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VOLUME I

AIR FORCE WRIGHT AERONAUTICAL LABORATORIES

A USER'S MANUAL FOR A DETAILED LEVEL FATIGUE CRACK GROWTH ANALYSIS COMPUTER CODE, VOLUME I — THE CRKGRO PROGRAM

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This report presents the description of a computer program which was developed to perform detailed fatigue crack-growth analysis on a cycle-by-cycle basis. This program is a two-dimensional crack-growth computer routine. An improved load interaction model which accounts for both the retardation and acceleration effects of the spectrum loading was implemented in the program. This program contains a crack library which consists of 10 subroutines, each

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) containing a specific stress intensity factor solution for a specific crack geometry. The program provides the option for counting the cycles for spectrum loadings through the range-pair counting routine built into the program. It also provides the option to perform parametric studies.

FOREWORD

This report presents the description of a computer code which was developed to perform detailed fatigue crack-growth analysis on a cycle-by-cycle basis. This computer code is a two-dimensional crack-growth analysis routine. An improved load interaction model which accounts for both the tensile overload retardation and compressive load acceleration effects of a spectrum loading has been implemented in this program. The development effort of this computer code was under Air Force Contract F33615-77-C-3121, Project 2401, "Structural Mechanics," Task 240101, "Structural Integrity for Military Aerospace Vehicles," Work Unit 24010120, entitled "Improved Methods for Predicting Spectrum Loading Effects." This contract was administrated by the Flight Dynamics Laboratory of the Air Force Wright Aeronautical Laboratories, Wright-Patterson Air Force Base, Ohio. R.M. Engle (AFWAL/FIBE) was the Air Force project engineer

This development effort was conducted by personnel from the Fatigue and Fracture Mechanics Group, Dynamics Technology, Structure Systems, under the direction of George Fitch, Jr., supervisor, Joseph S. Rosenthal, manager, and Dr. Leslie M. Lackman, director. James B. Chang was the program manager and principal investigator. Edward Klein was the original developer of this computer code.

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Section I

INTRODUCTION

This document describes a computer program which was developed to perform detailed fatigue crack growth analysis on a cycle-by-cycle basis. The fatigue crack growth prediction method incorporated in this computer code is an improved methodology based on state-of-the-art technologies. The development effort and correlation of the analytical predictions to the test data were documented in reference 1.

The baseline fatigue crack growth rate equation chosen in the program was the modified Walker equation (reference 2) with variable threshold stress intensity factor range. The generalized Willenborg retardation model (reference 3) and the Chang acceleration scheme (reference 4) were selected to handle the complex load interaction effects in a spectrum loading which include tensile overload retardation, and faster crack growth caused by the existence of the compressive load in compression-tension (negative stress ratio) cycles.

Reduction of the overload retardation effect when the overload is followed by a compression load is also accounted for using a reduction of the effective overload plastic zone size approach formulated by Chang (reference 1). The linear approximation method proposed by Vroman which was widely used in existing computer programs such as EFFGRO (reference 5) and CRACKS (reference 6) was adopted as the damage accumulation scheme. To account for the shape-change effect of a part-through crack (PTC), such as the surface flaw and a single corner crack at a fastener hole, the two-dimension (2-D) crack growth analysis approach used by many existing crack growth codes, including Rockwell's FLAGRO (reference 7) and NASA's CRACK (reference 8), was adopted in this computer program. The 2-D crack-growth-analysis approach assumes that growth in the two principal directions of a part-through crack is a function of the stress intensity factors at the extreme points in each direction. The CRKGRO program also provides the 1-D crack-growth-analysis option for the part-through cracks.

A collection of stress-intensity-factor solutions for various through-crack (TC) and PTC configurations has been incorporated into this program through a CRACK LIBRARY module which consists of 10 subroutines, each containing a specific stress-intensity-factor solution for a specific crack geometry. There are eight additional dummy routines stored in the program, which provides the user the capability for adding new stress-intensity-factor solutions for the crack geometries needed to be considered.

The program provides the option for counting the cycles for spectrum loadings through the range-pair counting routine built into the program. The program also provides the option to perform parametric studies on parameters which dominate the degree of damage such as the design limit stresses.

The CRKGRO program also provides four options for presenting the crack growth history in graphical plotting format. These options are (1) crack size versus number of flights, a versus N, (2) crack growth rates versus number of flights, da/dF versus N, (3) crack growth rate versus crack sizes, da/dF versus a, and (4) crack growth rate versus the maximum stress intensity factor per flight, da/dF versus K_{max}. For a parametric study, a maximum of seven curves can be plotted on one chart in order to provide the user a clear picture.

Section II

TECHNICAL DISCUSSION

The technical approach used in this computer program is applicable primarily for metallic structures which contain cracks or crack-like flaws subjected to cyclic loadings. The crack growth analysis methodology was developed based on linear elastic fracture mechanics (LEFM) principles; i.e., the range of crack-tip stress intensity factor, ΔK, is the controlling parameter for characterizing the cyclic crack growth rates.

This section includes a discussion of each of the following elements which form the overall analysis methodology incorporated in the program: fatigue crack-growth-rate equation, load interaction model, damage accumulation scheme, and stress-intensity-factor solutions.

FATIGUE CRACK-GROWTH-RATE EQUATION

For constant-amplitude loadings, the baseline fatigue crack-growth-rate equations used in this program are the modified Walker equation (reference 2) for positive stress ratios and the Chang equation (reference 4) for negative stress ratios. In mathematical forms, they can be expressed as follows:

For $\Delta K > \Delta K_{th}$, $R \geq 0$

$$da/dN = C\ [\Delta K/(1-\bar{R})^{1-m}]^n, \qquad \bar{R} \leq R^+_{cut},\ \bar{R} = R$$
$$\bar{R} > R^+_{cut},\ \bar{R} = R^+_{cut}$$

For $\Delta K > \Delta K_{th}$, $R < 0$

$$da/dN = C\ [(1 + \bar{R}^{\,2})^q\ K_{max}]^n, \qquad \bar{R} \geq R^-_{cut},\ \bar{R} = R$$
$$\bar{R} < R^-_{cut},\ \bar{R} = R^-_{cut}$$

For $\Delta K \leq \Delta K_{th}$

$$da/dN = 0$$

where C and n are the growth rate constants; m is the stress-ratio collapsing factor, q is the acceleration exponent, and $R^{\pm}_{cut}$ are the cutoff values for the stress ratios, either positive or negative.

The threshold stress-intensity-factor range ΔK_{th} is determined by

$$\Delta K_{th} = (1 - AR)\,\Delta K_{th_o}$$

where ΔK_{th_o} is the threshold value of the stress-intensity-factor range obtained from $R = 0$ constant amplitude tests; A is an empirical constant determined from constant-amplitude test data with various stress ratios.

A detailed description on the procedure for the determination of the crack-growth-rate constants is in Appendix A.

LOAD INTERACTION MODEL

Various load interaction effects on the crack growth behavior under spectrum loadings have been observed. The important effects are:

1. Tensile overloads cause significant retardation of the crack growth.

2. Compressive loads accelerate crack growth rates. Furthermore, a compressive load immediately following the tensile overload reduces the retardation effect introduced by the tensile overload.

TENSILE OVERLOAD RETARDATION MODEL

To account for the retardation effect, the generalized Willenborg model (reference 3) is adopted in this program. The generalized Willenborg model can be written in the following form:

$$(K_{max})_{eff} = K_{\infty_{max}} - \Phi\left[K_{max}^{oL}\left(1 - \frac{\Delta a}{Z_{oL}}\right)^{1/2} - K_{\infty_{max}}\right]$$

$$(K_{min})_{eff} = K_{\infty_{min}} - \Phi\left[K_{max}^{oL}\left(1 - \frac{\Delta a}{Z_{oL}}\right)^{1/2} - K_{\infty_{max}}\right]$$

$$\Phi = \left[1 - \left(K_{max_{TH}} \Big/ K_{\infty_{max}}\right)\right] \Big/ (R_{SO} - 1)$$

where $K_{\infty_{max}}$ is the stress-intensity-factor corresponding to the maximum remotely applied stress, K_{max}^{oL} is the stress-intensity-factor corresponding to the maximum stress of the overload, Δa is the incremental growth following the overload, Z_{oL} is the overload interaction zone size. R_{SO} is the overload shutoff ratio which is defined as:

$$R_{SO} = K_{max}^{oL} / K_{\infty_{max}}$$

For spectrum loading, the effective stress-intensity-factor range and effective stress ratio which are used in CRKGRO, are expressed in terms of the maximum and minimum effective stress intensity factors as follows:

$$\Delta K_{eff} = (K_{max})_{eff} - (K_{min})_{eff}$$

$$R_{eff} = (K_{min})_{eff} / (K_{max})_{eff}$$

In the load-interaction-accounted-for option, the program utilizes the following equation to account for tensile overload retardation effect:

For $\Delta K_{eff} > \Delta K_{th}$, $R_{eff} \geq 0$

$$da/dN = C[(\Delta K)_{eff}/(1 - \bar{R}_{eff})^{1-m}]^n \quad , \bar{R}_{eff} \leq R^{+}_{cut}, \bar{R}_{eff} = R_{eff}$$

$$\bar{R}_{eff} > R^{+}_{cut}, \bar{R}_{eff} = R^{+}_{cut}$$

For $\Delta K_{eff} \leq \Delta K_{th}$

$$da/dN = 0$$

where C, n, m and $R^{\pm}_{cut}$ are the same crack-growth-rate parameters described under "Fatigue Crack-Growth-Rate Equation." The threshold values of the stress-intensity-factor range are also identical to those used in the constant-amplitude cases.

COMPRESSIVE LOAD ACCELERATION MODEL

If the effective stress ratio is negative; i.e., $R_{eff} < 0$, the Chang negative stress ratio equation is used in this program, which accounts for the compressive load acceleration effect:

$$da/dN = C[(1 + \bar{R}^2_{eff})^q (K_{max})_{eff}]^n, \bar{R}_{eff} \geq R^{-}_{cut}, \bar{R}_{eff} = R_{eff}$$

$$\bar{R}_{eff} < R^{-}_{cut}, \bar{R}_{eff} = R^{-}_{cut}$$

where q is the acceleration index determined from test data generated for a specific negative stress ratio (R < 0) and its R = 0 counterpart.

The reduction of the overload retardation effect caused by a compressive spike load immediately following the tensile overload is accounted for by CRKGRO through an effective overload interaction zone concept proposed by Chang (reference 1). The effective overload interactive zone is defined in terms of the negative effective stress ratio ($R_{eff} < 0$) as:

$$(Z_{oL})_{eff} = (1 + \bar{R}_{eff})\,(Z_{oL}),\quad \bar{R}_{eff} \geq R^{-}_{cut},\ \bar{R}_{eff} = R_{eff}$$

$$\bar{R}_{eff} < R^{-}_{cut},\ \bar{R}_{eff} = R^{-}_{cut}$$

where Z_{oL} is the plastic zone size introduced by the tensile overload.

In CRKGRO, the plane strain plastic zone size is used if the stress intensity factor at the maximum depth for a part-through crack is to be calculated. The plane stress plastic zone size is used at the length direction for TC's and PTC's. The plane stress and plane strain plastic zone sizes are:

$$(Z_{oL})_{\text{plane strain}} = \frac{1}{6\pi}\left(\frac{K_{\infty max}}{F_{ty}}\right)^2$$

$$(Z_{oL})_{\text{plane stress}} = \frac{1}{2\pi}\left(\frac{K_{\infty max}}{F_{ty}}\right)^2$$

where F_{ty} is the material tensile yield strength.

DAMAGE ACCUMULATION SCHEME

The Vroman linear approximation method has been incorporated into this computer program as the damage accumulation scheme. The following paragraphs briefly describe the method.

For a given load spectrum as shown in table 1, the Vroman damage accumulation scheme proceeds by considering a load step (i) and using σ_{max_i} and σ_{min_i} to calculate $(da/dN)_i$. The value of $(0.01a)/(da/dN)_i$ is then compared to N_i, where "a" is the instantaneous crack size. If $(0.01a)/(da/dN)_i$ is greater than N_i, then the crack growth for that particular load step is $\Delta a = N_i \times (da/dN)_i$, the crack has then grown from "a" to $(a + \Delta a)$, and the program proceeds to the next load step.

If $(0.01a)/(da/dN)_i$ is less than or equal to N_i, the crack size will be $(a + 0.01a)$, and this load step is reexamined. This process continues with $(0.01a)/(da/dN)_i$ being compared to the remaining cycles in the step. When all load steps in the block or flight have been examined, the program then proceeds to the first step of the next block (or flight) and continues.

TABLE 1. A TYPICAL STRESS SPECTRUM TABLE (SCHEMATIC)

Step	Max stress	Min stress	No. of cyc/ block (flight)
1	σ_{max_1}	σ_{min_1}	N_1
2	σ_{max_2}	σ_{min_2}	N_2
3	σ_{max_3}	σ_{min_3}	N_3
.	.	.	.
.	.	.	.
.	.	.	.
i	σ_{max_i}	σ_{min_i}	N_i

STRESS-INTENSITY-FACTOR SOLUTIONS

Two major types of crack geometry are considered in this program: TC and PTC. Crack-tip stress-intensity-factor solutions for commonly detected TC and PTC are incorporated into the CRACK LIBRARY module of this program. The CRACK LIBRARY module consists of separate subroutines, each containing one set of stress-intensity-factor solution.

