18	4740.00	1.1535	1.1525	0.999416	3.99	.1826E-06
19	4860.00	1.1745	1.1755	0.999423	4.07	.1953E-06
20	5000.00	1.2030	1.2029	0.999714	4.17	.2047E-06
21	5110.00	1.2255	1.2261	0.999631	4.25	.2135E-06
22	5200.00	1.2475	1.2462	0.999676	4.33	.2168E-06
23	5300.00	1.2680	1.2680	0.999586	4.42	.2244E-06
24	5370.00	1.2840	1.2827	0.997279	4.47	.2377E-06
25	5480.00	1.3075	1.3078	0.996906	4.58	.2747E-06
26	5580.00	1.3340	1.3358	0.998606	4.70	.3384E-06
27	5660.00	1.3630	1.3641	0.998330	4.82	.4263E-06
28	5720.00	1.3910	1.3905	0.998571	4.95	.5150E-06
29	5780.00	1.4195	1.4233	0.998767	5.10	.6210E-06
30	5820.00	1.4495	1.4492	0.999200	5.24	.7387E-06
31	5840.00	1.4650	1.4636	0.999517	5.31	.8018E-06
32	5880.00	1.4970	1.4983	0.997557	5.50	.9763E-06
33	5910.00	1.5270	1.5276	0.998423	5.67	.1197E-05
34	5930.00	1.5495	1.5525	0.998977	5.82	.1409E-05
35	5945.00	1.5745	1.5728	0.999667	5.95	.1608E-05
36	5958.00	1.5960	1.5955	0.999620	6.10	.1814E-05
37	5970.00	1.6180	1.6188	0.999647	6.25	.1982E-05
38	5982.00	1.6425	1.6431	0.999761	6.43	.2148E-05
39	5992.00	1.6670	1.6653	0.999665	6.59	.2333E-05
40	6003.00	1.6910	1.6921	0.999658	6.80	.2510E-05
41	6012.00	1.7145	1.7151	0.999608	6.99	.2684E-05
42	6021.00	1.7410	1.7395	0.999766	7.20	.2885E-05
43	6030.00	1.7655	1.7665	0.999650	7.45	.3159E-05
44	6038.00	1.7920	1.7920	0.999650	7.70	.3489E-05
45	6045.00	1.8165	1.8168	0.999912	7.95	.3795E-05
46	6051.00	1.8400	1.8407	0.999802	8.21	.4063E-05
47	6058.00	1.8715	1.8701	0.999278	8.54	.4510E-05
48	6064.00	1.8980	1.8980	0.999026	8.89	.5011E-05
49	6068.00	1.9155	1.9182	0.999119	9.15	.5432E-05
50	6072.00	1.9410	1.9396	0.999480	9.44	.6020E-05
51	6076.00	1.9650	1.9635	0.998179	9.79	.7027E-05
52	6080.00	1.9915	1.9933	0.998681	10.25	.8129E-05
53	6084.00	2.0250	2.0270	0.999438	10.82	.9346E-05
54	6088.00	2.0705	2.0663	0.994527	11.55	.1193E-04
55	6091.00	2.1010	2.1035	0.990770	12.32	.1541E-04
56	6093.50	2.1315	2.1421	0.976278	13.21	.2296E-04
57	6095.50	2.1810				
58	6097.00	2.2275				
59	6098.50	2.3075				

* - DATA VIOLATES SIZE REQUIREMENTS

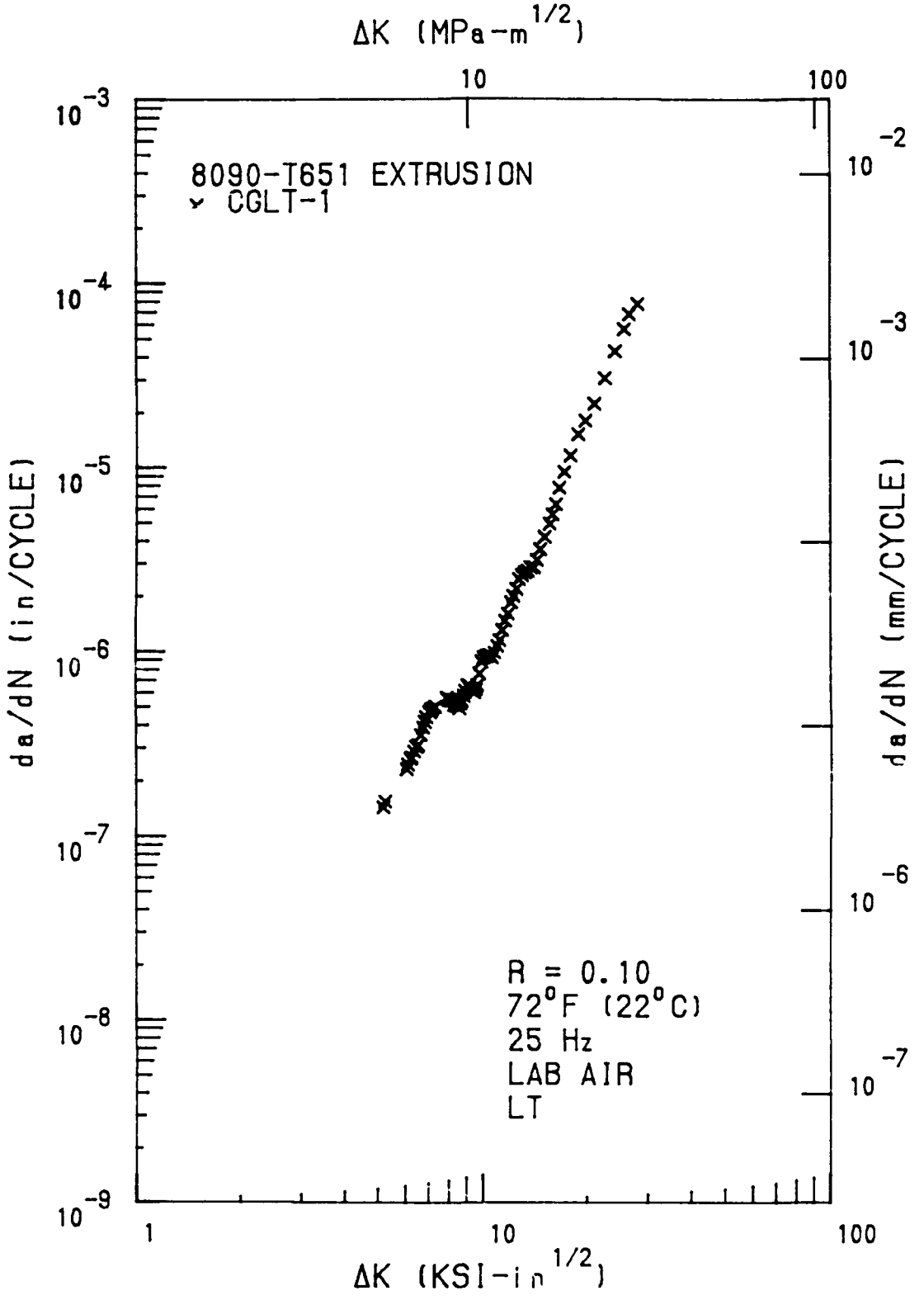

Figure A7. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Orientation). U.S. Air Force.

Table A34

Fatigue Crack Growth Rate Data Associated with Figure A7

Seven Point Incremental Polynomial Method per ASTM E647

08-09-1990

Specimen Number: CGLT-1 Specimen Type: CT

B= 0.2910 in W= 1.9950 in An= 0.6190

Pmax= 350.0 lbs Pmin= 35.0 lbs

R= 0.10 Frequency= 25.00 hz.

Test Temperature= 72 F Environment= LAB AIR

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	51.50	0.7220				
2	89.90	0.7280				
3	113.90	0.7310				
4	173.80	0.7410	0.7399	0.997775	6.17	.1424E-06
5	243.70	0.7490	0.7488	0.994495	6.23	.1524E-06
6	316.10	0.7590				
7	347.00	0.7650				
8	397.80	0.7770				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	145.90	0.7840				
2	186.30	0.7920				
3	268.20	0.8050				
3	288.20	0.8050				
4	385.90	0.8170				
5	377.20	0.8210				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	0.00	0.6240				
2	62.40	0.6340				
3	119.30	0.8440				
4	157.10	0.8540	0.8532	0.995182	6.01	.2288E-06
5	185.20	0.8610	0.8600	0.994030	6.06	.2410E-06
6	238.10	0.8710	0.8737	0.995207	6.18	.2592E-06
7	255.90	0.8800	0.8780	0.995870	6.22	.2630E-06
8	295.40	0.8890	0.8886	0.996306	6.31	.2835E-06
9	332.20	0.8990	0.8998	0.996488	6.41	.3006E-06
10	367.60	0.9100	0.9101	0.999064	6.50	.3080E-06
11	404.00	0.9230	0.9218	0.997447	6.61	.3460E-06
12	432.30	0.9310	0.9318	0.997407	6.71	.3838E-06
13	452.30	0.9380	0.9394	0.997748	6.79	.4106E-06
14	472.30	0.9490	0.9476	0.997412	6.87	.4346E-06
15	502.30	0.9620	0.9620	0.998783	7.02	.4633E-06
16	514.30	0.9680	0.9676	0.999204	7.08	.4699E-06
7	526.30	0.9730	0.9731	0.999028	7.13	.4830E-06
18	549.00	0.9840	0.9844	0.997838	7.26	.4965E-06
19	561.00	0.9900				
20	573.00	0.9980				
21	585.00	1.0020				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	597.00	1.0120				
2	609.00	1.0190				
3	621.00	1.0260				
4	633.00	1.0330	1.0322	0.997983	7.82	.5565E-06
5	645.00	1.0380	1.0389	0.997657	7.90	.5446E-06
6	657.00	1.0450	1.0453	0.997751	7.98	.5417E-06
7	669.00	1.0530	1.0519	0.997605	8.07	.5387E-06
8	681.00	1.0580	1.0587	0.998823	8.16	.5387E-06
9	693.00	1.0650	1.0650	0.998652	8.25	.5119E-06
10	705.00	1.0710	1.0706	0.997862	8.32	.5089E-06
11	717.00	1.0770	1.0770	0.997255	8.41	.5030E-06
12	729.00	1.0820	1.0829	0.997232	8.50	.4881E-06
13	741.00	1.0900	1.0883	0.993061	8.58	.5208E-06
14	753.00	1.0940	1.0947	0.992940	8.67	.5383E-06
15	765.00	1.1000	1.1013	0.993244	8.77	.5702E-06
16	777.00	1.1100	1.1081	0.994529	8.87	.6031E-06
17	787.00	1.1140	1.1147	0.998719	8.98	.6451E-06
18	797.00	1.1210	1.1215	0.998122	9.09	.6431E-06
19	807.00	1.1280	1.1278	0.995146	9.19	.6107E-06
20	817.00	1.1380	1.1342	0.998071	9.30	.6214E-06
21	827.00	1.1400	1.1402	0.997878	9.40	.5929E-06
22	837.00	1.1450	1.1454	0.994221	9.49	.6179E-06
23	847.00	1.1520	1.1514	0.998832	9.59	.6508E-06
24	857.00	1.1570	1.1580	0.996203	9.71	.7556E-06
25	867.00	1.1670	1.1650	0.998879	9.86	.8794E-06
26	875.00	1.1720	1.1734	0.994269	10.00	.9227E-06
27	883.00	1.1820	1.1819	0.994625	10.18	.9415E-06
28	891.00	1.1910	1.1894	0.994250	10.31	.9464E-06
29	899.00	1.1970	1.1973	0.995880	10.47	.9509E-06
30	907.00	1.2030	1.2041	0.997556	10.61	.9196E-06
31	915.00	1.2120	1.2109	0.997878	10.75	.9821E-06
32	923.00	1.2180	1.2192	0.997731	10.9	.1066E-05
33	931.00	1.2270	1.2282	0.997820	11.14	.1150E-05
34	939.00	1.2390	1.2373	0.997098	11.35	.1305E-05
35	945.00	1.2460	1.2454	0.996849	11.56	.1473E-05
36	951.00	1.2530	1.2546	0.996265	11.77	.1602E-05
37	957.00	1.2650	1.2641	0.997498	12.02	.1847E-05
38	961.00	1.2730	1.2721	0.997780	12.23	.1997E-05
39	965.00	1.2790	1.2805	0.997288	12.46	.2192E-05
40	969.00	1.2900	1.2890	0.998014	12.70	.2465E-05
41	972.00	1.2960	1.2968	0.998945	12.92	.2598E-05
42	975.00	1.3050	1.3055	0.997182	13.18	.2678E-05
43	978.00	1.3150	1.3135	0.996860	13.43	.2736E-05
44	981.00	1.3220	1.3219	0.997002	13.69	.2869E-05
45	984.00	1.3290	1.3303	0.997581	13.97	.2869E-05
46	987.00	1.3390	1.3382	0.995915	14.24	.3143E-05
47	990.00	1.3490	1.3480	0.996782	14.58	.3595E-05
48	993.00	1.3570	1.3592	0.996594	15.00	.4210E-05
49	996.00	1.3730	1.3723	0.997939	15.50	.4951E-05
50	997.50	1.3800	1.3798	0.997972	15.81	.5867E-05
51	999.00	1.3860	1.3888	0.997703	16.18	.6314E-05
52	1000.50	1.3970	1.3968	0.997389	16.53	.7762E-05
53	1002.00	1.4090	1.4091	0.995664	17.02	.9495E-05
54	1003.50	1.4220	1.4244	0.997314	17.83	.1167E-04
55	1005.00	1.4470	1.4436	0.995812	18.82	.1527E-04
56	1006.00	1.4580	1.4593	0.995933	19.72	.1811E-04
57	1007.00	1.4750	1.4784	0.993763	20.91	.2228E-04
58	1008.00	1.5020	1.5009	0.995690	22.45	.3075E-04
59	1008.60	1.5170	1.5215	0.994877	24.03	.4291E-04
60	1009.00	1.5340	1.5394	0.996790	25.56	.5666E-04
61	1009.20	1.5480	1.5490	0.996003	26.44	.6808E-04
62	1009.40	1.5660	1.5639	0.996413	27.91	.7713E-04
63	1009.60	1.5800				
64	1009.80	1.5970				
65	1010.00	1.6180				

* - DATA VIOLATES SIZE REQUIREMENTS

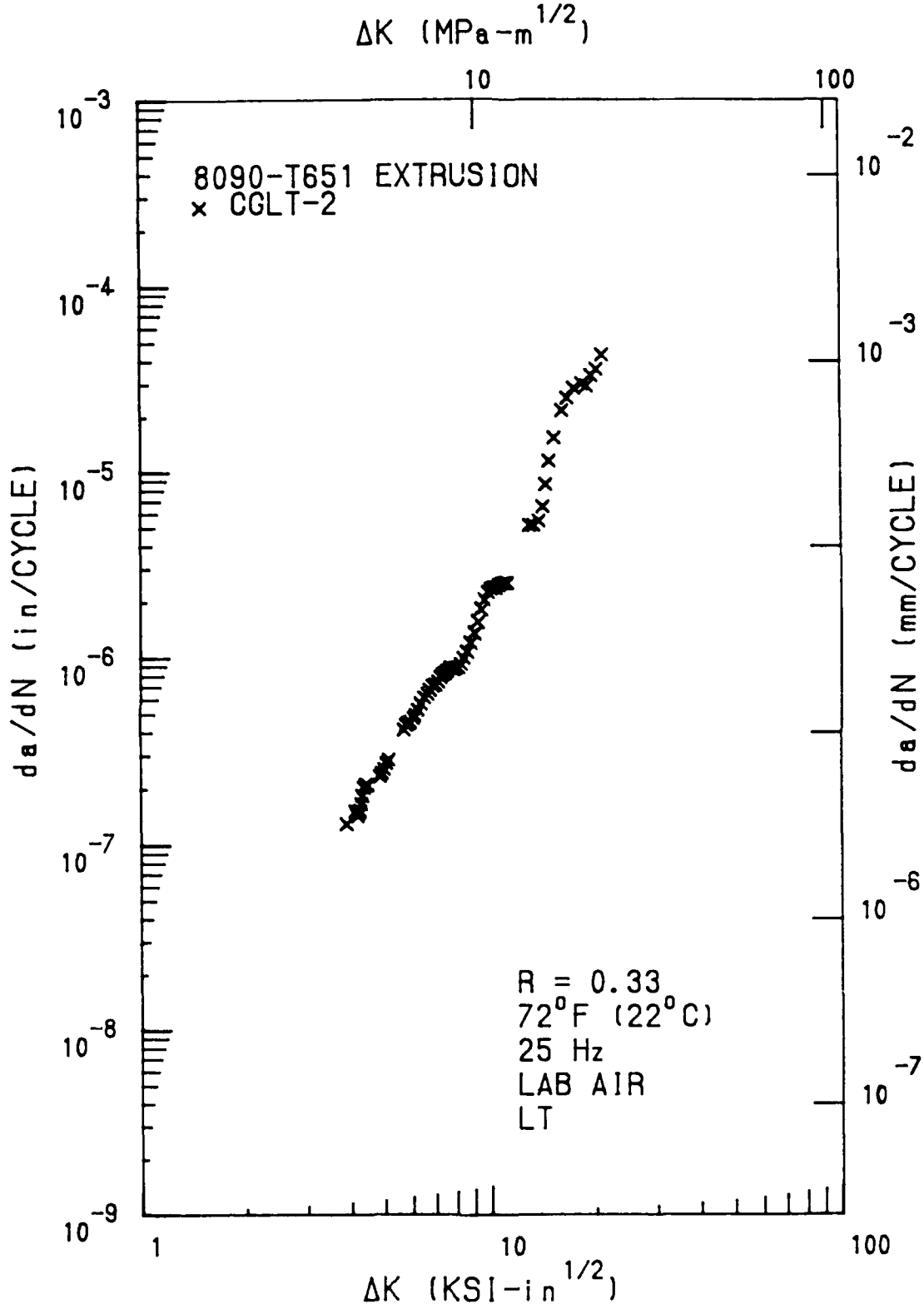

Figure A8. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Extrusion). U.S. Air Force.

Fatigue Crack Growth Rate Data Associated with Figure A8

Seven Point Incremental Polynomial Method per ASTM E647

08-09-1990

Specimen Number: CGLT-2 Specimen Type: CT

B= 0.2910 in W= 1.9910 in An= 0.6230

Pmax= 360.0 lbs Pmin= 116.0 lbs

R= 0.33 Frequency= 25.00 hz.

Test Temperature= 72 F Environment= LAB AIR

PT	CYCLES	Amean	Areg	MCC	Delta K	da/dN
1	0.00	0.7270				
2	40.00	0.7340				
3	120.00	0.7420				
4	160.00	0.7490	0.7481	0.999034	3.89	.1286E-06
5	200.00	0.7530				
6	240.00	0.7580				
7	280.00	0.7640				

PT	CYCLES	Amean	Areg	MCC	Delta K	da/dN
1	320.20	0.7700				
2	360.20	0.7760				
3	400.20	0.7830				
4	440.20	0.7880	0.7886	0.998992	4.11	.1502E-06
5	480.00	0.7950	0.7946	0.998930	4.14	.1457E-06
6	520.00	0.8000	0.8001	0.998866	4.17	.1421E-06
7	560.00	0.8060	0.8056	0.998829	4.20	.1483E-06
8	600.00	0.8110	0.8113	0.998853	4.23	.1509E-06
9	640.00	0.8170	0.8174	0.998592	4.27	.1643E-06
10	680.00	0.8250	0.8240	0.998860	4.30	.1821E-06
11	720.00	0.8310	0.8318	0.998928	4.35	.2009E-06
12	760.00	0.8400	0.8405	0.998374	4.40	.2079E-06
13	800.00	0.8500	0.8493	0.998823	4.45	.2074E-06
14	840.00	0.8590				
15	869.00	0.8630				
16	909.00	0.8710				

PT	CYCLES	Amean	Areg	MCC	Delta K	da/dN
1	990.00	0.8840				
2	1030.00	0.8920				
3	1065.00	0.8990				
4	1105.00	0.9070	0.9078	0.999674	4.83	.2303E-06
5	1139.00	0.9160	0.9159	0.999084	4.89	.2392E-06
6	1179.00	0.9260	0.9259	0.999316	4.96	.2515E-06
7	1216.00	0.9360	0.9352	0.998168	5.03	.2714E-06
8	1251.00	0.9440	0.9448	0.998511	5.10	.2819E-06
9	1286.00	0.9540				
10	1321.00	0.9670				
11	1351.00	0.9750				

PT	CYCLES	Amean	Areg	MCC	Delta K	da/dN
1	1381.30	0.9870				
2	1406.00	0.9940				
3	1436.00	1.0070				
4	1456.00	1.0160	1.0146	0.999129	5.67	.4087E-06
5	1476.00	1.0230	1.0234	0.998410	5.78	.4329E-06
6	1496.00	1.0310	1.0318	0.998976	5.83	.4411E-06
7	1516.00	1.0410	1.0410	0.998042	5.92	.4464E-06
8	1536.00	1.0510	1.0502	0.998472	6.01	.4714E-06
9	1556.00	1.0600	1.0598	0.998561	6.10	.4857E-06
10	1576.00	1.0680	1.0689	0.997708	6.19	.5179E-06
11	1596.00	1.0800	1.0792	0.999014	6.30	.5630E-06
12	1616.00	1.0900	1.0912	0.998345	6.43	.6088E-06
13	1636.00	1.1050	1.1044	0.998352	6.58	.6335E-06
14	1651.00	1.1150	1.1140	0.997783	6.69	.6645E-06
15	1666.00	1.1240	1.1243	0.997544	6.82	.6993E-06
16	1681.00	1.1330	1.1344	0.998140	6.94	.7082E-06
17	1696.00	1.1460	1.1452	0.997820	7.08	.7362E-06
18	1706.00	1.1540	1.1529	0.997571	7.18	.7704E-06
19	1716.00	1.1600	1.1610	0.997639	7.29	.8068E-06
20	1726.00	1.1680	1.1687	0.998657	7.40	.8179E-06
21	1736.00	1.1780	1.1772	0.998146	7.52	.8393E-06
22	1746.00	1.1860	1.1861	0.999526	7.65	.8679E-06
23	1756.00	1.1950	1.1949	0.999610	7.79	.8807E-06
24	1766.00	1.2030	1.2030	0.999185	7.91	.8714E-06
25	1776.00	1.2120	1.2120	0.998603	8.06	.8750E-06
26	1786.00	1.2200	1.2204	0.997649	8.19	.9179E-06
27	1796.00	1.2310	1.2296	0.997775	8.35	.9857E-06
28	1806.00	1.2380	1.2396	0.998248	8.53	.1065E-05
29	1816.00	1.2510	1.2505	0.998252	8.73	.1186E-05
30	1826.00	1.2630	1.2626	0.998830	8.96	.1352E-05
31	1833.00	1.2720	1.2726	0.997285	9.13	.1560E-05
32	1840.00	1.2830	1.2835	0.998034	9.33	.1819E-05
33	1845.00	1.2920	1.2920	0.999651	9.51	.2050E-05
34	1850.00	1.3040	1.3035	0.999237	9.81	.2250E-05
35	1853.00	1.3110	1.3107	0.999427	9.99	.2349E-05
36	1856.00	1.3180	1.3181	0.999821	10.16	.2406E-05
37	1859.00	1.3250	1.3254	0.999284	10.33	.2369E-05
38	1862.00	1.3330	1.3323	0.997863	10.51	.2452E-05
39	1865.00	1.3400	1.3398	0.998040	10.70	.2500E-05
40	1868.00	1.3460	1.3474	0.997759	10.90	.2517E-05
41	1871.00	1.3560	1.3550	0.997810	11.11	.2524E-05
42	1874.00	1.3670				
43	1877.00	1.3700				
44	1880.00	1.3780				

PT	CYCLES	Amean	Areg	MCC	Delta K	da/dN
1	1882.20	1.3830				
2	1883.00	1.3890				
3	1886.00	1.3980				
4	1888.00	1.4150	1.4127	0.990791	12.93	.5143E-05
5	1890.00	1.4240	1.4230	0.989935	13.31	.5163E-05
6	1892.00	1.4340	1.4346	0.992500	13.76	.5439E-05
7	1894.00	1.4430	1.4441	0.993056	14.14	.6826E-05
8	1895.00	1.4480	1.4501	0.989637	14.39	.8584E-05
9	1896.00	1.4580	1.4581	0.990983	14.74	.1182E-04
10	1897.00	1.4680	1.4684	0.990527	15.26	.1539E-04
11	1898.00	1.4850	1.4866	0.997721	16.10	.2159E-04
12	1898.50	1.4900	1.4978	0.999080	16.67	.2512E-04
13	1899.00	1.5100	1.5111	0.99897	17.43	.2840E-04
14	1899.50	1.5270	1.5265	0.99837	18.37	.3009E-04
15	1899.80	1.5360	1.5358	0.998475	18.97	.2930E-04
16	1900.10	1.5460	1.5448	0.987 06	19.58	.3331E-04
17	1900.40	1.5540	1.5537	0.990435	20.23	.3582E-04
18	1900.70	1.5610	1.5643	0.993055	21.03	.4273E-04
19	1901.00	1.5800				
20	1901.20	1.5880				
21	1901.40	1.6020				

* DATA VIOLATES SIZE REQUIREMENTS

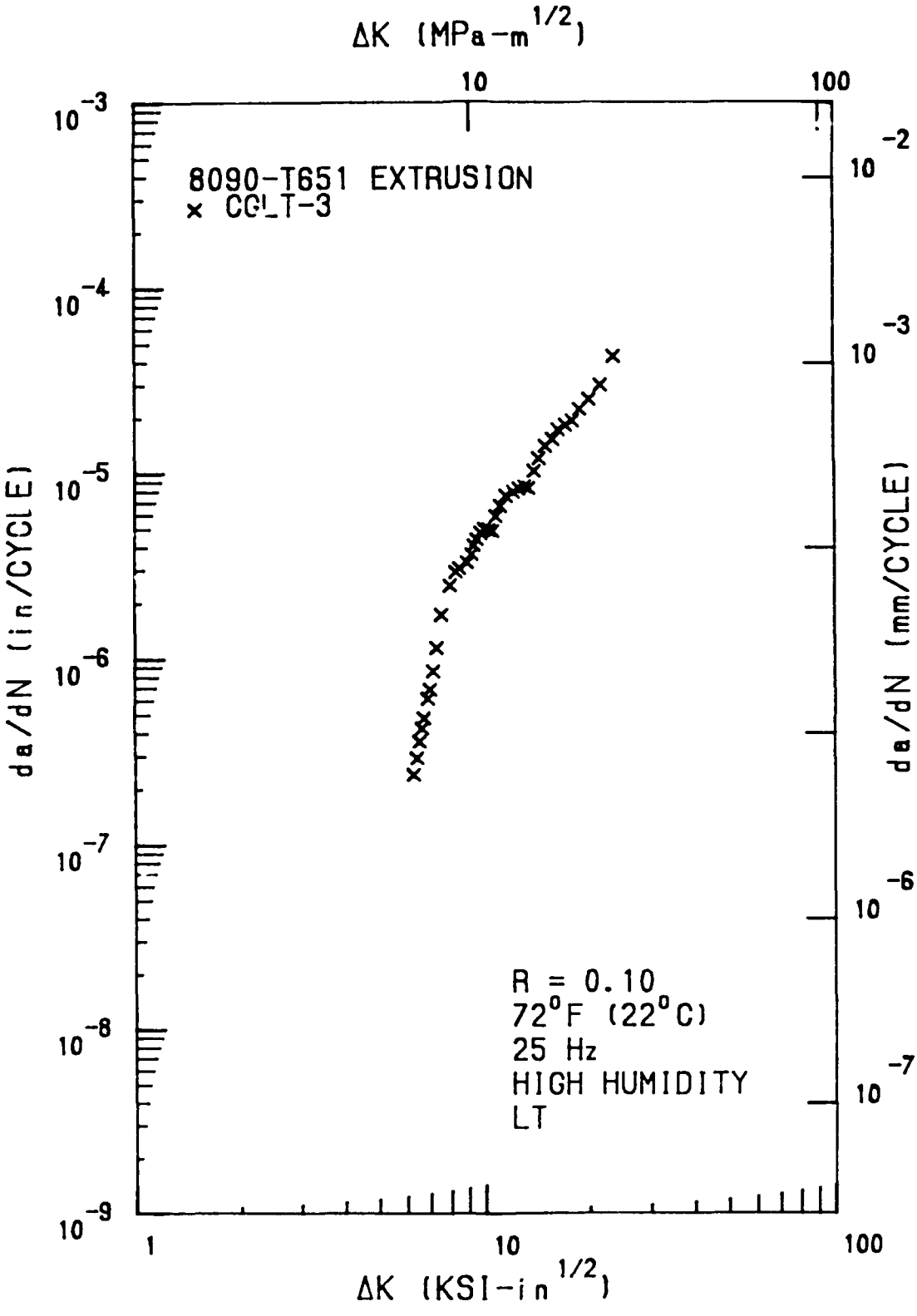

Figure A9. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Orientation). U.S. Air Force.

Fatigue Crack Growth Rate Data Associated with Figure A9

Seven Point Incremental Polynomial Method per ASTM E647

08-10-1990

Specimen Number: CGLT-3 Specimen Type: CT

B= 0.2910 in W= 1.9950 in An= 0.6280

Pmax= 400.0 lbs Pmin= 40.0 lbs

R= 0.10 Frequency= 25.00 hz.