For PTC's, this program accounts for the shape-change effects through the 2-D crack-growth-analysis approach. The 2-D crack-growth-analysis approach assumes that growth in the two principal directions of a PTC can be characterized by the stress-intensity-factors at the extreme points of each direction. In constant-amplitude loadings for example, the crack growth rates at the two extreme points, A and B, of a surface crack as shown in Figure 1 are calculated by CRKGRO using the following set of equations:

$$da/dN = C_A \left[\Delta K_A/(1 - R)^{1-m_A}\right]^{n_A}$$

$$dc/dN = C_B \left[\Delta K_B/(1 - R)^{1-m_B}\right]^{n_B}$$

where C_A, n_A, m_A and C_B, n_B, m_B are the material's crack-growth-rate parameters along the depth and the length directions, respectively; R is the cyclic stress ratio, and ΔK_A and ΔK_B are the stress-intensity-factor range at the maximum depth and length points, respectively.

The stress intensity factors at the maximum depth point A, and the maximum length point B built into CRKGRO are prepared using the compound solution format. In general, these can be expressed as:

$$K_A = \left[F_A\left(\frac{a}{t}, \frac{a}{c}, \frac{c}{b}\right)\right]\sigma\sqrt{\frac{\pi a}{Q}} \quad \text{at the maximum depth}$$

$$K_B = \left[F_B\left(\frac{a}{t}, \frac{a}{c}, \frac{c}{b} \quad \frac{a}{c}\right)\right]\sigma\sqrt{\frac{\pi c}{Q}} \quad \text{at the maximum length}$$

where a is the depth, c is the half-length for a surface crack, t is the thickness of the structure, b is the half-width of the structure, Q is the shape factor, and F_A and F_B are the geometrical magnification factors for the maximum depth point A and the maximum length point B as shown in Figure 1.

In CRKGRO, the geometrical magnification factors are in a polynomial format. For the surface crack shown in figure 1, the geometrical magnification factors are derived from the general surface crack stress-intensity-factor solution proposed by Newman (reference 9). At point B, the solution was derived from $\phi = 10°$ as suggested by Newman (Reference 12).

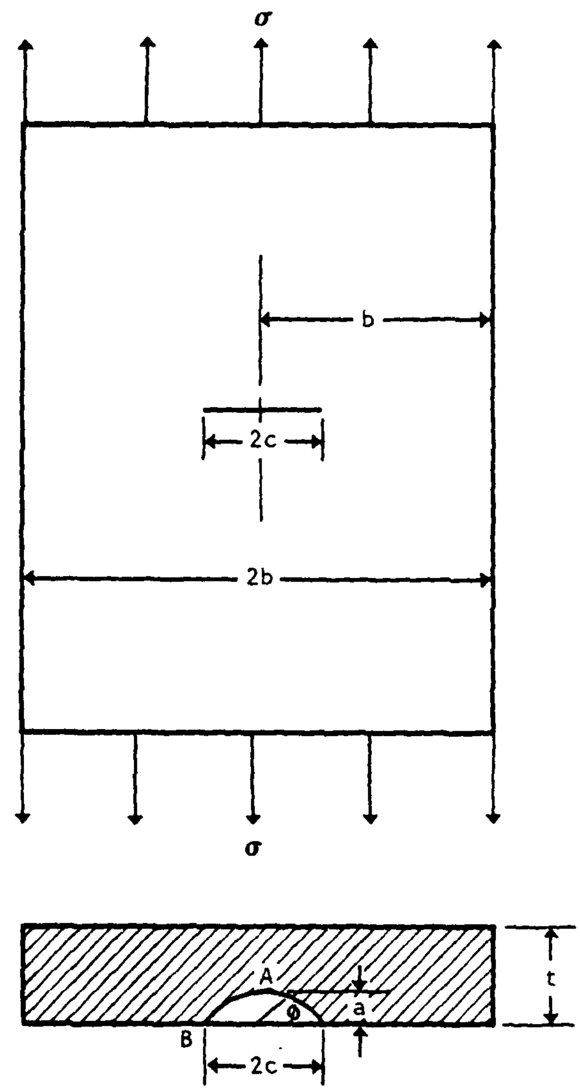


Figure 1. A Typical Surface Crack Configuration

At point A (ϕ = 90°)

$$F_A = \left\{1.13 - 0.09\ (a/c) + \left[\frac{0.89}{(0.2 + a/c)} - 0.54\right]\left(\frac{a}{t}\right)^2 + \left[0.5 - \frac{1}{(0.65 + a/c)} + 14\ (1 - a/c)^{24}\right]\left(\frac{a}{t}\right)^4\right\} \times \left[\sqrt{\sec\left(\frac{\pi c}{2b}\sqrt{\frac{a}{t}}\right)}\right]$$

At point B, (ϕ = 10°)

$$F_B = \left\{1.13 - 0.09(a/c) + \left[\frac{0.89}{(0.2 + a/c)} - 0.54\right]\left(\frac{a}{t}\right)^2 + \left[0.5 - \frac{1}{(0.65 + a/c)} + 14\ (1 - a/c)^{24}\right]\left(\frac{a}{t}\right)^4\right\} \times \left\{\left[1.1 + 0.35(a/t)^2\right]\left(\frac{a}{c}\right)\sqrt{\sec\left(\frac{\pi c}{2b}\sqrt{\frac{a}{t}}\right)}\right\}$$

The shape factor Q used in CRKGRO is also in a closed-form solution format which was formulated by Newman (reference 10) as:

$$Q = (1 + 1.464\ (a/c)^{1.65})$$

A collection of stress-intensity-factor solutions for various TC and PTC configurations has been incorporated into CRKGRO through a CRACK LIBRARY module which consists of separate subroutines, each containing one stress-intensity-factor solution. A crack code system is used in CRKGRO. Figure 2 shows the crack geometries with the corresponding assigned code number. For example, crack code 1010 is the surface flaw and 2010 is the centered TC. Each PTC subroutine has two sets of solutions, K_A and K_B. The stress intensity factor for a shallow crack ($a/c \leq 1$) and for a deep crack ($a/c > 1$) are included in the same subroutine. Ten stress-intensity-factor solutions have been incorporated in the CRACK LIBRARY module. Appendix B contains these solutions.

For part-through cracks, the CRKGRO program also provides the one-dimensional (1-D) crack growth analysis options. For the 1-D option, only the stress intensity factor at the maximum depth of a PTC is calculated. The aspect ratio ($a/_{2c}$) is assumed to be constant through the whole period of the growth of the PTC, i.e., the shape change of a PTC is not accounted for in the crack growth analysis.

The 1-D stress intensity factor solutions for various part-through cracks such as the surface crack, the edge corner crack, are presented also in Appendix B. These solutions are somewhat different than its 2-D option counterpart due to the fact that the shape change effect is not accounted for in the 1-D option, they were formulated using the compound solution technique with the average value using for geometry correction factor.

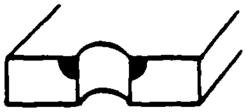
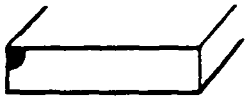
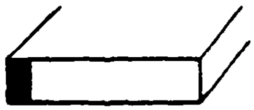
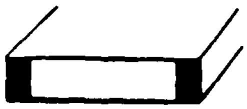
CODE NO.	DESCRIPTION	GEOMETRY
1010	SURFACE CRACK, CENTERED	
1030	ONE CORNER CRACK FROM CENTERED OPEN HOLE	
1050	TWO CORNER CRACKS FROM CENTERED OPEN HOLE	
1070	ONE CORNER EDGE CRACK	
2010	THROUGH-CRACK, CENTERED	
2020	ONE THROUGH-CRACK FROM CENTERED OPEN HOLE	
2030	TWO THROUGH-CRACKS FROM CENTERED OPEN HOLE	
2040	ONE THROUGH-EDGE CRACK	
2050	TWO THROUGH-EDGE CRACKS	
2060	ASTM COMPACT SPECIMEN	

Figure 2. Crack Library

Section III

PROGRAM OUTLINES

This computer code is called a detail crack growth analysis program and its identification is CRKGRO. A program flowchart is shown in figure 3. CRKGRO consists of 34 subroutines, of which 18 are basic to the stress-intensity-factor calculations identified as the CRACK LIBRARY. Currently, 10 stress-intensity-factor solutions have been incorporated into CRKGRO. Appendix B shows these 10 stress-intensity-factor solutions. The other eight subroutines are the dummy subroutines, in which a new stress-intensity-factor solution can be coded into the program.

1. CRKGRO - overall supervisory routine
2. CENTER - centers titles with assigned fields
3. CICON - converts characters to binary
4. CMBCD - moves BCD characters from one FORTRAN array to another
5. COCEN - converts binary to characters
6. CRIT - computes the critical crack length without growing the crack
7. CYCCNT - performs range-pair counting of the spectrum
8. GROW - supervisory crack growth routine
9. GETDAT - gets control card information
10. INPUT - reads the input data, consisting of the crack-growth-rate equation and load interaction model parameters, material and geometric constants, spectrum input, and output controls
11. LIBBD - provides titles for crack library; i.e., stress-intensity-factor solutions
12. NEWLFN - changes file name in FIT for versatile file number input when spectra are stored.
13. NUMBER - converts a character to an integer
14. OUTPUT - prints the echo of the input data and control printout options

15. PLOT - plots the grid, labeling, and data points for subroutine PTPARM

16. PTPARM - directs plotting of crack growth analysis results

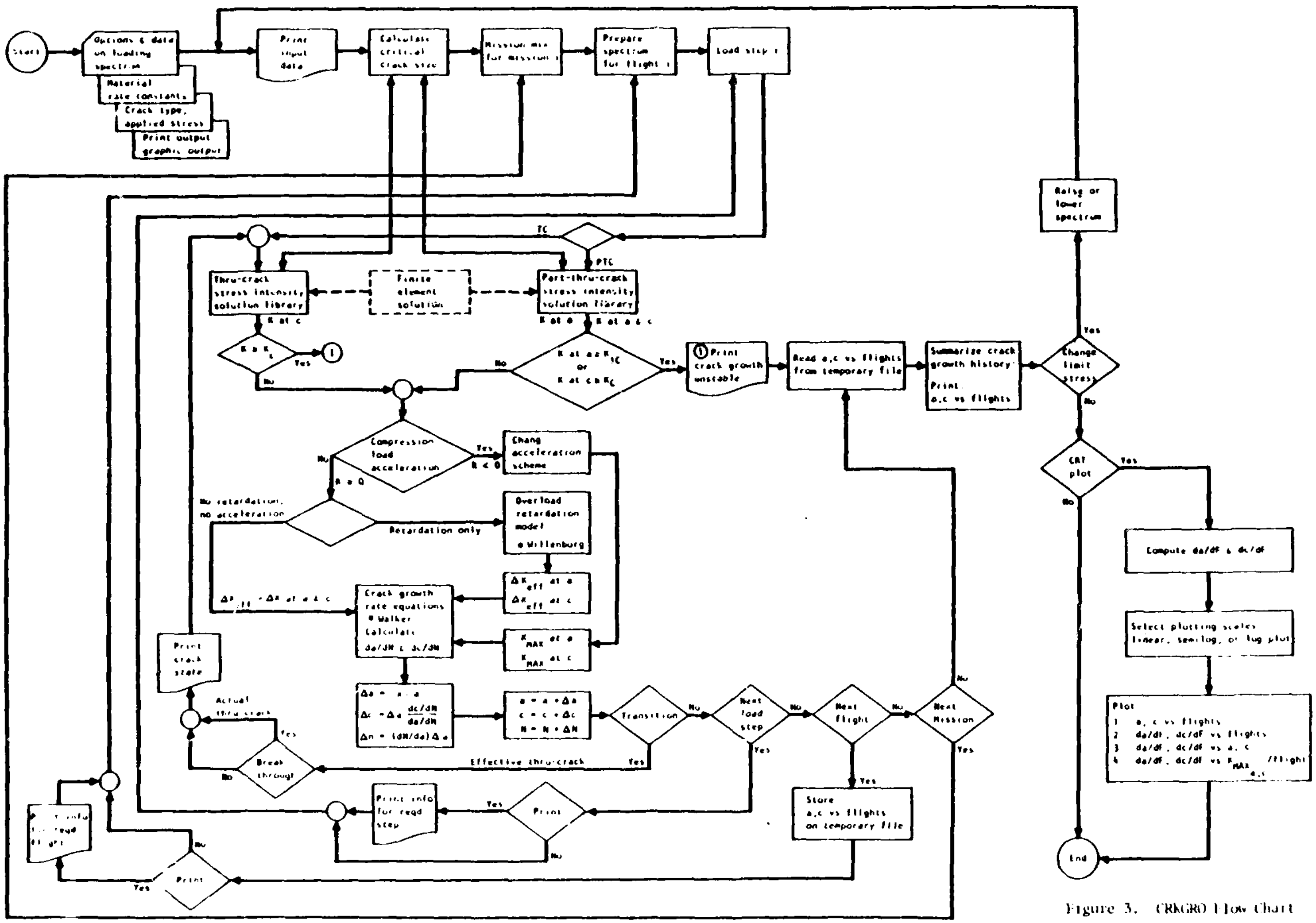


Figure 3. CRKGRO Flow Chart

Section IV

CRKGRO INPUT DATA DECK

The input data deck for CRKGRO is described in this section. A brief description of each type of input data card is presented in the following list, the overall deck setup is shown in figure 4, and a detailed description of each card follows