Test Temperature= 72 F Environment= HIGH HUMIDITY

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	120.00	0.7490				
2	240.00	0.7600				
3	298.40	0.7690				
4	329.00	0.7820	0.7798	0.985505	6.22	.2364E-06
5	389.00	0.8010	0.7969	0.987735	6.37	.2908E-06
6	441.00	0.8100	0.8120	0.982743	6.50	.3569E-06
7	469.00	0.8190	0.8220	0.989570	6.58	.4186E-06
8	498.00	0.8340	0.8333	0.995610	6.66	.4774E-06
9	528.00	0.8510	0.8496	0.993954	6.83	.6076E-06
10	548.00	0.8630	0.8624	0.994661	6.95	.6813E-06
11	568.00	0.8720	0.8751	0.989464	7.08	.8543E-06
12	588.00	0.8950	0.8907	0.988020	7.23	.1142E-05
13	608.00	0.9100	0.9145	0.982261	7.48	.1716E-05
14	628.00	0.9460	0.9532	0.987807	7.91	.2463E-05
15	638.00	0.9760	0.9773	0.991940	8.20	.2933E-05
16	643.00	1.0030	0.9937	0.991713	8.41	.3054E-05
17	652.00	1.0230	1.0254	0.991942	8.84	.3270E-05
18	658.00	1.0420	1.0447	0.987334	9.12	.3610E-05
19	661.00	1.0530	1.0539	0.999427	9.25	.4040E-05
20	664.00	1.0680	1.0668	0.999234	9.45	.4355E-05
21	667.00	1.0810	1.0808	0.999525	9.68	.4714E-05
22	670.00	1.0950	1.0955	0.999565	9.92	.4929E-05
23	673.00	1.1100	1.1108	0.998432	10.19	.4905E-05
24	676.00	1.1270	1.1264	0.998647	10.48	.4821E-05
25	679.00	1.1420	1.1379	0.988301	10.70	.5798E-05
26	682.00	1.1540	1.1550	0.976872	11.04	.6620E-05
27	685.00	1.1660	1.1757	0.977389	11.47	.7486E-05
28	688.00	1.2110	1.2008	0.970173	12.05	.7886E-05
29	690.00	1.2210	1.2193	0.978134	12.50	.8247E-05
30	692.00	1.2350	1.2378	0.979670	12.98	.8452E-05
31	694.00	1.2470	1.2494	0.998291	13.31	.8306E-05
32	696.00	1.2690	1.2668	0.996139	13.81	.1028E-04
33	697.50	1.2830	1.2828	0.996984	14.30	.1199E-04
34	699.00	1.2980	1.3018	0.997172	14.93	.1305E-04
35	700.50	1.3250	1.3234	0.995855	15.71	.1523E-04
36	701.50	1.3410	1.3396	0.995417	16.33	.1724E-04
37	702.50	1.3590	1.3584	0.995661	17.11	.1816E-04
38	703.50	1.3720	1.3758	0.995983	17.88	.1929E-04
39	704.50	1.4000	1.3945	0.994699	18.76	.2225E-04
40	705.50	1.4150	1.4178	0.995067	20.00	.2496E-04
41	706.50	1.4420	1.4443	0.993530	21.56	.2995E-04
42	707.50	1.4700	1.4747	0.989203	23.62	.4267E-04
43	708.00	1.4890				
44	708.50	1.5170				
45	709.00	1.5600				

* - DATA VIOLATES SIZE REQUIREMENTS

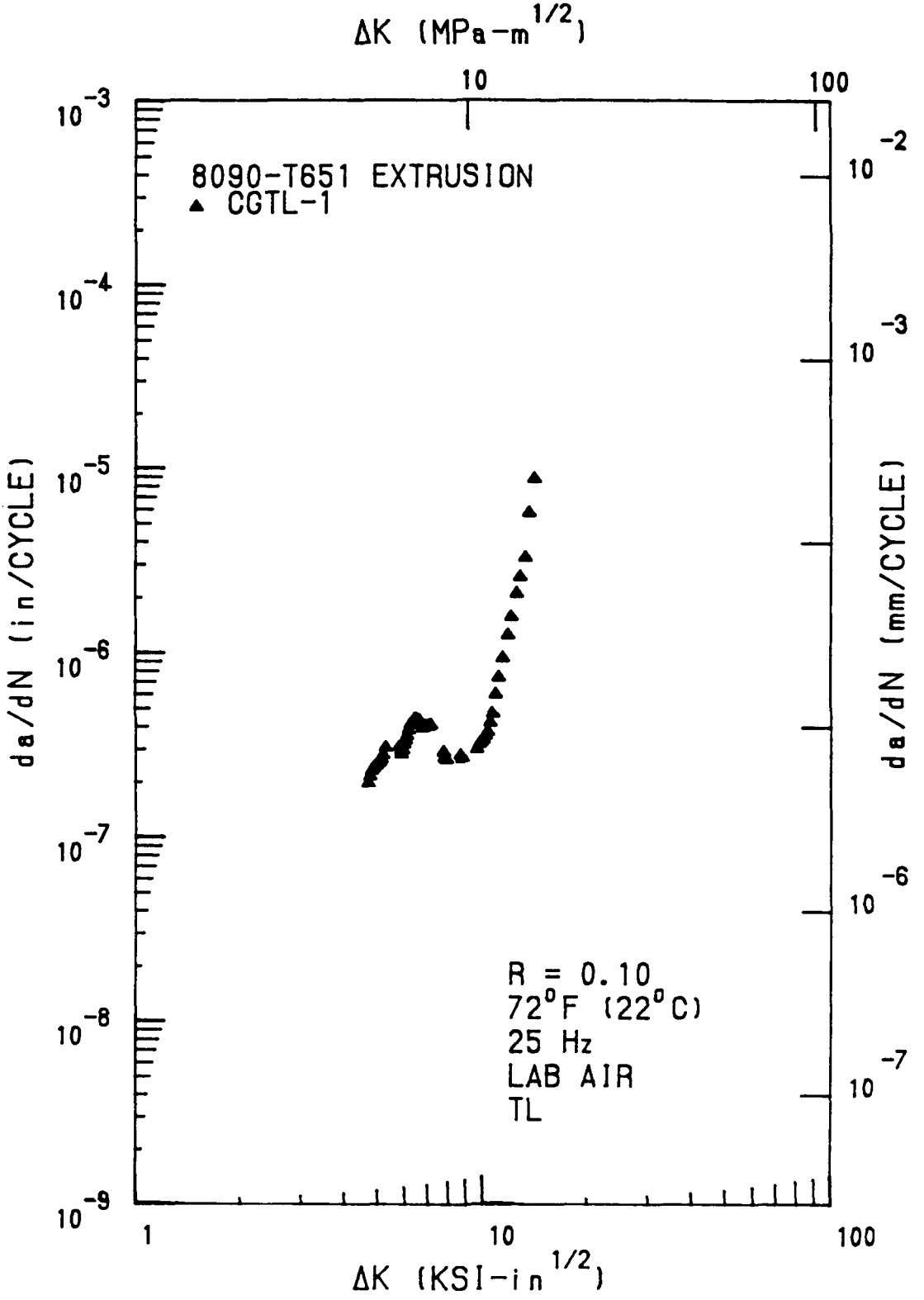

Figure A10. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). U.S. Air Force.

Table A37

Fatigue Crack Growth Rate Data Associated with Figure A10

Seven Point Incremental Polynomial Method per ASTM E647

08-10-1990

Specimen Number: CGTL-1 Specimen Type: CT

B= 0.2910 in W= 1.9920 in An= 0.6290

Pmax= 300.0 lbs Pmin= 30.0 lbs

R= 0.10 Frequency= 25.00 hz.

Test Temperature= 72 F Environment= LAB AIR

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	40.30	0.7330				
2	90.30	0.7380				
3	135.40	0.7460				
3	135.40	0.7460				
4	184.10	0.7500				
5	208.50	0.7550				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	227.10	0.7600				
2	270.30	0.7670				
3	305.50	0.7750				
4	340.80	0.7820	0.7809	0.998377	4.69	.1959E-06
5	380.80	0.7880	0.7885	0.999920	4.73	.2124E-06
6	420.80	0.7960	0.7969	0.998416	4.79	.2288E-06
7	460.80	0.8070	0.8071	0.994132	4.85	.2360E-06
8	495.80	0.8170	0.8164	0.997452	4.91	.2428E-06
9	530.80	0.8260	0.8249	0.996616	4.97	.2479E-06
10	577.70	0.8350	0.8356	0.998857	5.04	.2535E-06
11	612.70	0.8430	0.8441	0.998101	5.10	.2629E-06
12	647.70	0.8540	0.8535	0.998196	5.17	.2784E-06
13	682.70	0.8650	0.8640	0.998656	5.24	.3059E-06
14	712.70	0.8730				
15	742.00	0.8820				
16	772.00	0.8940				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	802.20	0.9080				
2	822.20	0.9140				
3	842.20	0.9230				
4	863.20	0.9290	0.9283	0.995383	5.74	.3067E-06
5	883.00	0.9330	0.9343	0.994117	5.79	.2936E-06
6	903.00	0.9400	0.9394	0.998180	5.83	.2803E-06
7	923.00	0.9450	0.9449	0.997080	5.88	.2972E-06
8	943.00	0.9510	0.9511	0.998383	5.93	.3196E-06
9	963.00	0.9570	0.9574	0.996550	5.99	.3357E-06
10	983.00	0.9650	0.9647	0.999227	6.05	.3554E-06
11	1003.00	0.9720	0.9719	0.998075	6.12	.3804E-06
12	1023.00	0.9800	0.9796	0.996811	6.19	.4089E-06
13	1043.00	0.9870	0.9880	0.998652	6.27	.4232E-06
14	1063.00	0.9970	0.9970	0.997995	6.36	.4339E-06
15	1083.00	1.0070	1.0060	0.998438	6.45	.4393E-06
16	1103.00	1.0150	1.0152	0.999478	6.54	.4321E-06
17	1123.00	1.0230	1.0236	0.999463	6.63	.4071E-06
18	1143.00	1.0320	1.0313	0.999417	6.71	.3911E-06
19	1163.00	1.0390	1.0388	0.997940	6.79	.3982E-06
20	1183.00	1.0460	1.0467	0.998101	6.88	.3982E-06
21	1203.00	1.0540	1.0546	0.998315	6.97	.3982E-06
22	1223.00	1.0640	1.0629	0.998631	7.07	.4054E-06
23	1243.00	1.0710				
24	1263.00	1.0790				
25	1283.00	1.0870				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	1303.30	1.0930				
2	1324.00	1.1010				
3	1344.00	1.1070				
4	1364.00	1.1130	1.1130	0.999263	7.70	.2879E-06
5	1384.00	1.1180	1.1181	0.997041	7.77	.2886E-06
6	1404.00	1.1240	1.1229	0.995150	7.84	.2630E-06
7	1444.00	1.1320				
8	1464.00	1.1390				
9	1484.00	1.1460				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	1504.00	1.1520				
2	1524.00	1.1570				
3	1544.00	1.1650				
4	1584.00	1.1740	1.1750	0.996697	8.63	.2775E-06
5	1604.00	1.1800	1.1806	0.996388	8.73	.2673E-06
6	1624.00	1.1870				
7	1664.00	1.1960				
8	1684.00	1.2000				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	1725.00	1.2080				
2	1765.00	1.2170				
3	1785.00	1.2240				
4	1805.00	1.2300	1.2295	0.997178	9.62	.2990E-06
5	1825.00	1.2350	1.2359	0.997482	9.75	.3179E-06
6	1845.00	1.2430	1.2420	0.998235	9.87	.3250E-06
7	1865.00	1.2480	1.2488	0.998251	10.01	.3375E-06
8	1885.00	1.2560	1.2558	0.998008	10.17	.3536E-06
9	1905.00	1.2630	1.2628	0.998756	10.31	.3732E-06
10	1925.00	1.2700	1.2702	0.997935	10.49	.4176E-06
11	1945.00	1.2780	1.2784	0.999514	10.68	.4666E-06
12	1965.00	1.2880	1.2877	0.995432	10.91	.5952E-06
13	1980.00	1.2970	1.2968	0.995890	11.13	.7353E-06
14	1995.00	1.3060	1.3061	0.996813	11.43	.9340E-06
15	2010.00	1.3230	1.3230	0.998423	11.83	.1240E-05
16	2017.00	1.3320	1.3317	0.995777	12.08	.1570E-05
17	2025.40	1.3440	1.3462	0.990993	12.52	.2090E-05
18	2030.40	1.3540	1.3556	0.987078	12.81	.2573E-05
19	2035.40	1.3690	1.3693	0.998620	13.27	.3272E-05
20	2038.40	1.3810	1.3801	0.995617	13.64	.3751E-05
21	2040.40	1.3860	1.3916	0.928549	14.06	.8749E-05
22	2042.40	1.3960				
23	2044.20	1.4330				
24	2044.40	1.4460				

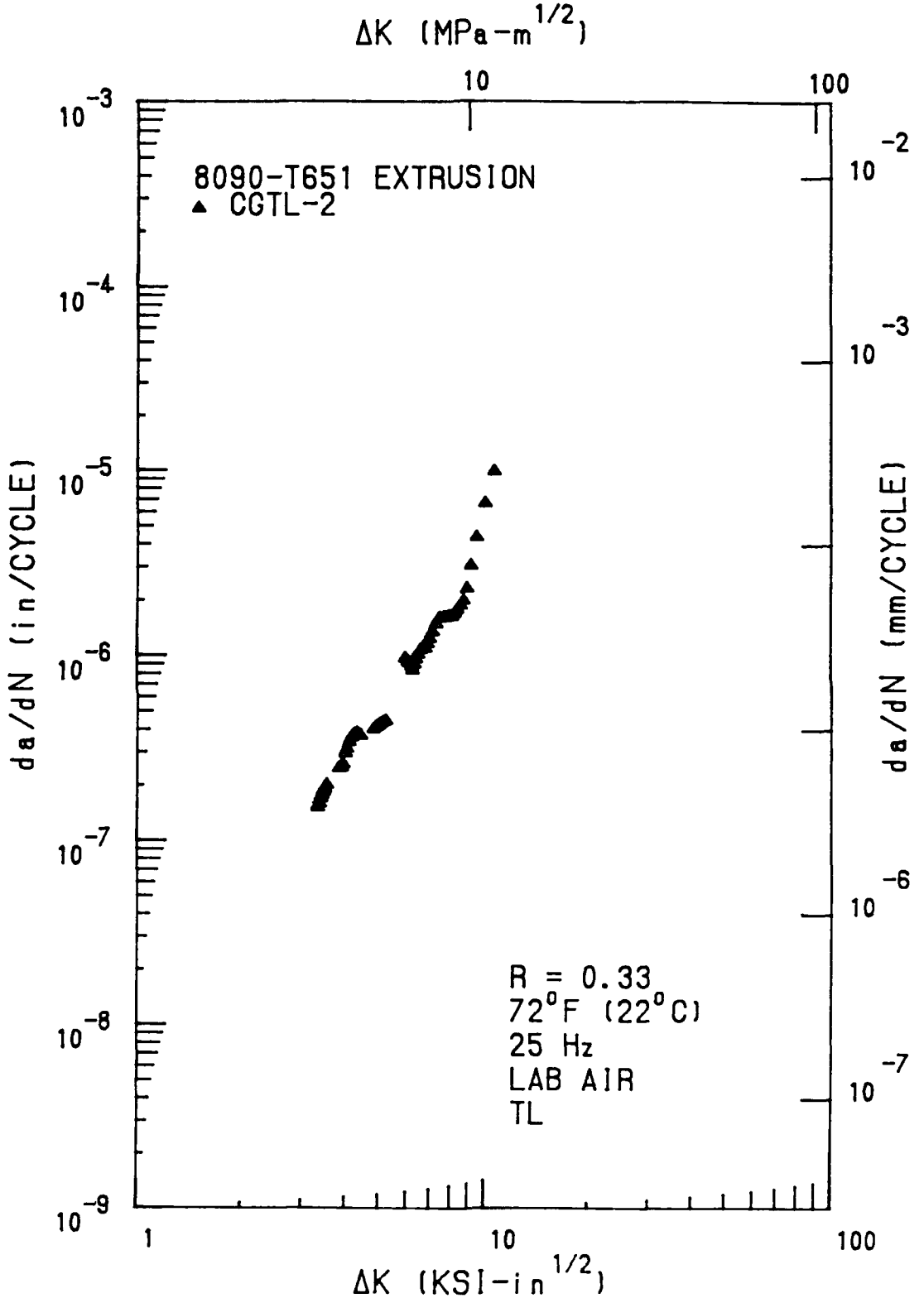

Figure A11. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). U.S. Air Force.

Table A38

Fatigue Crack Growth Rate Data Associated with Figure A11

Seven Point Incremental Polynomial Method per ASTM E647

08-13-1990

Specimen Number: CGTL-2 Specimen Type: CT

B= 0.2920 in W= 1.9950 in An= 0.6290

Pmax= 300.0 lbs Pmin= 100.0 lbs

R= 0.33 Frequency= 25.00 hz.