Card	Description
1a	"TITLE" keyword
1b	Title cards
1c	"END" keyword
2a	"MATERIAL" keyword
2b	Material description card
2c	Crack-growth-rate equation constants
2d	Material properties
3a	"THRESHOLD" keyword
3b	Delta K-threshold and variable delta K-threshold constant
4a	"LIMITS" keyword
4b	Initial and final crack sizes and stress ratio cutoff values
5a	"ANALYSIS" keyword
5b	Load interaction specifications
5c	Crack code and crack geometry
5d	Limit stresses
6a	"SPECTRUM" keyword
6b	Spectrum title card
6c	Spectrum scale factor, range-pair counting option, and file number
6d	Keyword for spectrum type, "MAX-MIN," "R-DELTA," "MEAN-ALT," and flight mission segment title
6e	Stress spectrum and occurrences
6f	"END" keyword
6g	"END SPECTRUM" keyword
6h	Mission mix
6i	Number of flights per block

Card	Description
7a	"OUTPUT" keyword
7b	Print and plot options
7c	Plotter type
7d	Plot types and scaling
8	"END DATA" keyword

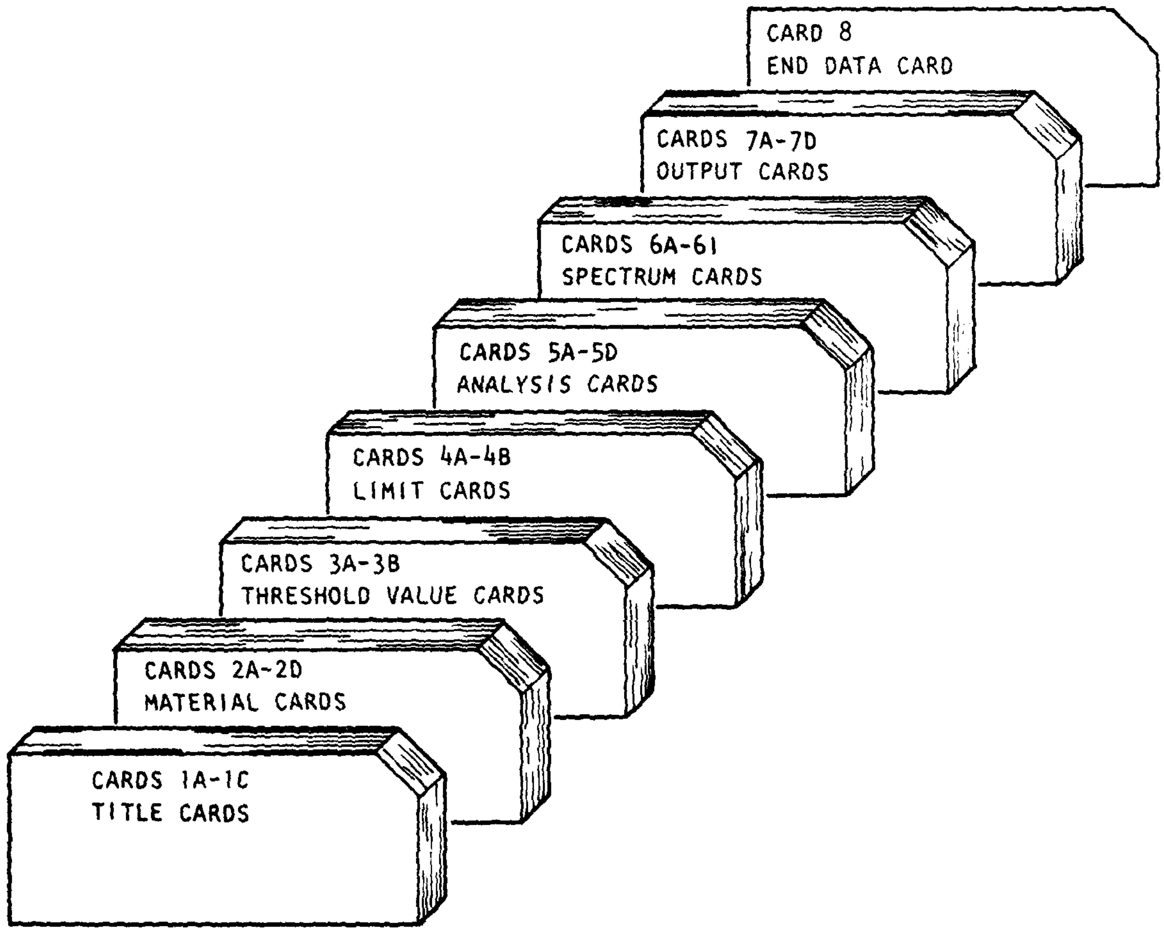


Figure 4. CRKGRO Input Deck Setup

INPUT DATA CARD 1a

Description: Title card keyword

Format and Example:

Column	1 5	6 80
	OPTION	
	TITLE	

Field	Contents
OPTION	"TITLE" keyword, beginning in column 1

Remarks: This card initiates the input of the title cards.

INPUT DATA CARDS NO. 1b

Description: Title cards

Format and Example:

Column 1	72	80
TITLE(1) through TITLE (18)		
BENCHMARK 443 FOR A DOUBLE CORNER CRACK		

Field	Contents
TITLE (I), I = 1, 18	Any alphanumeric information which the user desires to input for problem identification
Remarks:	There is no limit to the number of title cards input. All title cards are printed on the first page of output, but only the first title card is printed on succeeding pages and all plots.

INPUT DATA CARD 1c

Description: Termination of title card input

Format and Example:

Column	1–3	4–80
	OPTION	
	END	

Field	Contents
OPTION	"END" keyword, beginning in column 1 for terminating title card input

INPUT DATA CARD NO. 2a

Description: Material card keyword

Format and Example:

Column	1 8	9 80
	OPTION	
	MATERIAL	

Field	Contents
OPTION	"MATERIAL" keyword, beginning in column 1.

Remarks: This card initiates the input of the material description, crack-growth-rate constants, and static material properties.

INPUT DATA CARD NO. 2b

Description: Material description

Format and Example:

Column 1	60	70	80
MATID(1) through MATID(7)	BISLP		
2219-T851 ALUMINUM			

Field	Contents
MATID(I), I = 1, 6	Any Alphanumeric information which the user desires to input for material identification. 60 columns can be used for input
BISLP	Option to use single or bi-slope crack growth rate curves Blank - analyze with single-slope rate curve "BISLOPE" - analyze with bi-slope rate curve

INPUT DATA CARD NO. 2c

Description: Crack-growth-rate constants

Format and Example:

Column	1	10	20	30	40	50
	CSUBC	EXPNC	CBUBA	EXPNA	EXPM	
	5.066 E-10	3.83	5.066 E-10	3.83	0.60	

	60	80
	EXPQ	
	1.0	

Field	Contents
CSUBC	Crack-growth-rate equation coefficient C_c used in dc/dN equation
EXPNC	Crack-growth-rate equation exponent n_c used in dc/dN equation
CSUBA	Crack-growth-rate equation coefficient C_a used in da/dN equation
EXPNA	Crack-growth-rate equation exponent n_a used in da/dN equation
EXPM	Positive stress ratio collapsing factor m used in the modified Walker equation
EXPQ	Negative stress ratio acceleration index q used in the Chang equation

Remarks:

1. CSUBC and CSUBA must be in ksi units.

2. If the "BISLOPE" option is used (see card 2b) an extra input card is required for the lower part of the rate curve. This card is similar to card 2c, where CSUBCL, EXPNCL, CSUBAL, EXPNAL, EXPML, EXPQL is as defined above but for the lower part i.e. region I of the da/dN

versus ΔK rate curve, with the additional input values of TRANSL and ATLEV in columns 61-65 and 66-72, respectively.

TRANSL - ΔK at transition from upper to lower curve (e.g.: 3.7)

ATLEV - the level of da/dN at transition from upper to lower curve (e.g.: 1.0 -07)

INPUT DATA CARD 2d

Description: Material properties

Format and Example:

Column 1 10 20 30 80

CKC	AKIC	SIGMAY	
65.	45.	48.	

Field	Contents
CKC	Plane stress fracture toughness K_C(ksi $\sqrt{in.}$) used for the through-crack instability criterion
AKIC	Plane strain fracture toughness K_{IC}(ksi $\sqrt{in.}$) used for the part-through-crack instability criterion
SIGMAY	Material yield strength, σ_{ty}(ksi)

INPUT DATA CARD 3a

Description: Threshold keyword card

Format and Example:

Column	1	9 80
	OPTION	
	THRESHOLD	

Field	Contents
OPTION	"THRESHOLD" keyword, beginning in column 1

Remarks: This card initiates the input for the ΔK threshold option.

INPUT DATA CARD 3b

Description: Delta K-threshold and Constant

Format and Example:

Column	1 10	20	80
	DELKTH	THA	
	2.5	1.0	

Field	Contents
DELKTH	The fixed threshold value of ΔK at R = o, ΔK_{th_o} (Ksi $\sqrt{in.}$)
THA	The variable threshold constant

Remarks: $\Delta K_{th} = \Delta K_{th_o}$ (1-AR)

INPUT DATA CARD 4a

Description: Limits keyword card

Format and Example:

Column	1 6	80
	OPTION	
	LIMITS	

Field	Contents
OPTION	"LIMITS" keyword, beginning in column 1
Remarks:	This card initiates the input of the initial and final crack sizes and stress ratio cutoff values.

INPUT DATA CARD 4b

Description: Initial and final crack sizes and stress ratio cutoff values

Format and Example:

Column 1 10 20 30 40 50 60

CINIT	CF	AINIT	AF	RCUT	RCUTN	
0.06	0.90	0.06	0.5	0.75	-0.50	

Field	Contents
CINIT	Initial crack length (in.)
CF	Final crack length (in.)
AINIT	Initial crack depth (in.)
AF	Final crack depth (in.)
RCUT	The cutoff value of the positive stress ratio "R+," above which the material is assumed to have no stress ratio layering effect on the crack growth.
RCUTN	The cutoff value of the negative stress ratio "R-," below which the material is assumed to have no acceleration effect on the crack growth

Remarks:

1. If CF = 0, or blank, CF will be set equal to:

   a. the half width - for surface and center-thru cracks

   b. the width - for edge cracks

   c. the (half width-radius) - for cracks at holes.

   Analysis will terminate when either the critical crack size occurs or the crack length is equal to CF.

2. If AINIT = 0. or blank, and the crack type is a part through crack, the execution will terminate.

3. If AF = 0. or blank, AF will be set equal to the thickness. Analysis will terminate when either the critical crack size occurs or the crack depth is equal to AF.

4. RCUT must be in the range: $0. \leq$ RCUT $< 1.$

5. RCUTN must be in the range: $-1.0 <$ RCUTN $\leq 0.$

INPUT DATA CARD 5a

Description: Analysis keyword card

Format and Example:

Column 1 8 80

1	8 — 80
OPTION	
ANALYSIS	

Field	Contents
OPTION	"ANALYSIS" keyword, beginning in column 1

Remarks: This card initiates the input of load interaction data, crack code, crack geometry, and limit stresses.

INPUT DATA CARD 5b

Description: Load interaction specification

Format and Example:

Column 1 20 30 40

RET	RETTYP	RETDA	
LOAD INTERACTION	YES	3.0	

Field	Contents
RET	"LOAD INTERACTION" keyword, beginning in column 1
RETTYP	Load interaction application. If "NO" is input, no load interaction will be considered in the analysis, and the compressive minimum stresses will be set to zero. If RETTYP is blank or "YES," overload retardation and compression acceleration are considered. If "BOTH" is input, then both analyses will be performed.
RETDA	Retardation shutoff ratio

Remarks: The value of RETTYP must begin in column 21.

INPUT DATA CARD 5c

Description: Crack code and crack geometry

Format and Example:

Column	1 4	8 11	20	30	40	50
	CODE	DIM	WIDTH	T	RADIUS	NBRK
	1050	ONED	4.0	0.5	0.125	0

Field	Contents
CODE	Crack code consisting of four integers, beginning in column 1
DIM	Blank - Two-dimensional analysis "ONED" - One-dimensional analysis, beginning in column 5
WIDTH	Width of structure, W = 2b (in.) for non-edge cracks W = b (in.) for edge cracks
T	Thickness of structure, t (in.)
RADIUS	Radius of open hole, r (in.)
NBRK	Control for transition from a part-through crack to a through crack For NBRK = 0, breakthrough occurs when a/t = 1. For NBRK = 1, breakthrough occurs at $a/t = 0.5\,[1/0.86\,(a/2c)]^{0.821}$

Remarks: 1. Refer to figure 2 for a description of crack codes available in the current version of CRKGRO.

INPUT DATA CARD 5d

Description: Limit stresses and analysis control parameters

Format and Example:

Column 1 10 20 30

NLIM	SIGLIM(1)	INSTAB		
3	10.	BY MAXIMUM		

1 10 20 30 40

SIGLIM(2)	SIGLIM(3)	- - - - -	SIGLIM(NLIM)	
.85	1.2			

Field	Contents
NLIM	Number of limit stresses, integer, right-adjusted
SIGLIM(1)	Limit stress in ksi
INSTAB	Control for determining when instability is reached: (Starting in column 21.) "BY MAXIMUM" - by stress-intensity-factor value at maximum spectrum stress "Blank" - by stress-intensity-factor value at limit stress
SIGLIM(I), I = 2,7	Ratio of the ith limit stress to the first limit stress

Remarks:

1. If NLIM is greater than 1, then a parametric study is performed with the change in limit stress. The spectrum stresses also change by the ratio of limit stress change.

2. Limit stress ratios, SIGLIM(2-7), are input in fields of 10 on the next data card. A maximum of six limit stress ratios may be input on this card.

INPUT DATA CARD 6a

Description: SPECTRUM card keyword

Format and Example:

Column	1	10	80
	OPTION		
	SPECTRUM		

Field	Contents
OPTION	"SPECTRUM" keyword, beginning in column 1

Remarks: This card initiates the input of the spectrum data.

INPUT DATA CARD 6b

Description: Spectrum title card

Format and Example:

Column	1	70	80
	STITLE(1) through (7)		
	FIGHTER SPECTRUM		

Field	Contents
STITLE(I), I = 1,7	Any alphanumeric information which the user desires to input for overall spectrum identification

Remarks: Only information in columns 1-70 is printed.

INPUT DATA CARD 6c

<u>Description:</u> Spectrum scale factor, range-pair counting option and file number for stored spectrum (if any)

<u>Format and Example:</u>

Column 1 10 15 20 80

FAC	NRP	NFILE	
1.0	1	12	

Field	Contents
FAC	Factor used to scale the spectrum
NRP	Control for range-pairing each spectrum segment: 0 - no range-pair counting operation 1 - range-pair counting option
NFILE	Unit number of file where spectrum is stored: Blank - spectrum will be read in from cards 10-98 - spectrum will be read in from given file

<u>Remarks:</u>

1. All maximum and minimum stresses are scaled by the value of FAC.
2. The values of NRP and NFILE are integers, right-adjusted.

INPUT DATA CARD 6d

Description: Spectrum-type keyword and segment title

Format and Example:

Column 1 10 70 80

SPCTYP	SEGTTL(1) through SEGTTL(6)	
MAX-MIN	AIR-TO-GROUND SPECTRUM	

Field	Contents
SPCTYP	Spectrum-type keyword defining the following data cards as one of the following:

'MAX-MIN' - maximum and minimum stresses are input

'R-DELTA' - stress ratio and delta stress are input

'MEAN' - mean and alternating stresses are input

SEGTTL(I) I = 1, 6 — Mission segment description

Remarks:

1. The keyword for SPCTYP begins in column 1.
2. The mission segment description can be input in columns 11-70.
3. Cards 6d to 6f must be repeated for as many segments as there are in the spectrum to a maximum of 20 segments. There is no limit to the number of steps per segment, although a limit of 3,000 steps is established for the entire spectrum.
4. This card should always be a part of the input deck (not a part of a stored spectrum).

INPUT DATA CARD 6e

Description: Stress spectrum

Format and Example:

Column 1 5 15 25 35

	S1	S2	CYCLES	
	12.	-2.	1.	
	25.	10.	.01	
	6.5	2.1	25.	
	8.4	5.2	500.	

Field	Contents
S1	Depending on the spectrum type, S1 is one of the following: 1. Maximum stress 2. Delta stress 3. Mean stress
S2	Depending on the spectrum type, S2 is one of the following: 1. Minimum stress 2. Stress ratio 3. Alternating stress
CYCLES	Number of occurrences for each type of loading

Remarks:

1. The spectrum is considered to be in ksi units.
2. A value for CYCLES < 1 will be applied every $(\text{CYCLES})^{-1}$ times. If CYCLES = 0.1, the loading will be applied every 10th time that the flight segment is repeated.
3. A maximum of 3,000 steps is established for the entire spectrum.
4. If the spectrum is in terms of % design limit stress, the scale factor (card 6c) will convert the spectrum into the correct stress level.

INPUT DATA CARD 6f

Description: End-of-flight segment keyword card

Format and Example:

Column	1	10	80
	ENDSEG		
	END		

Field	Contents
ENDSEG	"END" keyword, beginning in column 1 for terminating flight segment spectrum input

Remarks:

1. The succeeding data card is either a flight-segment-type card 6d or card 6g.

2. If the spectrum is stored on a file, then the keyword "END" must also be stored on the file after each segment and/or at the end of the spectrum.

INPUT DATA CARD 6g

Description: End-of-spectrum keyword card

Format and Example:

Column 1	12	80
ENDSPC		
END SPECTRUM		

Field	Contents
ENDSPC	"END SPECTRUM" keyword, beginning in column 1 for terminating spectrum input

Remarks: This card should always be a part of the input deck (not part of a stored spectrum).

INPUT DATA CARD 6h

Description: Mission mix

Format and Example:

Column 1	80
MISSION = NBLKS *Σ(FACTORi*SEGMENTi)	
MISSION = 2500 (2S1 + 3S2 + 1S1 + 2S3)	

Field	Contents
MISSION	"MISSION =" keyword, starting in column 1
NBLKS	Number of times the complete mission string is repeated
FACTORi	Number of times the individual flight segment is repeated
SEGMENTi	Mission segment number preceded by the letter "S" for segment

Remarks:

1. The example illustrates an equation for mission mix. The characters "MISSION =" are required to initiate the mission mix. The parentheses are required, and the terms between them describe a complete mission string. All characters are free format.

2. The maximum number of individual mission segments is 20 (S1.....S20), and the maximum number of mission segments-mix is 100 (1S1+......).

3. No limit is established for NBLKS.

4. Other examples:

   MISSION = 10000

   MISSION = 500 (1S1 + 1S2 + 1S3 + 1S4 + 1S5 + 1S6 +
   1S5 + 1S4 + 1S3 + 1S2 + 1S1 + 1S2 + 1S3 +
   1S4 + 1S5 + 1S6)

5. The last entry must be a "+" sign for continuation of a mission-mix. The end of the mix is a closing parenthesis.

INPUT DATA CARD 6i

Description: Flights-per-block definition

Format and Example:

Column: 1 5 80

NFPB	
25	

Field	Contents
NFPB	Number of flights per block, integer, right-adjusted

Remarks: 1. This value is used for plotting only.

INPUT DATA CARD 7a

Description: Output keyword card

Format and Example:

Column	1	6	80
	OPTION		
	OUTPUT		

Field	Contents
OPTION	"OUTPUT" keyword, beginning in column 1

Remarks: This card initiates the input of printer and plotter controls.

INPUT DATA CARD 7b

Description: Print and plot options

Format and Example:

Column	1–5	6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45
	IPRSPC	NB	NCRT		NJUMP	IPR72	KPRT	INPRT	LNBLK
	1	10	1		1	0	1	0	-25

Field	Contents
IPRSPC	Control for printing the spectrum to be used 1 - print 0 - suppress print
NB	Control for printing the crack growth history in increments of NB number of blocks. The default value is 175.
NCRT	Control for plotting and reading plotting data: 1 - read plotting parameters on succeeding cards 0 - no plotting
NJUMP	Control for bypassing slow-growth steps: 0 - bypass steps with a growth rate less than 10^{-8} and $\Delta K < .2\Delta K_{max_x}$ 1 - retain slow-growth steps in analysis
IPR72	Control for limiting the line size: 1 - printed output will have a 72-column width 0 - printed output will have a 108-column width
KPRT	Control for printing stress intensity equations used 1 - print K equations 0 - do not print

INPUT DATA CARD 7b (Concluded)

Field	Contents
INPRT	Control for printing growth history of first block 1 - do not print 0 - print first block's growth
LNBLK	Control for printing intermediate growth history -i - growth of the first ith steps of each "NB"th block will be printed +i - growth of the last ith steps of each "NB"th block will be printed o - all steps of "NB"th block will be printed
Remarks:	If the spectrum is segmented and the first segment's number of steps <LNBLK, printing will stop at the 1st segment-end for "-i" or start at the last segment-start for "+1". First block's print will also follow LNBLK's option.

INPUT DATA CARD 7c

Description: Plotter-type specification

Format and Example:

Column	1 – 5	6 – 10	11 – 80
	NPLTYP	IBAUD	
	1	0	

Field	Contents
NPLTYP	Plotter type for DISSPLA processing: 1 - SC4020 2 - Tektronix 3 - Unipost or Calcomp
IBAUD	Tektronix terminal line speed in characters per second (used only when NPLTYP = 2)

Remarks:

1. All values are integers, right-adjusted.
2. Card 7c is input only if "NCRT" on card 7b is 1.

INPUT DATA CARD 7d

Description: Plot types and scaling parameters

Format and Example:

Column	1 – 5	10	15	20	25	30	50	55	60	
	OPT(1)	OPT(2)	OPT(3)	OPT(4)	SCALE (1,1)	SCALE (2,1)	---	SCALE (1,4)	SCALE (2,4)	
	1	1	1	1	0	0		0	1	

Field — Contents

OPT(1-4) Array specifying parameters to be plotted:

1 - plot
0 - no plot

OPT(1) = crack size versus life in flights
OPT(2) = crack growth rate versus life in flights
OPT(3) = crack growth rate versus crack size
OPT(4) = crack growth rate versus maximum K_{max} per flight

$\Bigg\}$ Y vs X

SCALE(2,4) Array specifying linear, semilog, or log-log grid scaling:

1. SCALE(1,*) = 0 - X-axis is linear
   1 - X-axis is log

2. SCALE(2,*) = 0 - Y-axis is linear
   1 - Y-axis is log

Remarks:

1. All values are integers, right-adjusted.
2. For part-through cracks, separate plots are produced for both crack length and depth.
3. Because one block represents the whole segment series or mission-mix expression between the parentheses on card 6h, the number of flights on card 6i must reflect both the multiple applications and segment repetitions.
4. Card 7d is input only if "NCRT" on card 7b is 1.

INPUT DATA CARD 8

Description: End-of-data keyword card

Format and Example:

Column 1	8	80
OPTION		
END DATA		

Field	Contents
OPTION	"END DATA" keyword, beginning in column 1

Remarks: This card terminates the reading of input data. If no input data errors were encountered, execution begins; otherwise, the program is terminated.

Section V

EXAMPLE CASES

This section presents two example cases which are designed to illustrate the capability of the CRKGRO program and exercises most of the program options. The first example is the crack growth prediction for a surface crack contained in a finite width plate as shown in figure 1, subjected to spectrum loadings. For the purpose of illustration, the spectrum selected for the analysis was a small block of random flight spectrum which consists of 57 cycles. Each cycle has different stress levels. The analysis was done by the two-dimension crack growth analysis option. Crack growth rate constants used in the analysis were the bi-slope constants. The following data were used in the analysis.

Material:

2219-T851 Aluminum Plate

Region II (upper slope) crack growth rate constants

$C = 5.066 \times 10^{-10}$ (in ksi unit)
$n = 3.83$

Bi-slope transition point:

$da/dN = 6 \times 10^{-7}$ in/cyc $\quad \Delta K = 5 \text{ ksi}\sqrt{\text{in}}$

Region I (lower slope) crack growth rate constants

$C = 2.126 \times 10^{-13}$ (in ksi unit)
$n = 9.23$

Crack growth rate parameters and fracture properties:

$m = 0.6$ $\quad \alpha = 1.0$

$K_{th_o} = 2.5 \text{ ksi}\sqrt{\text{in}}$ $\quad A = 1.0$

$R^+_{cut} = +0.75$ $\quad R^-_{cut} = -0.99$

$R_{so} = 3.0$ $\quad \sigma_{ty} = 48$ ksi

$K_{Ic} = 45 \text{ ksi}\sqrt{\text{in}}$ $\quad K_c = 65 \text{ ksi}\sqrt{\text{in}}$

Plate dimensions:

$2b = 6.0$ in. $\quad t = 0.25$ in.