Test Temperature= 72 F Environment= LAB AIR

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	200.00	0.7350				
2	240.00	0.7420				
3	278.00	0.7470				
4	318.00	0.7520	0.7526	0.997154	3.33	.1504E-06
5	358.00	0.7590	0.7585	0.997586	3.35	.1498E-06
6	398.00	0.7640	0.7646	0.997752	3.38	.1580E-06
7	438.00	0.7720	0.7710	0.997783	3.41	.1679E-06
8	478.00	0.7770	0.7777	0.998462	3.44	.1759E-06
9	518.00	0.7850	0.7852	0.998245	3.47	.1839E-06
10	558.00	0.7930	0.7926	0.998508	3.50	.1902E-06
11	598.00	0.8010	0.8007	0.999482	3.54	.2000E-06
12	638.00	0.8090				
13	678.00	0.8170				
14	692.00	0.8200				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	732.30	0.8280				
2	773.00	0.8370				
3	813.00	0.8510				
4	853.00	0.8590	0.8583	0.994665	3.83	.2451E-06
5	893.00	0.8660	0.8678	0.994046	3.88	.2469E-06
6	933.00	0.8770	0.8766	0.999270	3.93	.2567E-06
7	973.00	0.8880	0.8873	0.999072	3.99	.2937E-06
8	1003.00	0.8960	0.8968	0.998873	4.04	.3126E-06
9	1033.00	0.9060	0.9062	0.998811	4.09	.3388E-06
10	1063.00	0.9180	0.9169	0.998272	4.16	.3587E-06
11	1093.00	0.9270	0.9283	0.998601	4.22	.3760E-06
12	1123.00	0.9410	0.9399	0.998423	4.30	.3804E-06
13	1148.00	0.9480	0.9484	0.997723	4.35	.3924E-06
14	1167.00	0.9570	0.9570	0.999116	4.41	.3863E-06
15	1189.00	0.9660				
16	1211.00	0.9720				
17	1232.00	0.9790				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	1254.30	0.9900				
2	1274.30	0.9980				
3	1295.00	1.0060				
4	1315.00	1.0130	1.0129	0.998359	4.80	.3961E-06
5	1335.00	1.0200	1.0208	0.998879	4.86	.4077E-06
6	1355.00	1.0290	1.0294	0.997334	4.92	.4125E-06
7	1375.00	1.0390	1.0380	0.998232	4.99	.4214E-06
8	1395.00	1.0470	1.0465	0.998046	5.06	.4321E-06
9	1415.00	1.0540	1.0548	0.998111	5.13	.4393E-06
10	1435.00	1.0630	1.0635	0.998584	5.20	.4411E-06
11	1455.00	1.0730				
12	1475.00	1.0830				
13	1495.00	1.0910				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	1515.00	1.1020				
2	1535.00	1.1160				
3	1550.00	1.1300				
4	1560.00	1.1380	1.1391	0.996562	5.94	.9587E-06
5	1570.00	1.1510	1.1493	0.995576	6.05	.9288E-06
6	1579.00	1.1550	1.1543	0.995124	6.10	.9002E-06
7	1582.00	1.1600	1.1609	0.995798	6.18	.8737E-06
8	1589.00	1.1660	1.1657	0.998462	6.23	.8272E-06
9	1596.00	1.1720	1.1715	0.998487	6.31	.8029E-06
10	1603.00	1.1770	1.1780	0.998521	6.38	.9541E-06
11	1610.00	1.1850	1.1849	0.998612	6.47	.1010E-05
12	1617.00	1.1930	1.1924	0.998752	6.56	.1066E-05
13	1624.00	1.2000	1.2004	0.999740	6.67	.1087E-05
14	1631.00	1.2080	1.2080	0.999738	6.77	.1092E-05
15	1638.00	1.2160	1.2152	0.997402	6.87	.1158E-05
16	1645.00	1.2230	1.2234	0.997878	6.98	.1230E-05
17	1652.00	1.2310	1.2320	0.998531	7.10	.1342E-05
18	1659.00	1.2430	1.2417	0.998887	7.25	.1464E-05
19	1666.00	1.2520	1.2530	0.998230	7.42	.1587E-05
20	1673.00	1.2650	1.2649	0.998091	7.62	.1596E-05
21	1678.00	1.2740	1.2728	0.997736	7.75	.1602E-05
22	1683.00	1.2810	1.2812	0.998402	7.89	.1619E-05
23	1688.00	1.2880	1.2886	0.998644	8.03	.1629E-05
24	1693.00	1.2970	1.2966	0.999591	8.17	.1670E-05
25	1698.00	1.3050	1.3055	0.999428	8.34	.1757E-05
26	1703.00	1.3150	1.3145	0.999543	8.52	.1850E-05
27	1708.00	1.3240	1.3238	0.999007	8.70	.1971E-05
28	1713.00	1.3330	1.3329	0.999352	8.90	.2286E-05
29	1718.00	1.3440	1.3431	0.984203	9.12	.3036E-05
30	1723.00	1.3570	1.3584	0.988524	9.47	.4325E-05
31	1728.00	1.3770	1.3823	0.991737	10.07	.6591E-05
32	1731.00	1.4030	1.4040	0.986399	10.66	.9843E-05
33	1733.00	1.4200				
34	1734.00	1.4340				
35	1734.70	1.4540				

* - DATA VIOLATES SIZE REQUIREMENTS

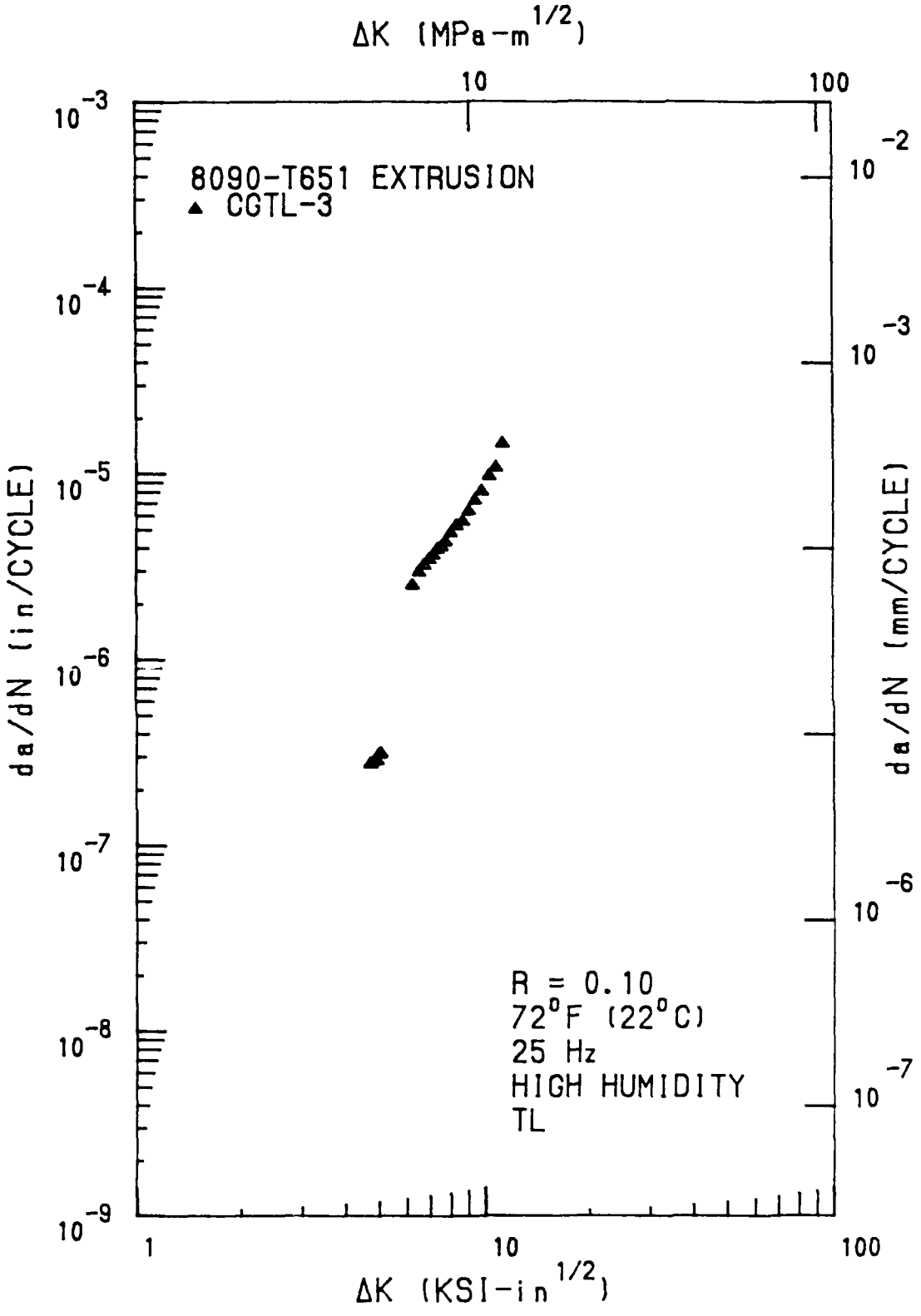

Figure A12. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). U.S. Air Force.

Table A39

Fatigue Crack Growth Rate Data Associated with Figure A12

Seven Point Incremental Polynomial Method per ASTM E647

08-13-1990

Specimen Number: CGTL-3 Specimen Type: CT

B= 0.2920 in W= 1.9920 in An= 0.6300

Pmax= 300.0 lbs Pmin= 30.0 lbs

R= 0.10 Frequency= 25.00 hz.

Test Temperature= 72 F Environment= HIGH HUMIDITY

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	31.00	0.7480				
2	62.00	0.7590				
3	93.00	0.7690				
4	155.00	0.7850	0.7852	0.998341	4.70	.2734E-06
5	186.00	0.7930	0.7924	0.997152	4.74	.2749E-06
6	248.00	0.8080	0.8095	0.997203	4.85	.2825E-06
7	279.00	0.8180	0.8184	0.996319	4.91	.2839E-06
8	310.00	0.8300	0.8272	0.994737	4.97	.3065E-06
9	341.00	0.8360	0.8376	0.992998	5.04	.3088E-06
10	372.00	0.8450				
11	403.00	0.8590				
12	434.00	0.8650				

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	465.00	0.8820				
2	496.00	0.8990				
3	527.00	0.9400				
4	547.00	0.9840	0.9846	0.999613	6.22	.2495E-05
5	557.00	1.0110	1.0110	0.999461	6.48	.2941E-05
6	564.00	1.0300	1.0320	0.999309	6.70	.3216E-05
7	571.00	1.0550	1.0552	0.998685	6.95	.3442E-05
8	575.00	1.0720	1.0694	0.998257	7.12	.3652E-05
9	579.00	1.0840	1.0846	0.997849	7.31	.3917E-05
10	583.00	1.0980	1.1000	0.998251	7.50	.4062E-05
11	587.00	1.1170	1.1163	0.998956	7.72	.4304E-05
12	591.00	1.1360	1.1344	0.999108	7.97	.4759E-05
13	595.00	1.1530	1.1539	0.998748	8.27	.5245E-05
14	599.00	1.1740	1.1755	0.998217	8.61	.5520E-05
15	603.00	1.1990	1.1980	0.997422	8.99	.6237E-05
16	606.00	1.2200	1.2172	0.995815	9.35	.7113E-05
17	609.00	1.2340	1.2390	0.996158	9.78	.7927E-05
18	612.00	1.2630	1.2627	0.996172	10.28	.9650E-05
19	614.00	1.2850	1.2824	0.997009	10.74	.1070E-04
20	616.00	1.3020	1.3034	0.980370	11.26	.1442E-04
21	618.00	1.3340				
22	620.00	1.3570				
23	622.00	1.4280				

* - DATA VIOLATES SIZE REQUIREMENTS

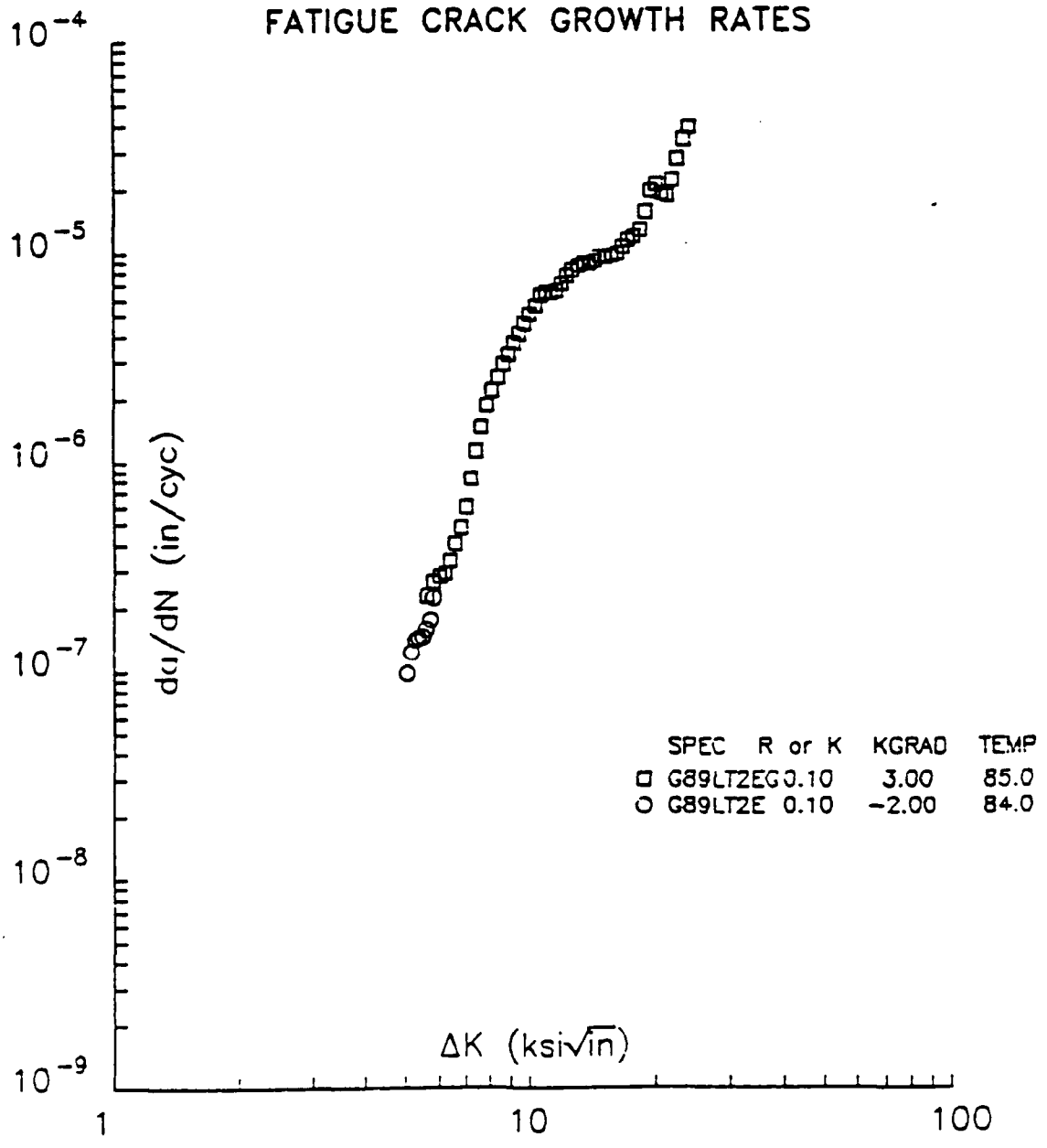

Figure A13. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Orientation). NASA-Langley.