Initial crack sizes:

$a_i = 0.10$ in. $\quad a_i/2c_i = 0.5$

All the input echoes and the print-outs of the output including the graphics are shown in the next few pages. Brief descriptions are provided for each page of the output printouts.

```
TITLE
SAMPLE CASE FOR SURFACE FLAW
END
MATERIAL
2219-T851 ALUMINUM                                                        FISLOPE
  5.765 -10 3.63       5.056 -10 3.63        .5        1.0
  2.126 -13 9.23       2.126 -13 9.23        .6        1.0        5.00 6.0 -07
  65.       45.        40.
THRESHOLD
  2.5       1.0
LIMITS
  .10                  .10                   .75       -.99
ANALYSIS
LOAD INTERACTION     YES          2.3
1010        6.0        .25
        1 30.          BY MAXIMUM
SPECTRUM
VARIABLE SPECTRUM SAMPLE CASE
.30          1
MAX-MIN
      50.1        29.6        1.000
      41.5        4.20        1.000
      20.1        7.80        1.000
      48.5        6.30        1.000
      37.1        8.40        1.000
      37.9        16.4        1.000
      26.6        17.8        1.000
      49.5        13.8        1.000
      26.9        4.00        1.000
      42.5        11.4        1.000
      74.1        20.3        1.000
      34.5        1.50        1.000
      21.0        7.80        1.000
      39.5        11.9        1.000
      23.6        2.10        1.000
      71.5        11.3        1.000
      43.6        8.50        1.000
      33.1        10.9        1.000
      36.3        -10.0       1.000
      51.4        0.600       1.000
      16.9        7.00        1.000
      55.9        31.7        1.000
      46.6        3.00        1.000
      17.3        6.90        1.000
      44.1        30.6        1.000
      42.4        25.3        1.000
      44.3        2.90        1.000
      31.2        4.90        1.000
      28.4        8.60        1.000
      29.7        18.0        1.000
```

```
   28.4      14.4      1.000
   44.2      16.4      1.000
   35.2       8.00     1.000
   51.9       8.10     1.000
   23.3       2.60     1.000
   21.7       8.70     1.000
   59.5      12.3      1.000
   47.3     -10.0      1.000
   67.1      42.2      1.000
   57.2      14.5      1.000
   35.4      11.8      1.000
   27.8       5.50     1.000
   19.6       3.70     1.000
   27.7       8.90     1.000
   31.1       6.60     1.000
   28.9       9.20     1.000
   22.6      12.5      1.000
   41.6       0.50     1.000
   26.4      10.3      1.000
   39.3      -.10      1.000
   19.5       5.10     1.000
   28.7       5.70     1.000
   31.4       4.30     1.000
   22.3      10.7      1.000
   24.5       1.60     1.000
   12.0       0.20     1.000
   48.2     -10.0      1.000
END
END SPECTRUM
MISSION=50000
   3
OUTPUT
   1 2000      0                        1     0   -20
END DATA
```

Remarks: Above are the printouts of the input card image listing. Each line contains the data punched in one card. The first three lines are the title cards. The next five lines are the material cards, followed by threshold value cards (lines 9 and 10), limit cards (lines 11 and 12); analysis cards (lines 13 through 16); spectrum cards (lines 17 through 81); output cards (lines 82 and 83) and end data card (line 84).

```
DETAILED  FATIGUE  CRACK  GROWTH  ANALYSIS  PROGRAM      C R K G R O

SAMPLE CASE FOR SURFACE FLAW

CRACK CODE     1010 --- SURFACE CRACK, CENTERED

LOAD INTERACTION :  WILLENBORG-CHANG

DAMAGE ACCUMULATION     VROMAN (LINEAR APPRX.)
CRACK GROWTH RATE EQ.      MODIFIED WALKER
ANALYSIS IS PERFORMED WITH A SPECTRUM THAT HAS BEEN RANGED PAIRED.

INSTABILITY WILL BE BASED ON MAXIMUM STRESS

MATERIAL :  2219-T851 ALUMINUM                                    BISLOPE

                                         DEPTH          LENGTH
                                       DIRECTION       DIRECTION
FRACTURE TOUGHNESS                       45.000          65.000
REGION II
GROWTH RATE EQ. CONST. C           5.0660E-1   .   5.0660E-10
GROWTH RATE EQ. EXP.   N               3.83            3.8300
GROWTH RATE EQ. EXP.   M               .69
GROWTH RATE EQ. EXP.   Q              1.000
REGION I :
TRANSITION TO LOWER CURVE        AT    5.    LEVEL 6.00E-07
GROWTH RATE EQ. CONST. C          2.1260E-13      2.1260E-13
GROWTH RATE EQ. EXP.   N             9.2300          9.2300
GROWTH RATE EQ. EXP.   M               .6
GROWTH RATE EQ. EXP.   G              1.000

YIELD STRENGTH              48.00

DELTA KTH = (1.- 1.00 * ABS(R)) * 2.000

+R CUT-OFF  =   .75
-R CUT-OFF  =  -.95

RETARDATION SHUT-OFF RATIO FOR CRACK ARREST = 2.3000

HALF PLATE WIDTH (B)  =  5.00
PLATE THICKNESS  (T)  =   .25

INITIAL HALF CRACK LENGTH (C)  =   .1000
INITIAL CRACK DEPTH       (A)  =   .1000
A/C RATIO                      =  1.000
```

M I S S I O N   M I X

MAXIMUM NUMBER OF LOAD BLOCKS = 500.0

THE LOADING SPECTRUM HAS 1 MISSION(S)

DESIGN LIMIT STRESS = 30.000 (KSI)

MISSION	NO. OF OCCURRENCES	NO. OF STEPS	CYCLES/MISSION-SEGMENT BEFORE RPC
1	1	57	57.0
TOTALS 1	1	57	57.0 CYCLES

VARIABLE SPECTRUM SAMPLE CASE

SPECTRUM HAS BEEN RANGE-PAIR COUNTED

SPECTRUM FOR SEGMENT 1

STEP NO	MAX.STRESS	MIN.STRESS	CYCLES
1	15.350	1.200	1.000
2	12.570	8.880	1.000
3	6.130	2.340	1.000
4	14.470	1.890	1.000
5	11.130	2.520	1.000
6	11.340	4.920	1.000
7	6.550	5.340	1.000
8	14.950	1.260	1.000
9	8.370	4.140	1.000
10	12.970	3.420	1.000
11	22.230	-3.000	1.000
12	10.350	6.090	1.000
13	6.350	2.340	1.000
14	11.950	.630	1.000
15	7.140	3.570	1.000
16	21.450	.450	1.000
17	13.960	3.390	1.000
18	9.930	3.270	1.000
19	16.320	2.550	1.000
20	15.420	.180	1.000
21	5.670	2.190	1.000
22	16.770	.840	1.000
23	14.580	9.510	1.000
24	5.190	2.070	1.000
25	13.230	7.590	1.000
26	12.720	9.180	1.000
27	13.290	.900	1.000
28	9.350	1.470	1.000
29	8.560	2.580	1.000
30	8.910	4.320	1.000

31	6.520	5.400	1.000
32	13.260	2.430	1.000
33	16.560	4.320	1.000
34	15.540	.870	1.000
35	6.340	2.430	1.000
36	6.510	2.610	1.000
37	17.850	-3.300	1.000
38	14.190	3.690	1.000
39	20.130	-3.900	1.000
40	17.160	12.660	1.000
41	16.620	4.350	1.000
42	6.340	3.540	1.000
43	5.360	1.650	1.000
44	8.310	2.670	1.000
45	9.330	1.110	1.000
46	8.640	2.760	1.000
47	6.780	3.750	1.000
48	12.460	.180	1.000
49	7.320	3.090	1.000
50	11.790	.150	1.000
51	5.950	1.530	1.000
52	8.610	1.710	1.000
53	9.420	0.980	1.000
54	6.530	3.210	1.000
55	7.350	1.290	1.000
56	3.600	.480	1.000
57	14.460	-.330	1.000

******************** END OF INPUT ********************

<u>Remarks</u>: Above are the input echoes arranged in a format such that they can be included directly in the crack growth analysis report.

```
CRACK GROWTH RATE EQUATION

   DA/DN = C*(DELTA K/((1-R)**(1-M)))**N

STRESS INTENSITY FACTOR SOLUTIONS

FOR A SHALLOW SURFACE CRACK WHERE A/C .LE. 1

   K(A) = ((1.13-0.09A/C) + (0.89/(0.2+A/C) -0.54)(A/T)**2
          + (0.5 - 1/(0.65+A/C) + 14(1-A/C)**24)(A/T)**4)
          * SQRT(SEC(PI*C/2B)*SQRT(A/T)) * SIGMA * SQRT(PI*A/Q)

   K(C) = ((1.13-0.09A/C) + (0.89/(0.2+A/C) -0.54)(A/T)**2
          + (0.5 - 1/(0.65+A/C) + 14(1-A/C)**24)(A/T)**4)
          *SQRT(SEC(PI*C/2B)*SQRT(A/T))
          *(1.07+.24(A/T)**2) * (.9698(A/C)**2+.0302)**.25
          * SQRT(A/C) * SIGMA * SQRT(PI*C/Q)

   WHERE Q = (1+1.464(A/C)**1.65)


FOR A DEEP SURFACE CRACK WHERE A/C .GT. 1

   K(A) = ((SQRT(C/A) * (1+1.04C/A) + 0.2(C/A)**4
          (A/T)**2 - 0.11(C/A)**4 (A/T)**4) * SQRT(C/A)
          *SQRT(SEC(PI*C/2B*SQRT(A/T)))) * SIGMA * SQRT(PI*A/Q)

   K(C) = ((SQRT(C/A) * (1+1.04C/A) + 0.2(C/A)**4 (A/T)**2
          - 0.11(C/A)**4 (A/T)**4) *
          *SQRT(SEC(PI*C/2B*SQRT(A/T))) * SQRT(A/C))
          *(1.07+.24(C/A)(A/T)**2) * (.9698+.0302(C/A)**2)**.25
          * SIGMA * SQRT(PI*C/Q)

   WHERE Q = (1+1.464(C/A)**1.65)


FOR A CENTER THROUGH CRACK

   K = SQRT(SEC(PI*C/2B)) * SIGMA * SQRT(PI*C)
```

<u>Remarks:</u> Above is the printout of the crack growth rate equation and stress intensity factor equations used in the crack growth analysis for crack codes 1010 and 2010.

SAMPLE CASE FOR SURFACE FLAW

ESTIMATION OF THE CRITICAL CRACK LENGTH
BASED ON KLIMIT AND CONSTANT ASPECT RATIO

ITERATION	CRACK SIZE	STRESS INTENSITY (LIMIT)	STRESS INTENSITY CORRECTION FACTOR
1	.1000	8.861	.8272
2	.2500	23.663	1.3971
1	.2500	26.751	1.0043
2	2.9852	1136.646	11.2840
3	1.6175	83.099	1.2288
4	.9338	54.685	1.0643
5	1.2756	67.778	1.1286
6	1.1047	61.976	1.0928
7	1.1902	64.374	1.1057
8	1.2329	66.061	1.1189
9	1.2115	65.214	1.1142

APPROXIMATE CRITICAL CRACK (A OR C) = 1.212
WHEN K-LIMIT IS WITHIN A 0.5% TOLERANCE OF K CRITICAL

Remarks: This is the printout of the critical crack size calculation based on the design limit stress. The calculation is performed through subroutine CRIT by an iteration procedure.

SAMPLE CASE FOR SURFACE FLAW

THE CRACK AT THE BEGINNING OF BLOCK 1 A = .100000
C = .100000

STEP	CYCLES	A C	A/2C A/T	DA/DN DC/DN	DELTAK DELTCK	KMAX-A KMAX-C	SIGMAX-A SIGMAX-C (EFF)	R-A R-C (EFF)	SIGMAX	R
1	1.	.1000 .1000	.5000 .4020	3.414E-07 5.[illegible]71E-07	5.30 5.87	5.76 6.38	15.030 15.030	.08 .08	15.030	.06
2	1.	.1000 .1000	.5000 .4020	3.529E-10 9.127E-10	1.41 1.57	4.47 4.91	11.661 11.564	.69 .69	12.570	.71
3	1.	.1000 .1000	.5000 .4020	0. 7.441E-11	1.41 1.57	2.31 2.49	6.030 5.665	.39 .37	6.030	.39
4	1.	.1000 .1000	.5000 .4020	2.7[illegible]0E-07 4.[illegible]5E-07	4.90 5.43	5.56 6.16	14.516 14.505	.12 .12	14.670	.13
5	1.	.1000 .1000	.5000 .4020	2.156E-06 5.[illegible]58E-08	3.30 3.66	3.79 4.13	9.891 9.717	.13 .11	11.130	.23
6	1.	.1000 .1000	.5000 .4020	4.[illegible]47E-09 1.136E-08	2.46 2.73	3.88 4.24	10.137 9.976	.37 .35	11.340	.43
7	1.	.1000 .1000	.5000 .4020	3.2[illegible]4E-11 7.[illegible]44E-11	1.24 1.38	2.83 2.98	7.394 7.023	.56 .54	8.580	.62
8	1.	.1000 .1000	.5000 .4020	3.1[illegible]5E-07 4.741E-07	5.21 5.77	5.66 6.27	14.775 14.768	.08 .08	14.850	.18
9	1.	.1000 .1000	.5000 .4020	8.[illegible]13E-11 1.[illegible]52E-10	1.51 1.67	2.70 2.81	7.047 6.622	.44 .41	8.070	.51
10	1.	.1000 .1000	.5000 .4020	7.4[illegible]4E-08 1.[illegible]94E-07	3.62 4.91	4.62 5.88	12.055 11.970	.22 .21	12.670	.27
11	1.	.1000 .1000	.5000 .4020	1.9[illegible]3E-06 2.[illegible]46E-06	9.66 10.72	8.52 9.44	22.230 22.230	-.13 -.13	22.230	-.13
12	1.	.1000 .1000	.5000 .4020	1.515E-10 3.[illegible]47E-10	1.63 1.81	2.84 2.94	7.420 6.926	.43 .38	10.350	.59
13	1.	.1000 .1000	.5000 .4020	0. 9.118E-11	1.52 1.68	2.41 2.37	6.300 5.573	.37 .29	6.300	.37
14	1.	.1000 .1000	.5000 .4020	3.1[illegible]3E-08 7.[illegible]7E-08	4.30 4.77	3.37 3.58	8.805 8.435	-.27 -.33	11.850	.05
15	1.	.1000 .1000	.5000 .4020	3.[illegible]15E-11 4.[illegible]0E-11	1.37 1.52	2.39 2.26	6.246 5.312	.43 .33	7.140	.50
16	1.	.1000 .1000	.5000 .4020	1.538E-06 2.[illegible]93E-06	8.04 8.92	8.22 9.11	21.450 21.450	.02 .02	21.450	.02

SAMPLE CASE FOR SURFACE FLAW

THE CRACK AT THE BEGINNING OF BLOCK 1 A = .100000
C = .100000

STEP	CYCLES	A C	A/2C A/T	DA/DN DC/DN	DELTAK DELTCK	KMAX-A KMAX-C	SIGMAX-A SIGMAX-C (EFF)	R-A R-C (EFF)	SIGMAX	R
17	1.	.1000	.5000	4.0[illegible]99E-08	3.71	3.78	9.658	.02	13.08[illegible]	.26
		.1000	.4020	6.5[illegible]4E-08	4.12	4.05	9.541	-.02		
18	1.	.1000	.5000	1.373E-09	2.55	2.64	6.895	.03	9.930	.33
		.1000	.4020	1.990E-09	2.83	2.69	6.322	-.05		
19	1.	.1000	.5000	3.6[illegible]3E-07	5.49	5.65	14.743	.03	16.890	.15
		.1000	.4020	5.276E-07	6.09	6.20	14.607	.02		
20	1.	.1000	.5000	2.541E-07	5.84	4.88	12.751	-.20	15.420	.01
		.1000	.4020	3.558E-07	6.47	5.33	12.555	-.21		

THE CRACK AT THE END OF BLOCK 1 A = .100008
C = .100013

<u>Remarks:</u> Above are the printouts of the detail data related to the performance of the cycle-by-cycle crack growth analysis. For each step, the printouts show the data in the following order: step number, number of cycles in this step, calculated crack depth (a) and half-crack length (c), calculated da/dn and dc/dn, calculated ΔK_a and ΔK_c, calculated $Kmax_a$ and $Kmax_c$, calculated effective σ_{max}, calculated effective stress ratio, input remote maximum cyclic stress, and input stress ratio.

Detailed data for the first 20 steps of the input spectrum are shown in the printout as requested.

The last line in the printout indicated that after the application of the first block (57steps) of the spectrum, the crack is a = 0.100008 in., c = 0.100013 in.

SAMPLE CASE FOR SURFACE FLAW

THE CRACK AT THE BEGINNING OF BLOCK 200. A = .122259
C = .131754

STEP	CYCLES	A C	A/2C A/T	DA/DN DC/DN	DELTAK DELTCK	KMAX-A KMAX-C	SIGMAX-A SIGMAX-C (EFF)	R-A R-C (EFF)	SIGMAX	R
1	1.	.1223	.4640	3.517E-07	6.24	5.38	11.939	-.16	15.030	.06
		.1318	.4915	4.721E-07	6.79	5.78	11.777	-.17		
4	1.	.1223	.4640	2.870E-07	5.76	5.16	11.452	-.12	14.670	.13
		.1318	.4915	3.798E-07	6.27	5.53	11.277	-.13		
5	1.	.1223	.4640	1.548E-08	3.88	3.23	7.167	-.20	11.130	.23
		.1318	.4915	2.752E-08	4.22	3.35	6.835	-.26		
6	1.	.1223	.4640	6.520E-09	2.90	3.33	7.387	.13	11.340	.43
		.1318	.4915	1.205E-08	3.15	3.47	7.067	.09		
8	1.	.1223	.4640	3.265E-07	6.13	5.27	11.696	-.16	14.850	.08
		.1318	.4915	4.356E-07	6.67	5.66	11.527	-.18		
10	1.	.1223	.4640	1.322E-07	4.26	4.12	9.138	-.03	12.870	.27
		.1318	.4915	1.775E-07	4.64	4.36	8.894	-.06		
11	1.	.1223	.4640	3.767E-06	11.38	10.03	22.230	-.13	22.230	-.13
		.1318	.4915	5.119E-06	12.39	10.91	22.230	-.13		
14	1.	.1223	.4640	1.238E-07	5.06	3.72	8.245	-.36	11.850	.05
		.1318	.4915	1.694E-07	5.51	3.52	7.984	-.41		
16	1.	.1223	.4640	2.374E-06	9.47	9.67	21.450	.02	21.450	.02
		.1318	.4915	3.368E-06	10.30	10.52	21.450	.02		
17	1.	.1223	.4640	1.295E-07	4.37	4.23	9.376	-.03	13.080	.26
		.1318	.4915	[illegible]	4.75	4.49	9.152	-.06		
18	1.	.1223	.4640	2.361E-09	3.00	2.72	6.020	-.11	9.930	.33
		.1318	.4915	3.370E-09	3.27	2.76	5.618	-.19		
19	1.	.1223	.4640	6.594E-07	6.47	6.56	14.541	.01	16.890	.15
		.1318	.4915	9.112E-07	7.04	7.09	14.444	.01		
20	1.	.1223	.4640	4.538E-07	6.87	5.62	12.458	-.22	15.420	.21
		.1318	.4915	6.141E-07	7.48	6.04	12.318	-.24		

THE CRACK AT THE END OF BLOCK 2000 - A = .122275
C = .131775

<u>Remarks:</u> This is the printout which provided the detail data related to the cycle-by-cycle crack growth analysis. Again, only the first 20 steps of the spectrum were printed out.

SAMPLE CASE FOR SURFACE FLAW

THE CRACK AT THE BEGINNING OF BLOCK 4000 A = .171747 C = .200436

STEP	CYCLES	A C	A/2C A/T	DA/DN DC/DN	DELTAK DELTCK	KMAX-A KMAX-C	SIGMAX-A SIGMAX-C (EFF)	R-A R-C (EFF)	SIGMAX	R
1	1.	.1717	.4284	8.957E-07	8.19	6.76	11.541	-.20	15.930	.38
		.2004	.6904	1.239E-06	8.90	7.33	11.388	-.21		
4	1.	.1717	.4284	7.530E-07	7.48	6.45	11.021	-.16	14.670	.13
		.2004	.6904	9.779E-07	8.23	6.99	10.856	-.19		
5	1.	.1717	.4284	1.217E-07	5.04	3.68	6.279	-.37	11.130	.23
		.2004	.6904	1.742E-07	5.54	3.85	5.980	-.44		
6	1.	.1717	.4284	4.620E-08	3.76	3.83	6.534	.02	11.340	.43
		.2004	.6904	8.101F-08	4.13	4.02	6.245	-.03		
8	1.	.1717	.4284	8.196E-07	7.96	6.61	11.283	-.20	14.850	.08
		.2004	.6904	1.146E-06	8.75	7.16	11.122	-.22		
10	1.	.1718	.4284	2.490E-07	5.53	4.98	8.507	-.11	12.870	.27
		.2004	.6904	3.323E-07	6.08	5.33	8.282	-.14		
11	1.	.1718	.4284	1.008F-05	14.78	13.02	22.230	-.13	22.230	-.13
		.2005	.6914	1.449E-05	16.24	14.31	22.230	-.13		
14	1.	.1718	.4284	3.398E-07	6.57	4.41	7.522	-.49	11.850	.05
		.2005	.6905	5.021F-07	7.22	4.70	7.292	-.54		
16	1.	.1718	.4284	7.816E-06	12.30	12.56	21.450	.02	21.450	.02
		.2005	.6905	1.123F-05	13.52	13.81	21.450	.02		
17	1.	.1718	.4284	2.771E-07	5.68	5.13	8.755	-.11	13.080	.26
		.2005	.6905	3.735F-07	6.24	5.51	8.558	-.13		
18	1.	.1718	.4284	1.394E-08	3.90	2.86	4.888	-.36	9.930	.33
		.2005	.6905	2.621F-08	4.29	2.92	4.538	-.47		
19	1.	.1718	.4284	1.729F-06	8.40	8.37	14.283	-.00	16.890	.15
		.2005	.6905	2.428E-06	9.23	9.14	14.195	-.01		
20	1.	.1718	.4284	1.173E-06	8.93	7.08	12.082	-.26	15.420	.01
		.2005	.6905	1.662E-06	9.81	7.70	11.957	-.27		

THE CRACK AT THE END OF BLOCK 4000 A = .171765 C = .200496

****

BREAKTHROUGH HAS OCCURRED, A= .25001 C= .32334
AT 1.0 CYCLES OF STEP 16 IN BLOCK 5097

****

TRANSITION INTO CODE NR. 2013

Remarks: This printout provided the information on when the surface crack became the through-the-thickness crack. The total cycles applied were 5096 x 57 + 16 x 1 = 290,488 cycles.

```
SAMPLE CASE FOR SURFACE FLAW
THE CRACK AT THE BEGINNING OF BLOCK   5605      C = .681804
 STEP CYCLES   C      DC/DN     DELTCK KMAX-C  SIGMAX    R     SIGMAX-   R
                                                               (EFF)  (EFF)

****************************************************************************
 AT FRACTIONAL (.7,.8, OR .9) KSUBC OF   45.500
 KLIMIT= 45.506        C=    .682307
 IN BLOCK  5605        (   1-TH MIX   1-TH TIME)    STEP    16  CYCLE     0.0
****************************************************************************
```

Remarks: This printout indicated that if the real fracture toughness of the material is K_c = 45.5 ksi $\sqrt{in}$ (70% of input value), the crack will become unstable after the application of 5604 x 57 +15 = 319,443 cycles of loading.

```
SAMPLE CASE FOR SURFACE FLAW
THE CRACK AT THE BEGINNING OF BLOCK  5693      C = .854758
 STEP CYCLES  -C      DC/DN     DELTCK--KMAX--C--SIGMAX---R-----SIGMAX -- R----
                                                               (EFF)  (EFF)

*****************************************************************************
 AT FRACTIONAL (.7,.8, OR .9) KSUBC OF  52.000
 KLIMIT= 52.008       C=    .856797
 IN BLOCK  5693 ---- ( --1-TH MAX- 1-TH TIME) ---- STEP ----39---CYCLE------ 0.0----
*****************************************************************************
```

Remarks: This printout indicated that if the real fracture toughness of the material is $K_C = 52$ ksi $\sqrt{in}$ (80% of the input value), the crack will become unstable after the application of 5692 x 57 + 38 = 324,482 cycles of loading.

```
SAMPLE CASE FOR SURFACE FLAW
THE CRACK AT THE BEGINNING OF BLOCK  5748      C =1.020344
 STEP CYCLES   C     DC/DN     DELTCK KMAX-C  SIGMAX    R     SIGMAX    R
                                                                (EFF)  (EFF)

*******************************************************************
 AT FRACTIONAL (.7,.8, OR .9) KSUBC OF  58.500
 KLIMIT= 58.505       C=  1.031465
 IN BLOCK  5748    --(  1-TH MIX  1-TH TIME) ---STEP --- 18 --CYCLE ---  0.0
*******************************************************************
```

Remarks: This printout indicated that if the real material fracture toughness is K_C = 58.5 ksi $\sqrt{\text{in}}$ (90% of the input value), the crack will become unstable after the application of 5747 x 57 + 17 = 327,596 cycles of loading.

```
SAMPLE CASE FOR SURFACE FLAW

THE CRACK AT THE BEGINNING OF BLOCK  5782      C =1.199965

STEP CYCLES    C      DC/DN     DELTEK KMAX-C  SIGMAX    R      SIGMAX    R
                                                                (EFF)  (EFF)

*************************************************************************************
KLIMIT=    65.000    IS GREATER THAN   KSUBC=     65.000
VALUES BEFORE INSTABILITY WERE
STEP      4       CYCLE          6.    OF BLOCK   5783     ( 1-TH MIX   1-TH TIME)
 C= 1.2?6107
*************************************************************************************
```

<u>Remarks</u>: This printout indicated that if the design limit stress is used in the instability criteria, the crack will become unstable after the application of 5782 x 57 + 3 = 329,577 cycles of loading.

```
SAMPLE CASE FOR SURFACE FLAW
THE CRACK AT THE BEGINNING OF BLOCK  5833      C =1.711887
STEP CYCLES   C     DC/DN     DELTEK KMAX-C  SIGMAX   R     SIGMAX   R
                                                        (EFF)  (EFF)

****************************************************************************
**** INSTABILITY OCCURRED BY APPLIED KMAX NOT KLIMIT ****
KMAX=      65.637    IS GREATER THAN KSURC=      65.000
VALUES BEFORE INSTABILITY WERE
STEP     11     CYCLE      0.     OF BLOCK  5833     (  1-TH MIX   1-TH TIME)
C= 1.713165
****************************************************************************
```

Remarks: This printout indicated that the instability occurred when the maximum spectrum stress was applied. The total crack growth life is 5832 x 57 + 10 = 332,434 cycles.