Table A40

Fatigue Crack Growth Rate Data Associated with Figure A13

AUTOMATED FATIGUE CRACK GROWTH RATE ANALYSIS

Specimen Id.	G89LT2E	Geometry	CT
Contract #	AFCO-OP	Orientation	LT
Material	8090-T651	Yield (ksi)	67.5
Temperature (F)	84	Modulus	11.4
Environment	AIR 94-99%RH		

Specimen Dimensions (in)

Thickness	0.235	Notch depth	0.809
Width	2.000	Gage length	0.200
Height	1.200	Alpha ratio	1.250

Precrack Parameters

Pmax (lbs)	340.0	Stress ratio (R)	0.10
Final a (in)	0.877	Kmax	8.27

Test Parameters

Initial a (in)	0.809	Initial K	7.55
K-gradient	-2.00	Stress ratio (R)	0.10

K Coeff	Ev8/P Coeff
0.886000	1.000980
4.640000	-4.669510
-13.320000	18.460100
14.720000	-236.824997
-5.600000	1214.880000
0.000000	-2143.570100

Analysis Codes: KRP 2 0

Visual Observations

Ev8/P	Crack (Ev8/P)	Crack (visual)	Error	CAF

Comments

Date of test: 12-19-1989

Specimen Id. G89LT2E Page 1

Pmax (lbs)	Ev8/P	a (in)	N (X1)	Δa (in)	ΔN (X1)	Δa/ΔN (in/cyc)	ΔK (ksi√in)
	42.10	0.8757	60961				
263	42.87	0.8846	90541	0.0184	82509	2.231E-07	5.84
255	43.72	0.8941	143470	0.0197	112686	1.746E-07	5.73
247	44.64	0.9043	203226	0.0203	128475	1.577E-07	5.61
238	45.59	0.9144	271945	0.0201	139752	1.436E-07	5.50
230	46.55	0.9243	342978	0.0205	143740	1.428E-07	5.39
222	47.60	0.9349	415685	0.0210	150433	1.398E-07	5.28
214	48.67	0.9454	493411	0.0206	170072	1.211E-07	5.17
207	49.74	0.9555	585756	0.0203	209572	9.689E-08	5.07
	50.84	0.9657	702983				

Table A41

Fatigue Crack Growth Rate Data Associated with Figure A13

AUTOMATED FATIGUE CRACK GROWTH RATE ANALYSIS

Specimen Id.	G89LT2EG	Geometry	CT
Contract #	AFCO-OP	Orientation	LT
Material	8090-T651	Yield (ksi)	67.5
Temperature (F)	85	Modulus	11.4
Environment	AIR 90-99%RH		

Specimen Dimensions (in)

Thickness	0.235	Notch depth	0.809
Width	2.000	Gage length	0.200
Height	1.200	Alpha ratio	1.250

Precrack Parameters

Pmax (lbs)	194.0	Stress ratio (R)	0.10
Final a (in)	0.974	Kmax	5.43

Test Parameters

Initial a (in)	0.960	Initial K	5.48
K-gradient	3.00	Stress ratio (R)	0.10

K Coeff	Ev8/P Coeff
0.886000	1.000980
4.640000	-4.669510
-13.320000	18.460100
14.720000	-236.824997
-5.600000	1214.880000
0.000000	-2143.570100

Analysis Codes

KRP Z 0

Visual Observations

Ev8/P	Crack (Ev8/P)	Crack (visual)	Error	CAF

Comments

Date of test: 12-20-1989

Specimen Id. G89LT2EG Page 1

Pmax (lbs)	$E_{48/P}$	a (in)	N (X1)	Δa (in)	ΔN (X1)	Δa/ΔN (in/cyc)	ΔK (ksi√in)
	54.18	0.9948	62551				
214	55.41	1.0049	111987	0.0205	90544	2.269E-07	5.65
217	56.71	1.0153	153094	0.0206	77548	2.658E-07	5.82
220	58.03	1.0255	189535	0.0204	72763	2.802E-07	6.00
223	59.40	1.0357	225857	0.0202	69153	2.914E-07	6.19
227	60.77	1.0456	258688	0.0202	60332	3.348E-07	6.38
230	62.23	1.0559	286189	0.0202	49906	4.041E-07	6.57
233	63.69	1.0658	308594	0.0199	41794	4.773E-07	6.78
236	65.21	1.0758	327983	0.0205	34342	5.955E-07	6.99
239	66.85	1.0863	342937	0.0209	25671	8.149E-07	7.21
242	68.56	1.0968	353654	0.0202	18267	1.107E-06	7.43
245	70.19	1.1065	361203	0.0190	13161	1.445E-06	7.65
249	71.81	1.1158	366815	0.0193	10502	1.837E-06	7.88
251	73.61	1.1258	371705	0.0199	9168	2.166E-06	8.11
255	75.45	1.1356	375983	0.0199	7918	2.510E-06	8.36
258	77.38	1.1456	379623	0.0204	7141	2.860E-06	8.62
261	79.47	1.1561	383125	0.0208	6487	3.206E-06	8.88
264	81.62	1.1664	386110	0.0198	5472	3.615E-06	9.15
267	83.65	1.1758	388597	0.0191	4763	4.011E-06	9.45
269	85.82	1.1855	390873	0.0197	4381	4.502E-06	9.71
272	88.14	1.1956	392978	0.0200	4006	5.004E-06	10.00
275	90.56	1.2056	394879	0.0195	3534	5.532E-06	10.30
278	92.95	1.2151	396511	0.0198	3193	6.200E-06	10.62
281	95.63	1.2254	398072	0.0200	3123	6.392E-06	10.93
283	98.25	1.2351	399634	0.0205	3202	6.391E-06	11.28
286	101.30	1.2458	401274	0.0206	3130	6.579E-06	11.61
289	104.20	1.2557	402765	0.0194	2775	7.004E-06	11.97
291	107.15	1.2653	404048	0.0195	2511	7.762E-06	12.33
293	110.32	1.2752	405276	0.0201	2454	8.200E-06	12.70
296	113.74	1.2854	406502	0.0205	2393	8.582E-06	13.09
298	117.35	1.2957	407669	0.0203	2296	8.839E-06	13.50
300	121.01	1.3057	408798	0.0196	2234	8.770E-06	13.91
302	124.68	1.3153	409903	0.0197	2162	9.130E-06	14.33
304	128.74	1.3254	410960	0.0202	2113	9.557E-06	14.76
306	132.96	1.3355	412016	0.0199	2111	9.433E-06	15.21
308	137.30	1.3453	413071	0.0203	2110	9.630E-06	15.69
310	142.13	1.3558	414125	0.0204	2062	9.912E-06	16.16
311	146.98	1.3658	415132	0.0203	1920	1.057E-05	16.67
313	152.25	1.3761	416045	0.0202	1765	1.147E-05	17.18
314	157.60	1.3860	416897	0.0196	1653	1.188E-05	17.70
315	163.09	1.3957	417698	0.0195	1526	1.280E-05	18.23
316	168.94	1.4055	418423	0.0200	1290	1.550E-05	18.78
317	175.34	1.4157	418988	0.0205	1042	1.965E-05	19.36
318	182.18	1.4260	419464	0.0204	968	2.108E-05	19.96
318	189.29	1.4361	419956	0.0192	1009	1.904E-05	20.55
319	196.04	1.4452	420473	0.0192	1035	1.856E-05	21.18
319	203.97	1.4553	420991	0.0205	927	2.211E-05	21.81
319	212.62	1.4657	421400	0.0202	726	2.786E-05	22.47
319	221.32	1.4756	421717	0.0206	601	3.421E-05	23.19
319	231.42	1.4863	422001	0.0209	535	3.911E-05	23.90
	241.68	1.4965	422252				

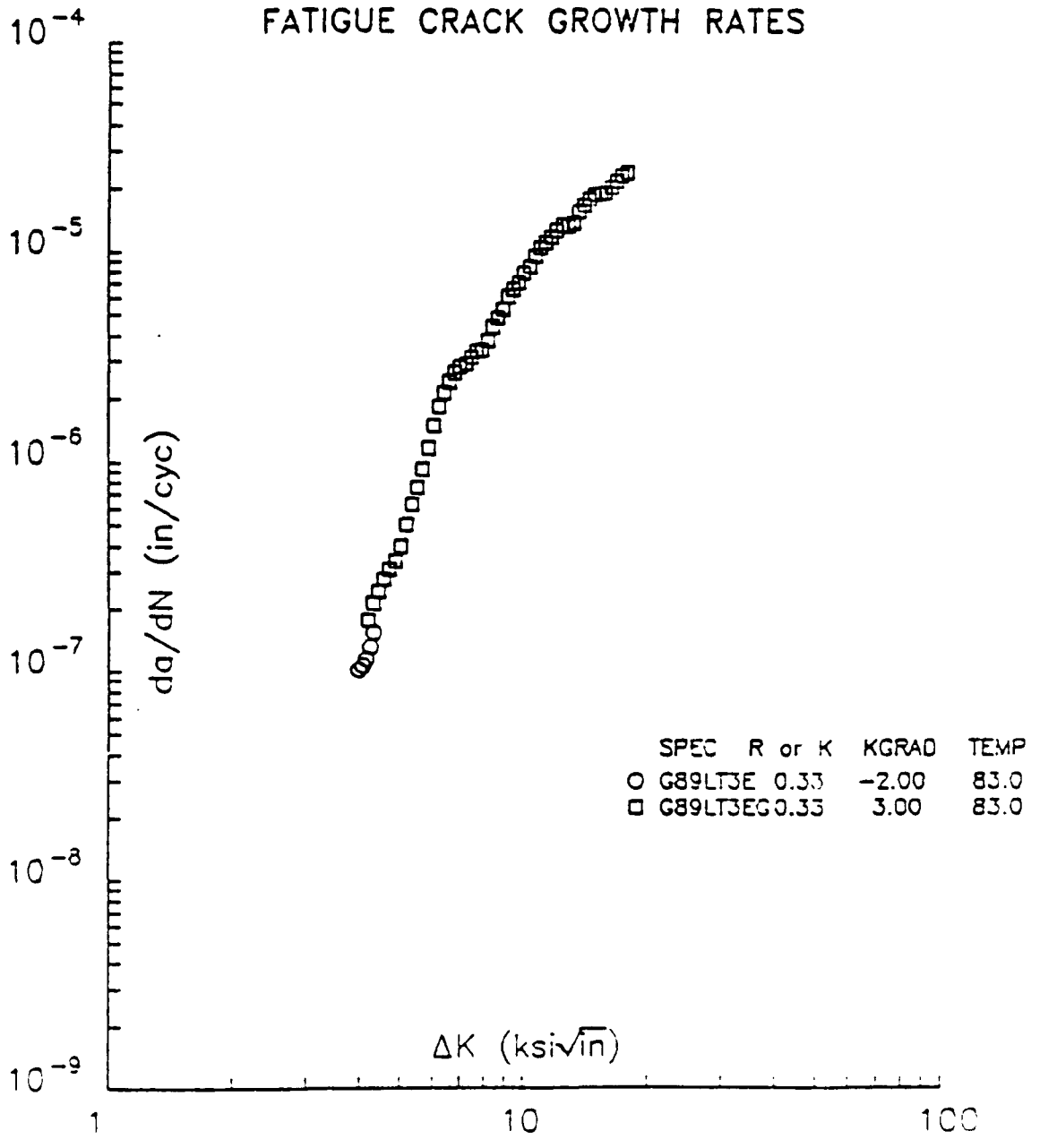

Figure A14. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (L-T Orientation). NASA-Langley.

Table A42

Fatigue Crack Growth Rate Data Associated with Figure A14

AUTOMATED FATIGUE CRACK GROWTH RATE ANALYSIS

Specimen Id.	G89LT3E	Geometry	CT
Contract #	AFCO-OP	Orientation	LT
Material	8090-T651	Yield (ksi)	67.5
Temperature (F)	83	Modulus	11.4
Environment	AIR 95-98%RH		

Specimen Dimensions (in)

Thickness	0.233	Notch depth	0.806
Width	2.000	Gage length	0.200
Height	1.200	Alpha ratio	1.250

Precrack Parameters

Pmax (lbs)	330.0	Stress ratio (R)	0.33
Final a (in)	0.854	Kmax	7.84

Test Parameters

Initial a (in)	0.806	Initial K	7.35
K-gradient	-2.00	Stress ratio (R)	0.33

K Coeff	EvB/P Coeff
0.886000	1.000980
4.640000	-4.669510
-13.320000	18.460100
14.720000	-236.824997
-5.600000	1214.880000
0.000000	-2143.570100

Analysis Codes

KRP 2 0

Visual Observations

EvB/P	Crack (EvB/P)	Crack (visual)	Error	CAF

Comments

Date of test: 12-12-1989

Specimen Id. G89LT3E Page 1

Pmax (lbs)	EδB/P	a (in)	N (X1)	Δa (in)	ΔN (X1)	Δa/ΔN (in/cyc)	ΔK (ksi√in)
	40.86	0.8611	169637				
261	41.70	0.8711	229231	0.0200	130571	1.529E-07	4.32
256	42.55	0.8810	300207	0.0199	152827	1.303E-07	4.24
248	43.43	0.8910	382058	0.0199	174626	1.137E-07	4.15
239	44.32	0.9009	474834	0.0199	189240	1.051E-07	4.07
231	45.26	0.9109	571298	0.0201	199161	1.010E-07	3.99
	46.22	0.9210	673995				

Table A43

Fatigue Crack Growth Rate Data Associated with Figure A14

AUTOMATED FATIGUE CRACK GROWTH RATE ANALYSIS

Specimen Id.	G89LT3EG	Geometry	CT
Contract #	AFCO-OP	Orientation	LT
Material	8090-T651	Yield (ksi)	67.5
Temperature (F)	83	Modulus	11.4
Environment	AIR 96-98%RH		

Specimen Dimensions (in)

Thickness	0.233	Notch depth	0.806
Width	2.000	Gage length	0.200
Height	1.200	Alpha ratio	1.250

Precrack Parameters

Pmax (lbs)	219.0	Stress ratio (R)	0.33
Final a (in)	0.927	Kmax	5.77

Test Parameters

Initial a (in)	0.927	Initial K	5.77
K-gradient	3.00	Stress ratio (R)	0.33

K Coeff	EvB/P Coeff
0.886000	1.007980
4.640000	-4.669510
-13.320000	18.461100
14.720000	-236.824997
-5.600000	1214.880000
0.000000	-2143.570100

Analysis Codes

KRP 2 0

Visual Observations

EvB/P	Crack (EvB/P)	Crack (visual)	Error	CAF

Comments

Date of test: 12-13-1989

Specimen Id. G89LT3EG Page 1

Pmax (lbs)	E48/P	a (in)	N (X1)	Δa (in)	ΔN (X1)	Δa/ΔN (in/cyc)	ΔK (ksi√in)
	48.42	0.9430	121854				
228	49.46	0.9531	185035	0.0202	114602	1.761E-07	4.18
232	50.56	0.9632	236456	0.0203	96108	2.109E-07	4.31
235	51.68	0.9733	281143	0.0204	84164	2.424E-07	4.44
239	52.85	0.9836	320620	0.0204	73660	2.771E-07	4.58
242	54.04	0.9937	354803	0.0202	65743	3.075E-07	4.72
246	55.26	1.0038	386363	0.0205	60496	3.391E-07	4.87
250	56.57	1.0142	415299	0.0205	51308	3.999E-07	5.02
253	57.87	1.0243	437672	0.0196	38965	5.030E-07	5.17
257	59.13	1.0338	454264	0.0197	31571	6.238E-07	5.33
261	60.53	1.0440	469243	0.0206	27315	7.539E-07	5.49
264	62.00	1.0544	481579	0.0196	21410	9.177E-07	5.65
268	63.36	1.0637	490653	0.0196	16873	1.159E-06	5.83
271	64.91	1.0740	498452	0.0203	13684	1.483E-06	6.00
275	66.47	1.0840	504336	0.0197	10804	1.825E-06	6.19
279	68.04	1.0937	509256	0.0200	9412	2.120E-06	6.38
282	69.74	1.1039	513748	0.0199	8302	2.397E-06	6.57
286	71.41	1.1136	517558	0.0197	7431	2.654E-06	6.77
289	73.20	1.1236	521179	0.0203	7243	2.805E-06	6.97
293	75.10	1.1339	524801	0.0205	7062	2.908E-06	7.19
296	77.07	1.1442	528241	0.0203	6507	3.123E-06	7.41
300	79.07	1.1542	531303	0.0197	5926	3.327E-06	7.64
303	81.06	1.1639	534167	0.0195	5727	3.399E-06	7.87
307	83.16	1.1737	537030	0.0205	5441	3.772E-06	8.11
310	85.54	1.1844	539608	0.0209	4765	4.383E-06	8.36
314	87.88	1.1946	541795	0.0199	4177	4.774E-06	8.62
317	90.23	1.2044	543785	0.0195	3698	5.264E-06	8.88
320	92.65	1.2140	545493	0.0194	3210	6.046E-06	9.14
323	95.17	1.2238	546996	0.0195	2987	6.539E-06	9.41
326	97.81	1.2336	548481	0.0200	2822	7.073E-06	9.70
329	100.66	1.2437	549817	0.0202	2596	7.782E-06	9.99
332	103.59	1.2538	551077	0.0202	2408	8.392E-06	10.30
335	106.69	1.2639	552226	0.0202	2134	9.449E-06	10.62
338	109.88	1.2739	553211	0.0201	1938	1.036E-05	10.94
341	113.22	1.2840	554163	0.0203	1843	1.102E-05	11.28
343	116.78	1.2942	555054	0.0201	1725	1.166E-05	11.62
346	120.37	1.3041	555889	0.0199	1591	1.248E-05	11.98
348	124.16	1.3141	556645	0.0199	1510	1.320E-05	12.34
351	128.12	1.3241	557399	0.0196	1510	1.299E-05	12.71
353	132.15	1.3337	558155	0.0196	1446	1.353E-05	13.10
355	136.47	1.3436	558845	0.0204	1348	1.513E-05	13.50
357	141.27	1.3541	559503	0.0208	1282	1.621E-05	13.91
359	146.23	1.3644	560127	0.0201	1154	1.744E-05	14.34
360	151.22	1.3742	560657	0.0190	1035	1.839E-05	14.[illegible]
362	156.11	1.3834	561161	0.0193	1043	1.845E-05	15.22
363	161.73	1.3935	561700	0.0202	1079	1.874E-05	15.66
364	167.72	1.4037	562240	0.0204	1035	1.973E-05	16.15
365	174.09	1.4139	562736	0.0201	945	2.126E-05	16.64
366	180.55	1.4238	563186	0.0198	877	2.259E-05	17.15
367	187.47	1.4337	563613	0.0200	856	2.342E-05	17.67
	194.85	1.4438	564041				

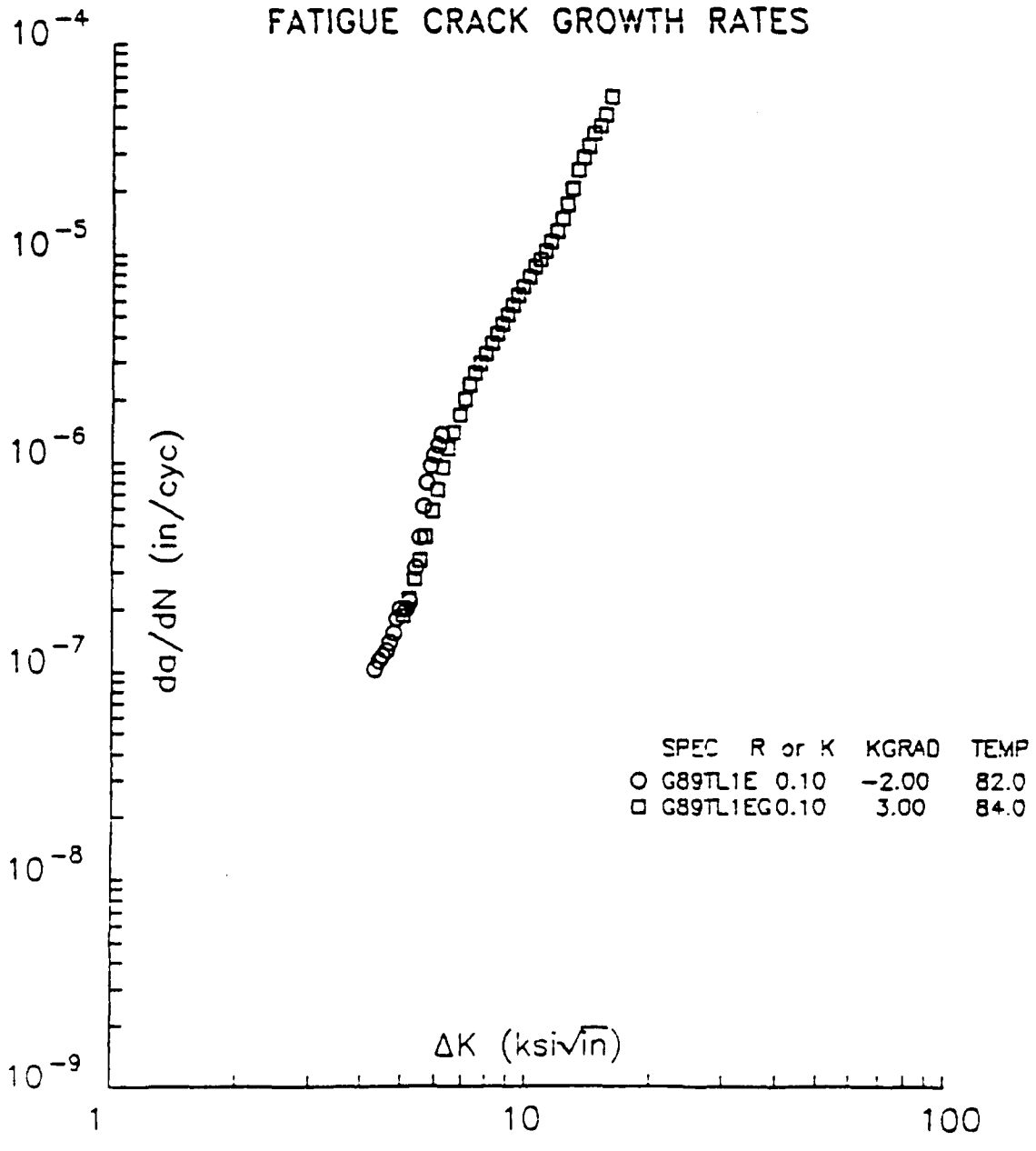

Figure A15. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). NASA-Langley.

Table A44

Fatigue Crack Growth Rate Data Associated with Figure A15

AUTOMATED FATIGUE CRACK GROWTH RATE ANALYSIS

Specimen Id.	G89TL1E	Geometry	CT
Contract #	AFCO-OP	Orientation	TL
Material	8090-T651	Yield (ksi)	57.9
Temperature (F)	82	Modulus	11.4
Environment	90-98%RH		

Specimen Dimensions (in)

Thickness	0.237	Notch depth	0.805
Width	2.000	Gage length	0.200
Height	1.200	Alpha ratio	1.250

Precrack Parameters

Pmax (lbs)	146.0	Stress ratio (R)	0.10
Final a (in)	1.059	Kmax	4.62

Test Parameters

Initial a (in)	0.805	Initial K	7.66
K-gradient	-2.00	Stress ratio (R)	0.10

K Coeff	Ev8/P Coeff
0.886000	1.000980
4.640000	-4.669510
-13.320000	18.460100
14.720000	-236.824997
-5.600000	1214.880000
0.000000	-2143.570100

Analysis Codes

KRP 2 0

Visual Observations

Ev8/P	Crack (Ev8/P)	Crack (visual)	Error	CAF

Comments

Date of test: 11-16-1989

Specimen Id. G89TL1E Page 1

Pmax (lbs)	Ev8/P	a (in)	N (X1)	Δa (in)	ΔN (X1)	Δa/ΔN (in/cyc)	ΔK (ksi√in)
	40.00	0.8506	31702				
291	40.84	0.8609	38869	0.0203	15000	1.350E-06	6.17
281	41.67	0.8708	46702	0.0199	16669	1.196E-06	6.05
272	42.53	0.8809	55538	0.0204	18770	1.087E-06	5.92
263	43.44	0.8912	65471	0.0201	20764	9.681E-07	5.81
254	44.32	0.9010	76301	0.0196	24614	7.956E-07	5.69
245	45.23	0.9108	90085	0.0200	32765	6.096E-07	5.58
237	46.20	0.9209	109067	0.0202	46531	4.347E-07	5.47
229	47.19	0.9310	136616	0.0200	63367	3.164E-07	5.36
217	48.20	0.9410	172433	0.0300	137871	2.172E-07	5.20
210	50.30	0.9610	274487	0.0298	149186	1.997E-07	5.10
199	51.38	0.9708	321619	0.0203	101169	2.008E-07	4.95
192	52.57	0.9813	375656	0.0206	115945	1.779E-07	4.85
186	53.75	0.9914	437564	0.0198	129926	1.521E-07	4.75
179	54.91	1.0011	505583	0.0197	145381	1.357E-07	4.66
173	56.16	1.0111	582946	0.0202	162756	1.239E-07	4.57
167	57.45	1.0212	668341	0.0203	173486	1.169E-07	4.47
161	58.79	1.0314	756432	0.0200	179273	1.113E-07	4.39
155	60.12	1.0412	847614	0.0196	191433	1.025E-07	4.30
	61.50	1.0510	947865				

Table A45

Fatigue Crack Growth Rate Data Associated with Figure A15

AUTOMATED FATIGUE CRACK GROWTH RATE ANALYSIS

Specimen Id.	G89TL1EG	Geometry	CT
Contract #	AFCO-OP	Orientation	TL
Material	8090-T651	Yield (ksi)	57.9
Temperature (F)	84	Modulus	11.4
Environment	91-98% RH		

Specimen Dimensions (in)

Thickness	0.237	Notch depth	0.805
Width	2.000	Gage length	0.200
Height	1.200	Alpha ratio	1.250

Precrack Parameters

Pmax (lbs)	146.0	Stress ratio (R)	0.10
Final a (in)	1.059	Kmax	4.62

Test Parameters

Initial a (in)	1.059	Initial K	5.07
K-gradient	3.00	Stress ratio (R)	0.10

K Coeff	EvB/P Coeff
0.886000	1.000980
4.640000	-4.669510
-13.320000	18.460100
14.720000	-236.824997
-5.600000	1214.880000
0.000000	-2143.570100

Analysis Codes: KRP Z 0

Visual Observations

EvB/P	Crack (EvB/P)	Crack (visual)	Error	CAF

Comments

Date of test: 11-17-1989

Specimen Id. G89TL1EG Page 1

Pmax (lbs)	E_{48}/P	a (in)	N (X1)	Δa (in)	ΔN (X1)	Δa/ΔN (in/cyc)	ΔK (ksi√in)
	65.83	1.0800	85856				
167	67.41	1.0900	144784	0.0201	109642	1.834E-07	5.01
169	69.09	1.1001	195497	0.0203	91400	2.218E-07	5.16
171	70.81	1.1102	236184	0.0201	73078	2.757E-07	5.32
173	72.58	1.1203	268576	0.0199	58197	3.422E-07	5.48
176	74.38	1.1302	294381	0.0206	46513	4.435E-07	5.66
178	76.42	1.1409	315088	0.0212	36397	5.833E-07	5.83
180	78.47	1.1514	330779	0.0199	26982	7.367E-07	6.01
182	80.39	1.1608	342070	0.0195	20827	9.386E-07	6.20
184	82.53	1.1709	351605	0.0201	17288	1.164E-06	6.38
186	84.72	1.1809	359358	0.0197	14211	1.385E-06	6.58
188	86.93	1.1906	365816	0.0205	12267	1.673E-06	6.79
190	89.49	1.2014	371625	0.0210	10475	2.008E-06	6.99
192	92.01	1.2117	376291	0.0198	8418	2.354E-06	7.21
194	94.47	1.2213	380043	0.0190	7074	2.691E-06	7.42
196	96.98	1.2307	383365	0.0198	6639	2.989E-06	7.65
198	99.87	1.2411	386682	0.0208	6306	3.294E-06	7.88
200	102.86	1.2515	389671	0.0204	5518	3.696E-06	8.13
201	105.89	1.2615	392200	0.0199	4802	4.137E-06	8.38
203	108.99	1.2713	394473	0.0196	4308	4.555E-06	8.63
205	112.20	1.2811	396508	0.0197	3871	5.097E-06	8.89
206	115.61	1.2910	398344	0.0198	3494	5.668E-06	9.15
208	119.14	1.3009	400001	0.0197	3152	6.238E-06	9.43
209	122.80	1.3107	401496	0.0196	2841	6.907E-06	9.71
211	126.65	1.3205	402843	0.0202	2619	7.712E-06	10.01
212	130.90	1.3309	404115	0.0209	2426	8.632E-06	10.32
213	135.46	1.3415	405269	0.0204	2152	9.466E-06	10.64
215	139.89	1.3513	406267	0.0198	1906	1.039E-05	10.97
216	144.64	1.3613	407175	0.0198	1718	1.154E-05	11.30
217	149.52	1.3711	407984	0.0198	1530	1.293E-05	11.64
218	154.75	1.3811	408705	0.0199	1345	1.476E-05	11.99
219	160.19	1.3909	409329	0.0199	1154	1.723E-05	12.36
219	166.00	1.4010	409860	0.0201	977	2.054E-05	12.73
220	172.16	1.4110	410307	0.0205	818	2.507E-05	13.13
221	178.92	1.4215	410678	0.0199	688	2.891E-05	13.52
221	185.36	1.4309	410994	0.0194	600	3.230E-05	13.94
221	192.53	1.4408	411278	0.0202	545	3.712E-05	14.35
222	200.39	1.4511	411539	0.0204	507	4.027E-05	14.79
222	208.59	1.4612	411784	0.0199	432	4.609E-05	15.25
222	217.01	1.4710	411971	0.0191	341	5.620E-05	15.70
	225.51	1.4804	412125				