SAMPLE CASE FOR SURFACE FLAW

ANALYSIS IS DONE WITH LOAD INTERACTION

CRACK GROWTH SUMMARY TABLE FOR EVERY 39 BLOCKS

INITIAL CRACK DEPTH WAS A= .1000
INITIAL CRACK LENGTH WAS C= .1000

A	.1003	.1006	.1010	.1013	.1016	.1020	.1023	.1026	.1030	.1033
C	.1005	.1010	.1014	.1019	.1024	.1029	.1034	.1039	.1044	.1049
A	.1037	.1040	.1044	.1049	.1051	.1055	.1059	.1063	.1067	.1070
C	.1055	.1060	.1065	.1071	.1076	.1081	.1087	.1092	.1098	.1104
A	.1074	.1078	.1083	.1087	.1091	.1095	.1099	.1104	.1108	.1112
C	.1110	.1115	.1121	.1127	.1133	.1139	.1145	.1152	.1158	.1164
A	.1117	.1121	.1126	.1131	.1136	.1140	.1145	.1150	.1155	.1160
C	.1171	.1177	.1184	.1190	.1197	.1204	.1211	.1218	.1225	.1232
A	.1165	.1171	.1176	.1181	.1187	.1192	.1198	.1203	.1209	.1215
C	.1239	.1246	.1254	.1261	.1268	.1276	.1284	.1291	.1299	.1307
A	.1221	.1227	.1233	.1239	.1246	.1252	.1259	.1265	.1272	.1279
C	.1315	.1324	.1332	.1340	.1349	.1358	.1367	.1376	.1385	.1394
A	.1286	.1293	.1300	.1307	.1314	.1322	.1329	.1337	.1344	.1352
C	.1403	.1413	.1423	.1433	.1443	.1453	.1463	.1474	.1484	.1495
A	.1360	.1369	.1377	.1385	.1394	.1403	.1412	.1421	.1430	.1440
C	.1506	.1518	.1529	.1541	.1552	.1564	.1577	.1589	.1602	.1615

A	.1449	.1459	.1469	.1480	.1490	.1501	.1512	.1523	.1534	.1546
C	.1628	.1642	.1655	.1670	.1684	.1699	.1714	.1729	.1745	.1761
A	.1558	.1570	.1582	.1595	.1608	.1621	.1635	.1649	.1663	.1678
C	.1776	.1795	.1812	.1830	.1849	.1868	.1887	.1907	.1927	.1948
A	.1693	.1709	.1725	.1741	.1759	.1776	.1794	.1813	.1832	.1852
C	.1970	.1992	.2015	.2039	.2063	.2088	.2114	.2141	.2169	.2196
A	.1872	.1894	.1916	.1938	.1962	.1986	.2012	.2038	.2066	.2094
C	.2229	.2260	.2293	.2327	.2362	.2399	.2439	.2479	.2520	.2565
A	.2124	.2155	.2186	.2222	.2258	.2296	.2336	.2377	.2421	.2467
C	.2611	.2660	.2712	.2767	.2825	.2886	.2952	.3022	.3096	.3176
A										
C	.3276	.3416	.3568	.3733	.3915	.4115	.4337	.4584	.4861	.5174
A										
C	.5532	.5946	.6430	.7037	.7712	.8599	.9770	1.1438	1.423[illegible]	

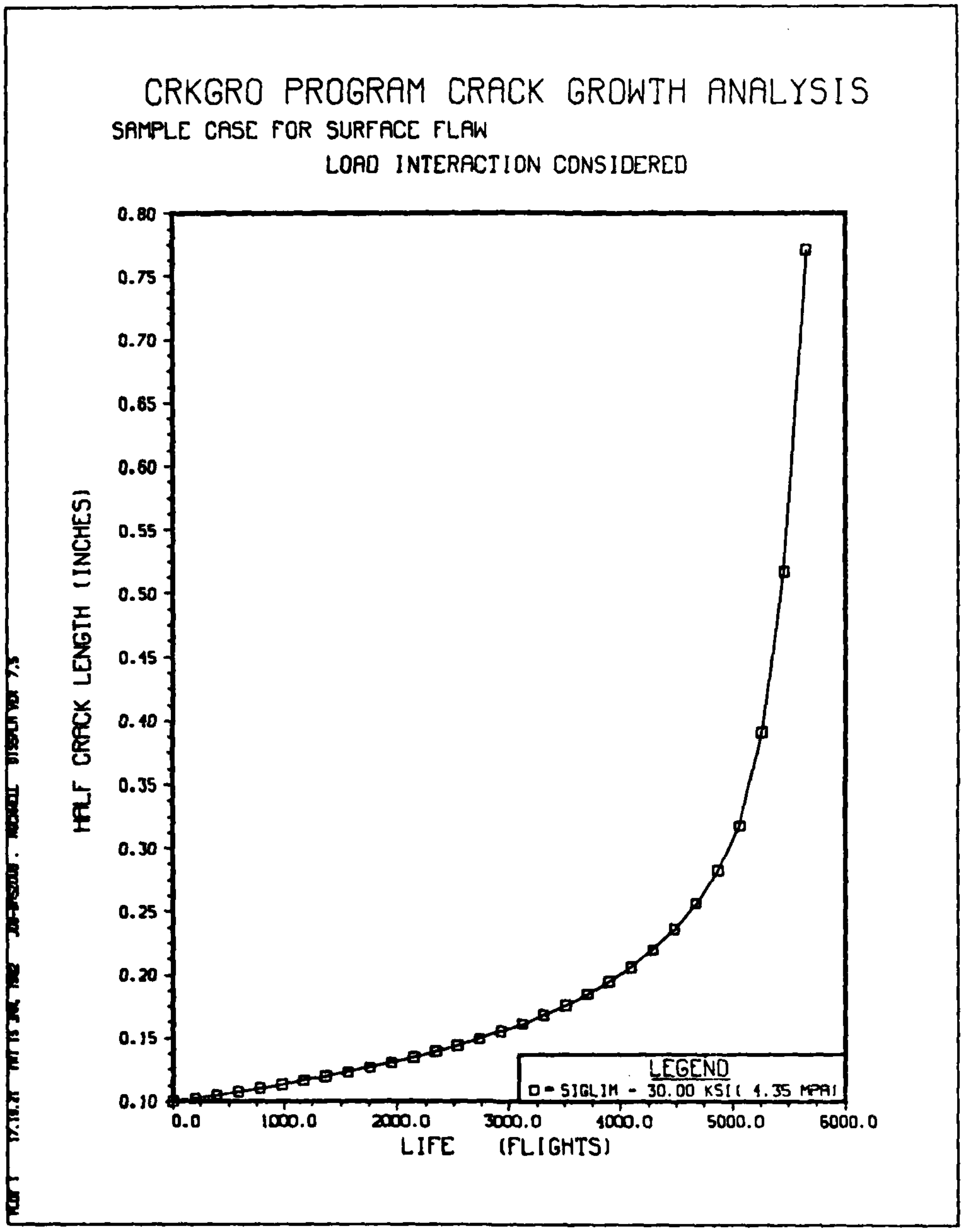
CRITICAL CRACK IS: C=1.7132IN BLOCK 5[illegible]3 STEP 11 CYCLE 0. (1-TH MIX 1-TH TIME)

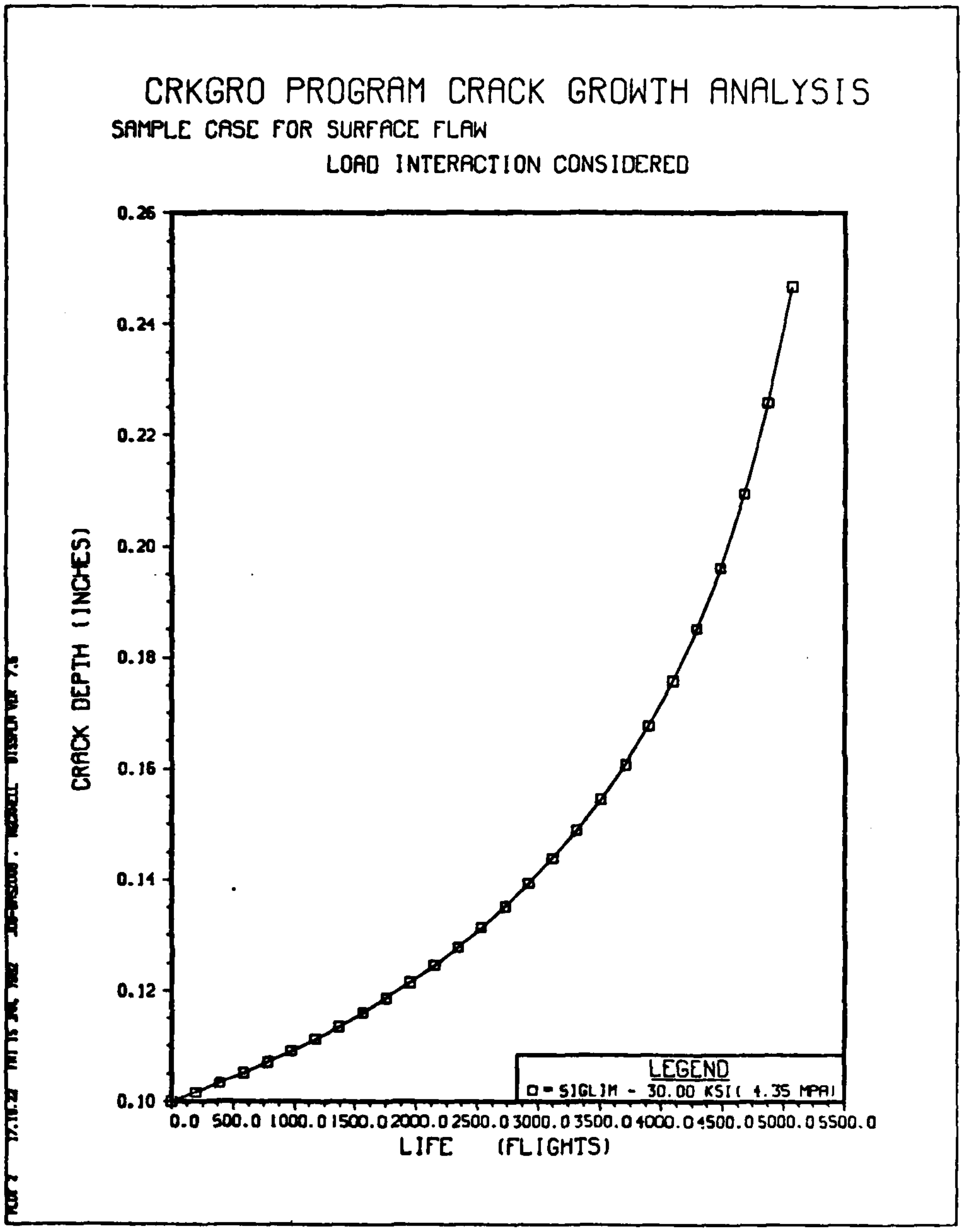
****

DETAILED FATIGUE CRACK GROWTH ANALYSIS PROGRAM C R K G R O

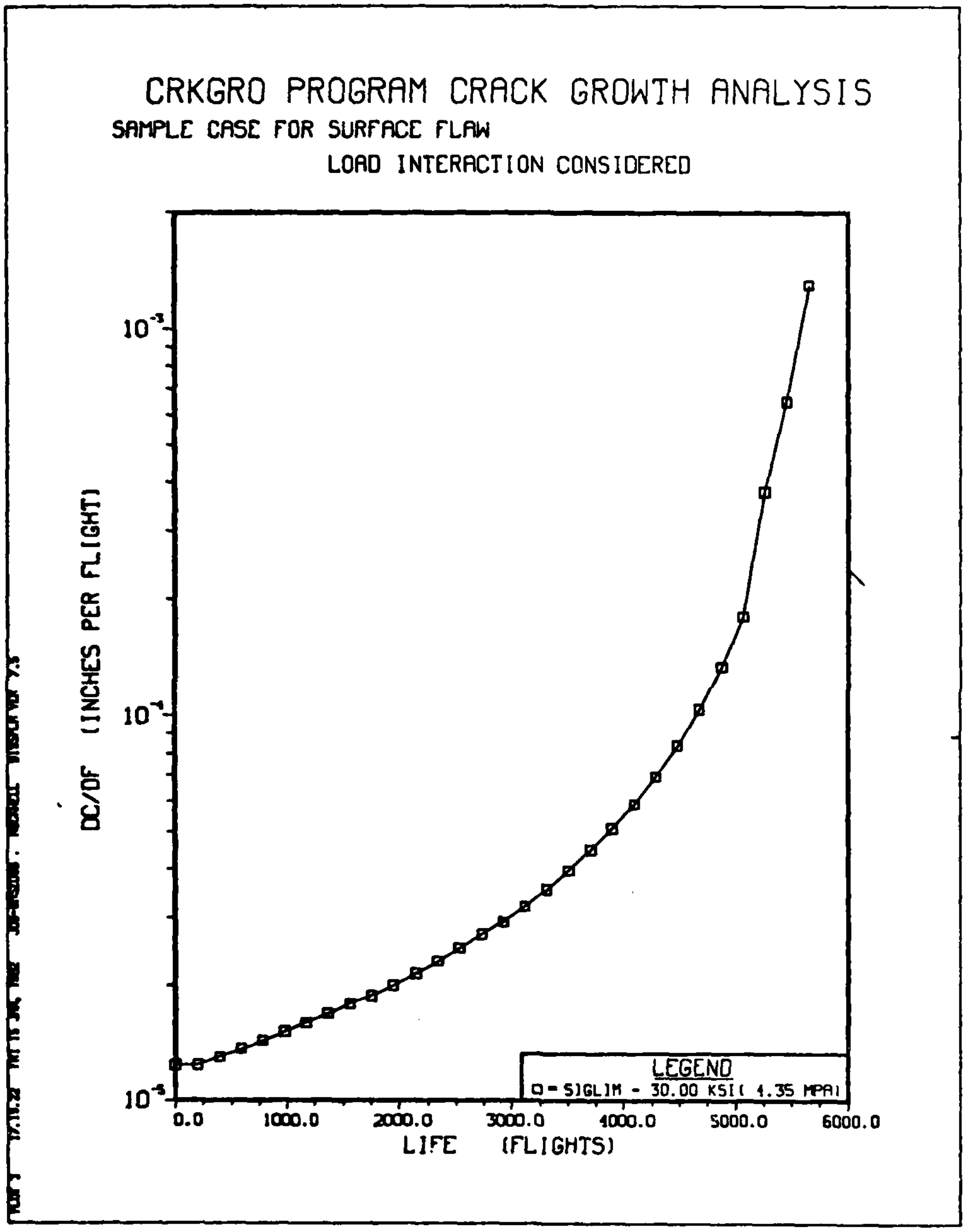
******************** E-O-F ON INPUT UNIT ********************