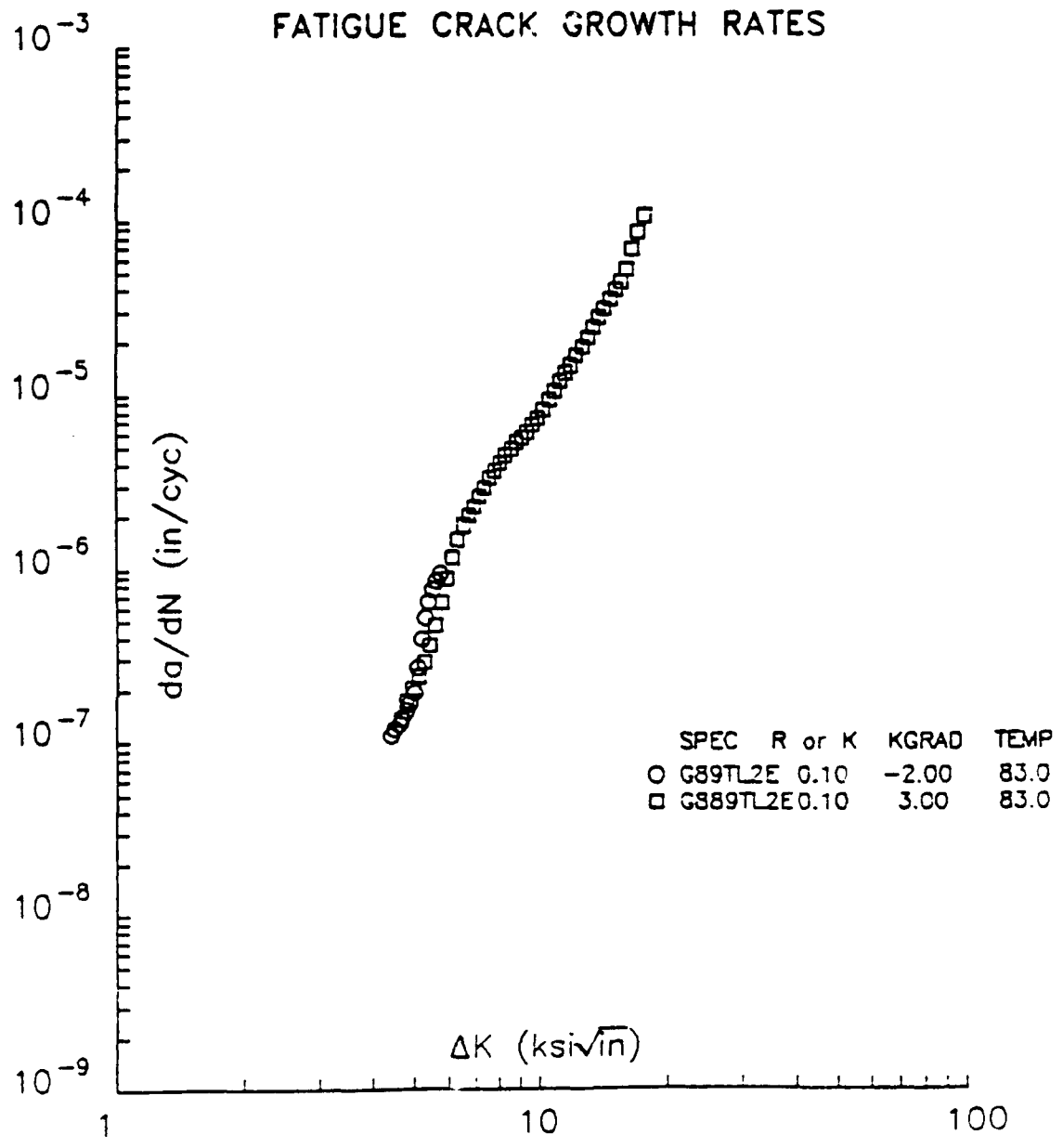

Figure A16. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). NASA-Langley.

Table A46

Fatigue Crack Growth Rate Data Associated with Figure A16

AUTOMATED FATIGUE CRACK GROWTH RATE ANALYSIS

Specimen Id.	G89TL2E	Geometry	CT
Contract #	AFCO-OP	Orientation	TL
Material	8090-T651	Yield (ksi)	57.9
Temperature (F)	83	Modulus	11.4
Environment	AIR 96-99%RH		

Specimen Dimensions (in)

Thickness	0.238	Notch depth	0.807
Width	2.000	Gage length	0.200
Height	1.200	Alpha ratio	1.250

Precrack Parameters

Pmax (lbs)	340.0	Stress ratio (R)	0.10
Final a (in)	0.871	Kmax	8.09

Test Parameters

Initial a (in)	0.807	Initial K	7.41
K-gradient	-2.00	Stress ratio (R)	0.10

K Coeff	EvB/P Coeff
0.886000	1.000980
4.640000	-4.669510
-13.320000	18.460100
14.720000	-236.824997
-5.600000	1214.880000
0.000000	-2143.570100

Analysis Codes: KRP 2 0

Visual Observations

EvB/P	Crack (EvB/P)	Crack (visual)	Error	CAF

Comments

Date of test: 12-14-1989

Specimen Id. G89TL2E Page 1

Pmax (lbs)	EvB/P	a (in)	N (K1)	Δa (in)	ΔN (K1)	Δa/ΔN (in/cyc)	ΔK (ksi√in)
	41.91	0.8736	43738				
263	42.66	0.8823	52701	0.0187	19962	9.392E-07	5.72
255	43.54	0.8923	63700	0.0199	23377	8.531E-07	5.62
246	44.45	0.9022	76077	0.0200	26370	7.585E-07	5.51
238	45.39	0.9123	90069	0.0201	30917	6.493E-07	5.40
230	46.34	0.9223	106994	0.0201	38429	5.234E-07	5.29
222	47.34	0.9324	128498	0.0205	52053	3.948E-07	5.18
215	48.40	0.9429	159047	0.0198	73948	2.683E-07	5.08
207	49.38	0.9523	202446	0.0191	98717	1.940E-07	4.98
200	50.43	0.9620	257764	0.0199	118375	1.683E-07	4.88
194	51.55	0.9722	320822	0.0204	132677	1.534E-07	4.79
187	52.71	0.9824	390442	0.0201	146090	1.379E-07	4.69
180	53.87	0.9923	466911	0.0200	157316	1.268E-07	4.60
174	55.08	1.0023	547758	0.0201	168814	1.190E-07	4.51
168	56.34	1.0124	635725	0.0202	184498	1.092E-07	4.42
	57.62	1.0225	732256				

Table A47

Fatigue Crack Growth Rate Data Associated with Figure A16

AUTOMATED FATIGUE CRACK GROWTH RATE ANALYSIS

Specimen Id.	G889TL2E	Geometry	CT
Contract #	AFCO-OP	Orientation	TL
Material	8090-T651	Yield (ksi)	57.9
Temperature (F)	83	Modulus	11.4
Environment	AIR 96-98%RH		

Specimen Dimensions (in)

Thickness	0.238	Notch depth	0.807
Width	2.000	Gage length	0.200
Height	1.200	Alpha ratio	1.250

Precrack Parameters

Pmax (lbs)	160.0	Stress ratio (R)	0.10
Final a (in)	1.027	Kmax	4.78

Test Parameters

Initial a (in)	1.027	Initial K	4.78
K-gradient	3.00	Stress ratio (R)	0.10

K Coeff	EvB/P Coeff
0.8116000	1.000900
4.6..0000	-4.669510
-13.320000	18.460130
14.720000	-236.824997
-5.600000	1214.880000
0.000000	-2143.570100

Analysis Codes

KRP 2 0

Visual Observations

EvB/P	Crack (EvB/P)	Crack (visual)	Error	CAF

Comments

Date of test: 12-15-1989

Specimen Id. G889TL2E Page 1

Pmax (lbs)	E48/P	a (in)	N (X1)	Δa (in)	ΔN (X1)	Δa/ΔN (in/cyc)	ΔK (ksi√in)
	60.41	1.0432	100470				
166	61.79	1.0529	181957	0.0198	145375	1.361E-07	4.66
168	63.25	1.0630	245845	0.0203	116988	1.737E-07	4.80
170	64.80	1.0732	298944	0.0205	99307	2.062E-07	4.95
173	66.39	1.0835	345152	0.0207	86157	2.402E-07	5.10
175	68.07	1.0939	385101	0.0204	70335	2.902E-07	5.26
177	69.73	1.1039	415487	0.0199	54699	3.636E-07	5.42
180	71.45	1.1138	439800	0.0203	43003	4.728E-07	5.59
182	73.31	1.1242	458490	0.0202	31595	6.387E-07	5.76
184	75.12	1.1340	471395	0.0204	23227	8.771E-07	5.94
186	77.15	1.1446	481717	0.0210	18065	1.165E-06	6.13
189	79.23	1.1550	489460	0.0198	13424	1.477E-06	6.31
191	81.17	1.1644	495141	0.0193	10924	1.771E-06	6.51
193	83.31	1.1744	500384	0.0199	9855	2.016E-06	6.70
195	85.50	1.1843	504996	0.0194	8473	2.284E-06	6.90
197	87.69	1.1937	508857	0.0197	7584	2.601E-06	7.11
199	90.14	1.2040	512580	0.0202	6887	2.940E-06	7.32
201	92.63	1.2140	515744	0.0198	5966	3.325E-06	7.54
203	95.18	1.2238	518548	0.0202	5460	3.699E-06	7.78
205	97.97	1.2342	521203	0.0201	4937	4.075E-06	8.01
207	100.72	1.2440	523485	0.0193	4301	4.498E-06	8.25
209	103.52	1.2535	525504	0.0196	4011	4.894E-06	8.50
211	106.58	1.2636	527495	0.0207	3893	5.306E-06	8.76
212	109.95	1.2742	529398	0.0204	3625	5.632E-06	9.03
214	113.22	1.2840	531120	0.0198	3281	6.046E-06	9.31
216	116.70	1.2940	532679	0.0199	2968	6.711E-06	9.59
217	120.30	1.3039	534088	0.0197	2688	7.328E-06	9.88
219	124.01	1.3137	535367	0.0199	2438	8.152E-06	10.18
220	128.02	1.3238	536526	0.0202	2187	9.232E-06	10.49
222	132.23	1.3339	537554	0.0202	1938	1.043E-05	10.81
223	136.64	1.3440	538464	0.0199	1682	1.182E-05	11.14
224	141.12	1.3539	539236	0.0198	1522	1.298E-05	11.48
225	145.92	1.3638	539986	0.0207	1442	1.438E-05	11.84
226	151.36	1.3745	540678	0.0202	1228	1.643E-05	12.19
227	156.38	1.3839	541214	0.0190	1027	1.845E-05	12.56
228	161.71	1.3935	541705	0.0197	944	2.084E-05	12.94
229	167.68	1.4036	542158	0.0207	862	2.401E-05	13.33
230	174.26	1.4142	542567	0.0205	751	2.726E-05	13.74
230	180.76	1.4241	542908	0.0199	652	3.050E-05	14.17
231	187.72	1.4341	543220	0.0207	596	3.475E-05	14.61
231	195.60	1.4448	543504	0.0203	511	3.964E-05	15.05
231	203.05	1.4543	543730	0.0185	426	4.346E-05	15.50
231	210.44	1.4633	543930	0.0191	370	5.164E-05	15.96
231	219.27	1.4734	544100	0.0207	305	6.781E-05	16.44
231	229.07	1.4840	544235	0.0215	253	8.520E-05	16.97
231	239.97	1.4950	544353	0.0220	210	1.052E-04	17.53
	251.72	1.5060	544445				

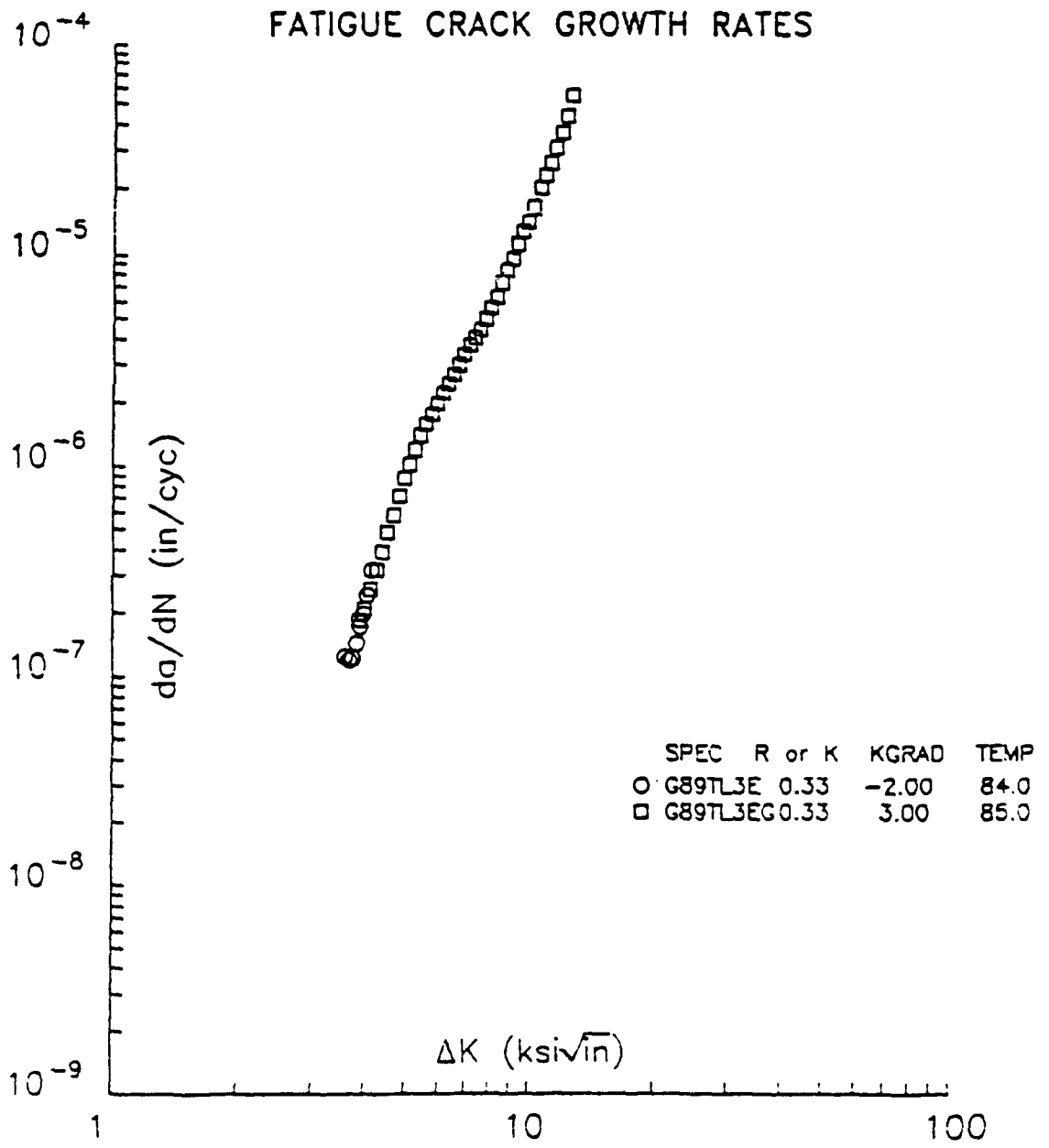

Figure A17. Fatigue Crack Growth Rate Data for Alcan 8090-T651 1" x 4" Extrusion (T-L Orientation). NASA-Langley.

Table A48

Fatigue Crack Growth Rate Data Associated with Figure A17

AUTOMATED FATIGUE CRACK GROWTH RATE ANALYSIS

Specimen Id.	G89TL3E	Geometry	CT
Contract #	AFCO-OP	Orientation	TL
Material	8090-T651	Yield (ksi)	57.9
Temperature (F)	84	Modulus	11.4
Environment	AIR 93-98%RH		

Specimen Dimensions (in)

Thickness	0.238	Notch depth	0.808
Width	2.000	Gage length	0.200
Height	1.200	Alpha ratio	1.250

Precrack Parameters

Pmax (lbs)	330.0	Stress ratio (R)	0.33
Final a (in)	0.873	Kmax	7.87

Test Parameters

Initial a (in)	0.808	Initial K	7.21
K-gradient	-2.00	Stress ratio (R)	0.33

K Coeff	Ev8/P Coeff
0.886000	1.000930
4.640000	-4.669510
-13.320000	18.460100
14.720000	-236.824997
-5.600000	1214.880000
0.000000	-2143.570100

Analysis Codes
KRP 2 0

Visual Observations

Ev8/P	Crack (Ev8/P)	Crack (visual)	Error	CAF

Comments

Date of test: 11-25-1989

Specimen Id. G89TL3E Page 1

Pmax (lbs)	Ev8/P	a (in)	N (X1)	Δa (in)	ΔN (X1)	Δa/ΔN (in/cyc)	ΔK (ksi√in)
	41.99	0.8747	108038				
256	42.72	0.8830	130795	0.0184	57796	3.180E-07	4.15
248	43.60	0.8931	165835	0.0197	80844	2.443E-07	4.07
239	44.49	0.9028	211639	0.0198	99969	1.977E-07	3.99
232	45.42	0.9128	265803	0.0200	116390	1.721E-07	3.91
224	46.38	0.9228	328029	0.0200	139696	1.435E-07	3.83
216	47.38	0.9329	405499	0.0199	163790	1.216E-07	3.76
209	48.38	0.9427	491819	0.0200	169002	1.185E-07	3.68
202	49.44	0.9529	574501	0.0203	165369	1.225E-07	3.61
	50.52	0.9630	657187				

Table A49

Fatigue Crack Growth Rate Data Associated with Figure A17

AUTOMATED FATIGUE CRACK GROWTH RATE ANALYSIS

Specimen Id.	G89TL3EG	Geometry	CT
Contract #	AFCO-OP	Orientation	TL
Material	8090-T651	Yield (ksi)	57.9
Temperature (F)	85	Modulus	11.4
Environment	AIR 91-98%RH		

Specimen Dimensions (in)

Thickness	0.238	Notch depth	0.808
Width	2.000	Gage length	0.200
Height	1.200	Alpha ratio	1.250

Precrack Parameters

Pmax (lbs)	191.0	Stress ratio (R)	0.33
Final a (in)	0.969	Kmax	5.23

Test Parameters

Initial a (in)	0.957	Initial K	5.22
K-gradient	3.00	Stress ratio (R)	0.33

K Coeff	EvB/P Coeff
0.886000	1.000980
4.640000	-4.669510
-13.320000	18.460100
14.720000	-236.824997
-5.600000	1214.880000
0.000000	-2143.570100

Analysis Codes: KRP 2 0

Visual Observations

EvB/P	Crack (EvB/P)	Crack (visual)	Error	CAF

Comments

Date of test: 12-08-1989

Specimen Id. G89TL3EG Page 1

Pmax (lbs)	EB/P	a (in)	N (Kl)	Δa (in)	ΔN (Kl)	Δa/ΔN (in/cyc)	ΔK (ksi√in)
	52.74	0.9827	44566				
205	53.94	0.9930	101306	0.0200	108138	1.845E-07	3.89
208	55.11	1.0027	152705	0.0200	95372	2.094E-07	4.01
211	56.40	1.0130	196678	0.0206	79435	2.591E-07	4.13
214	57.71	1.0233	232140	0.0204	64443	3.171E-07	4.26
217	59.06	1.0334	261122	0.0204	52181	3.902E-07	4.39
220	60.46	1.0436	284321	0.0202	41764	4.833E-07	4.53
223	61.87	1.0536	302886	0.0201	34255	5.855E-07	4.67
226	63.34	1.0637	318576	0.0204	28412	7.189E-07	4.81
229	64.90	1.0740	331298	0.0199	22787	8.735E-07	4.96
232	66.39	1.0836	341362	0.0194	19081	1.018E-06	5.11
235	67.98	1.0935	350379	0.0199	16650	1.194E-06	5.26
238	69.64	1.1035	358013	0.0202	14444	1.396E-06	5.42
241	71.40	1.1136	364824	0.0205	12966	1.584E-06	5.59
244	73.25	1.1240	370978	0.0200	11351	1.760E-06	5.76
247	75.02	1.1336	376175	0.0194	9842	1.972E-06	5.93
250	76.90	1.1434	380820	0.0201	9013	2.233E-06	6.12
253	78.95	1.1537	385188	0.0205	8299	2.472E-06	6.30
256	81.04	1.1639	389119	0.0198	7274	2.727E-06	6.49
259	83.11	1.1736	392462	0.0194	6366	3.048E-06	6.69
262	85.26	1.1833	395485	0.0200	5882	3.401E-06	6.89
265	87.62	1.1936	398344	0.0205	5434	3.767E-06	7.10
267	90.06	1.2038	400919	0.0200	4875	4.094E-06	7.32
270	92.49	1.2135	403218	0.0202	4493	4.494E-06	7.55
273	95.19	1.2240	405411	0.0204	4056	5.039E-06	7.78
276	97.88	1.2340	407274	0.0197	3500	5.623E-06	8.01
278	100.60	1.2437	408911	0.0198	3121	6.332E-06	8.26
281	103.54	1.2537	410394	0.0203	2754	7.378E-06	8.51
283	106.67	1.2640	411665	0.0200	2358	8.473E-06	8.77
286	109.76	1.2737	412752	0.0196	2022	9.676E-06	9.03
288	113.02	1.2835	413686	0.0199	1741	1.145E-05	9.31
290	116.52	1.2936	414494	0.0199	1526	1.305E-05	9.58
292	120.08	1.3035	415212	0.0198	1375	1.443E-05	9.88
294	123.87	1.3135	415869	0.0200	1186	1.690E-05	10.18
296	127.84	1.3235	416398	0.0205	989	2.075E-05	10.50
298	132.21	1.3340	416858	0.0206	864	2.387E-05	10.82
300	136.63	1.3441	417262	0.0200	735	2.716E-05	11.15
302	141.14	1.3540	417593	0.0195	610	3.200E-05	11.49
303	145.79	1.3636	417872	0.0193	513	3.766E-05	11.83
304	150.66	1.3733	418106	0.0198	441	4.501E-05	12.19
306	156.06	1.3835	418313	0.0202	357	5.640E-05	12.55
	161.62	1.3935	418463				

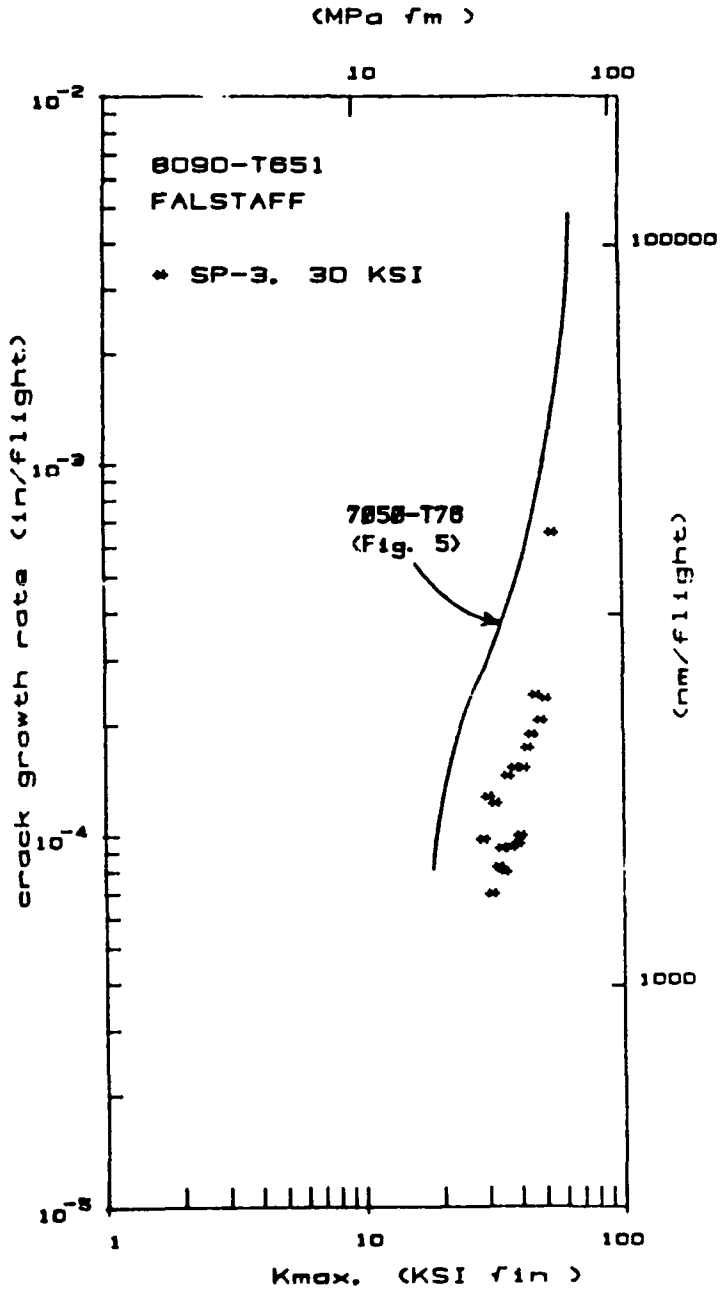

Figure A18 FALSTAFF Spectrum Results for 8090-T651 Extrusion. Reduced in Terms of Growth Rate and Maximum Spectrum Stress Intensity.

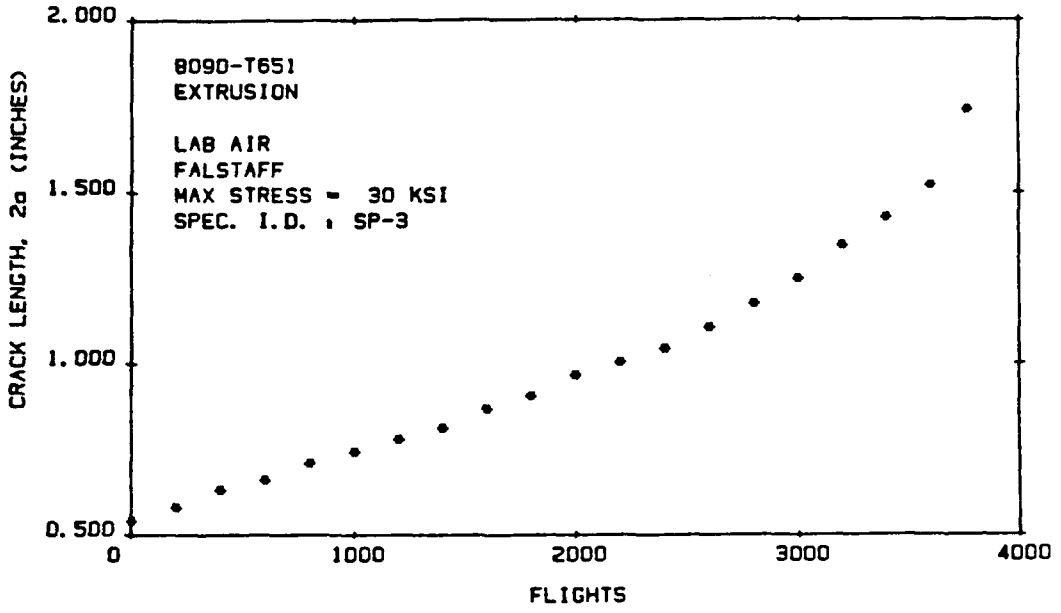

Figure A19 Crack Length Versus Flights for 8090-T651 Extrusion Under FALSTAFF Loading, Max Stress=30 KSI.

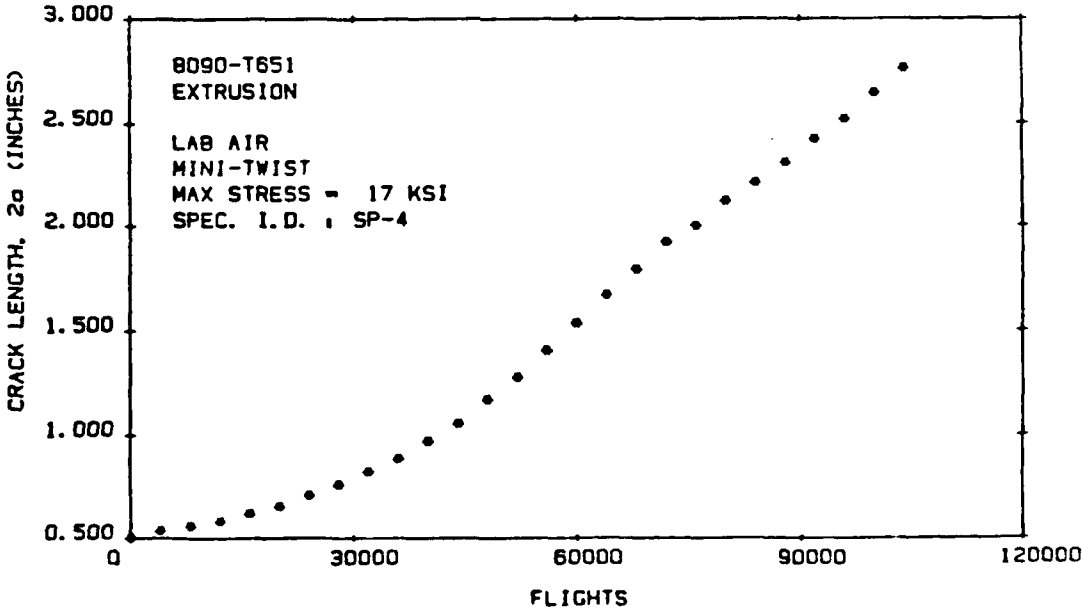

Figure A20 Crack Length Versus Flights for 8090-T651 Extrusion Under Mini-TWIST Loading, Max Stress=17 KSI.

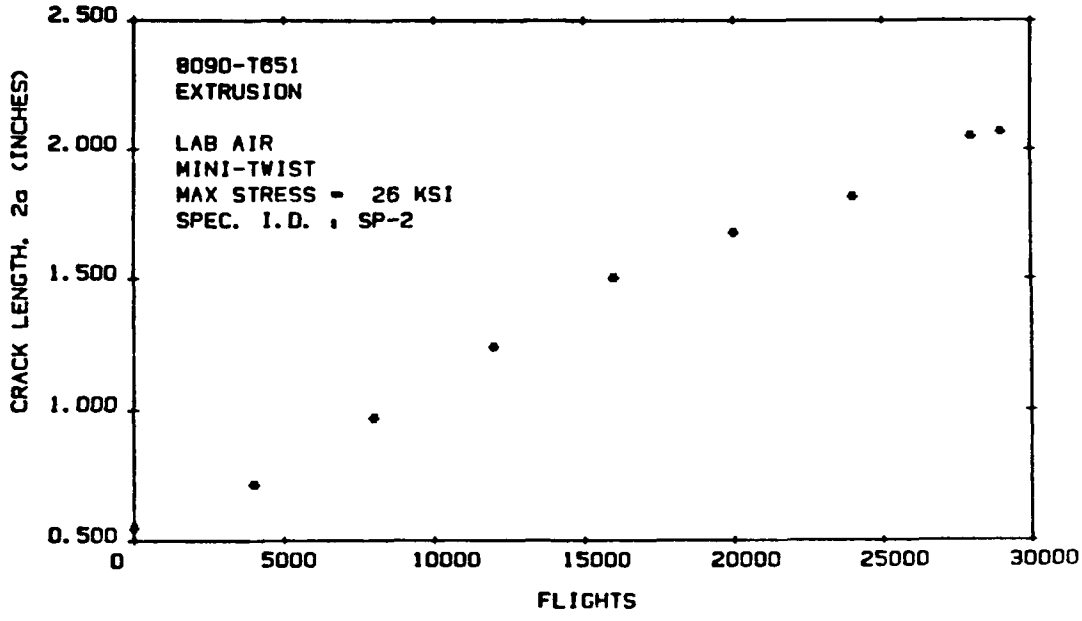

Figure A21 Crack Length Versus Flights for 8090-T651 Extrusion Under Mini-TWIST Loading, Max Stress=26 KSI.

U.S. Government Printing Office 548-