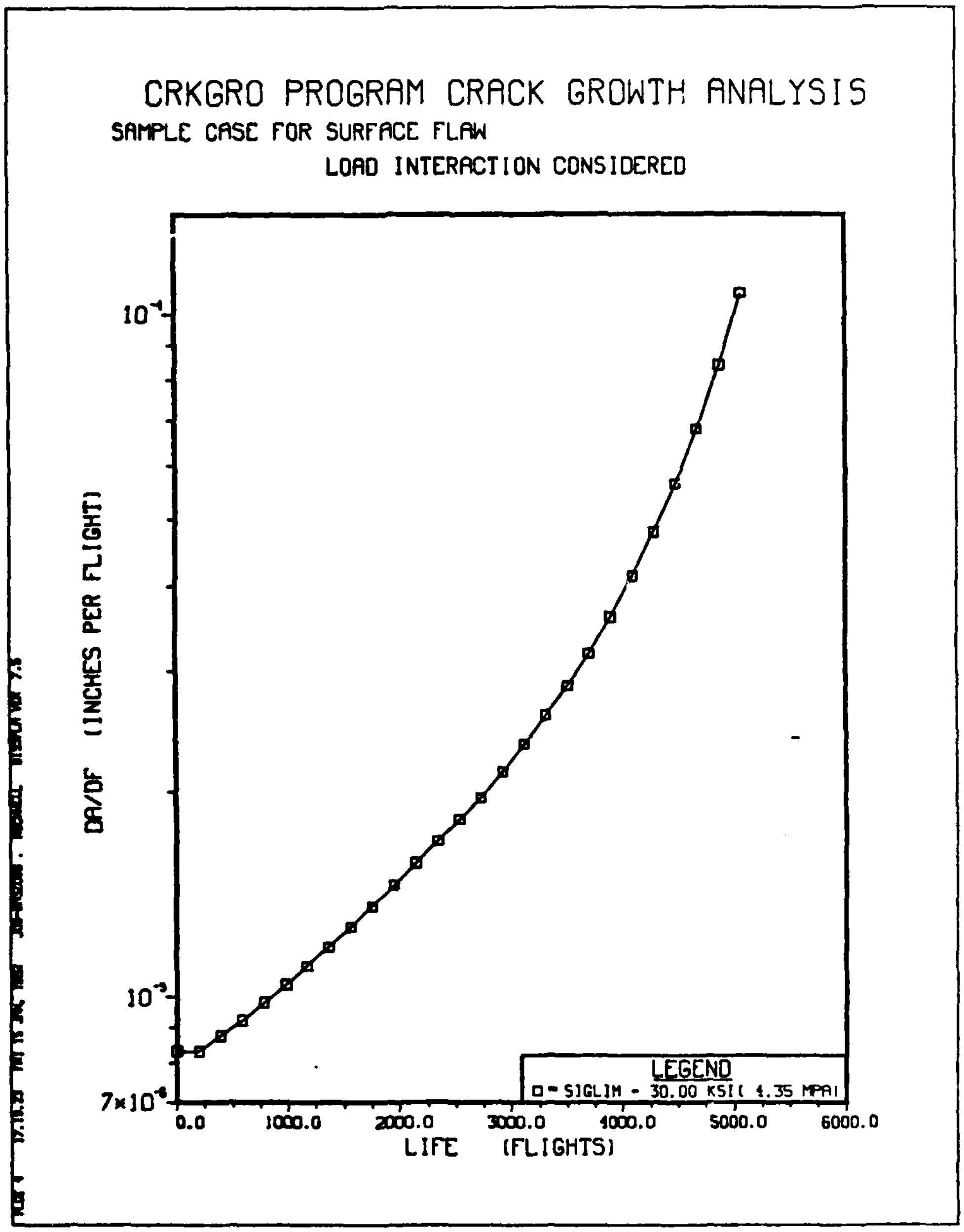
Remarks: Above is the summary crack growth table which can be directly used in the crack growth analysis report.


CRKGRO PROGRAM CRACK GROWTH ANALYSIS
SAMPLE CASE FOR SURFACE FLAW
LOAD INTERACTION CONSIDERED
HALF CRACK LENGTH (INCHES)
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
0.0
1000.0
2000.0
3000.0
4000.0
5000.0
6000.0
LIFE (FLIGHTS)
LEGEND
□ - SIGLIM - 30.00 KSI(4.35 MPA)

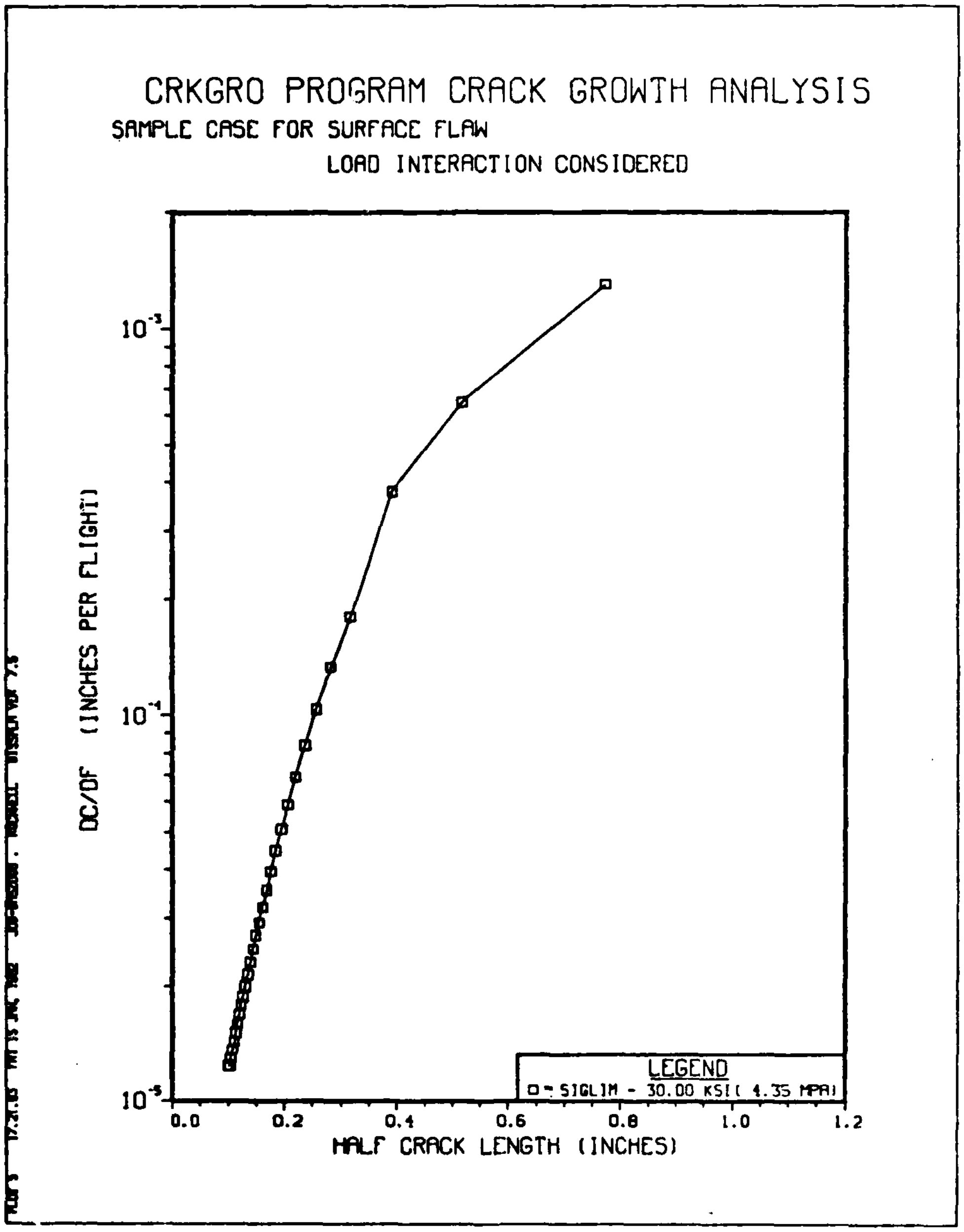


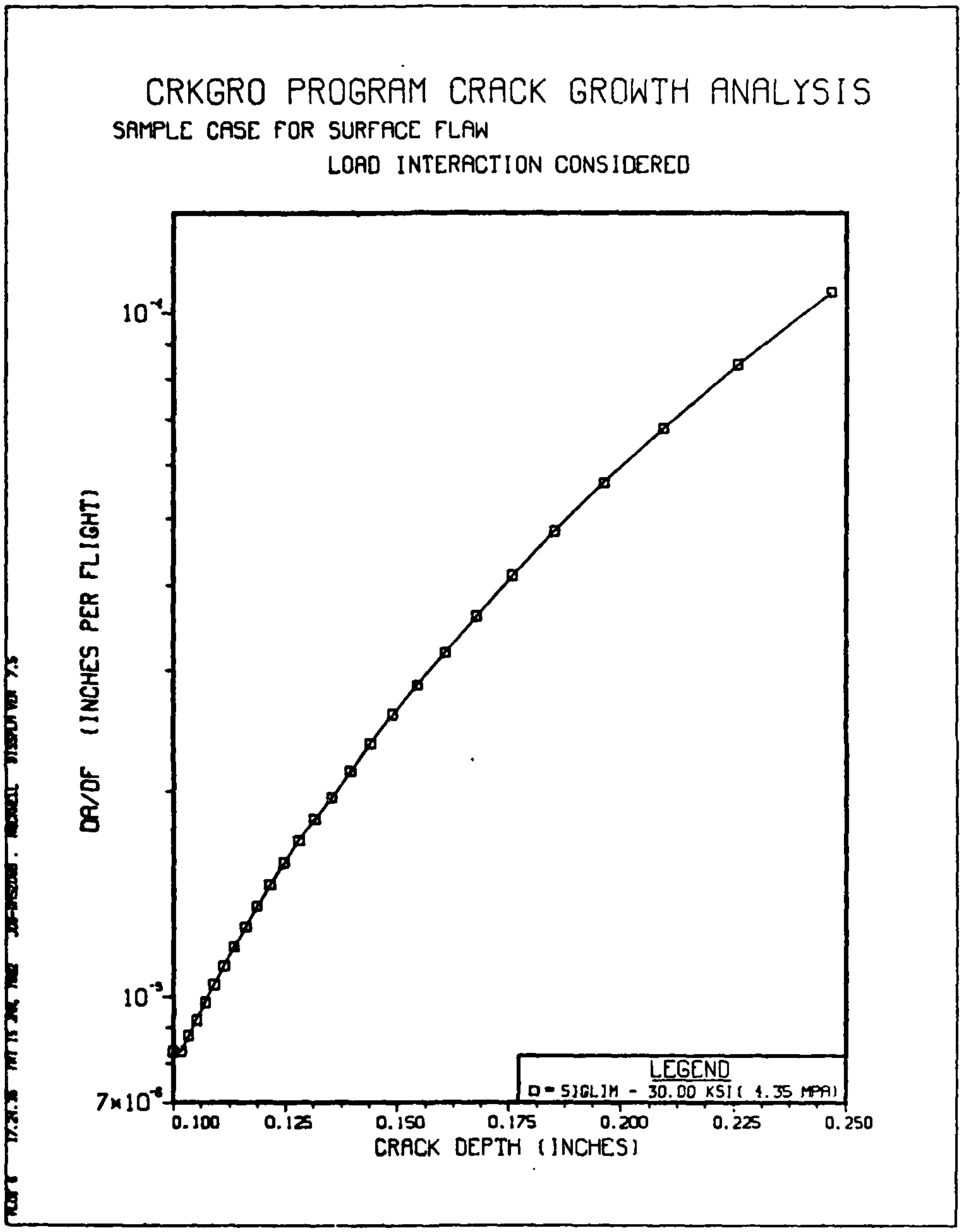
CRKGRO PROGRAM CRACK GROWTH ANALYSIS
SAMPLE CASE FOR SURFACE FLAW
LOAD INTERACTION CONSIDERED
CRACK DEPTH (INCHES)
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.0 500.0 1000.0 1500.0 2000.0 2500.0 3000.0 3500.0 4000.0 4500.0 5000.0 5500.0
LIFE (FLIGHTS)
LEGEND
□ = SIGLIM - 30.00 KSI(4.35 MPA)


CRKGRO PROGRAM CRACK GROWTH ANALYSIS
SAMPLE CASE FOR SURFACE FLAW
LOAD INTERACTION CONSIDERED
DC/DF (INCHES PER FLIGHT)
LIFE (FLIGHTS)
0.0
1000.0
2000.0
3000.0
4000.0
5000.0
6000.0
LEGEND
□ = SIGLIM - 30.00 KSI(4.35 MPA)

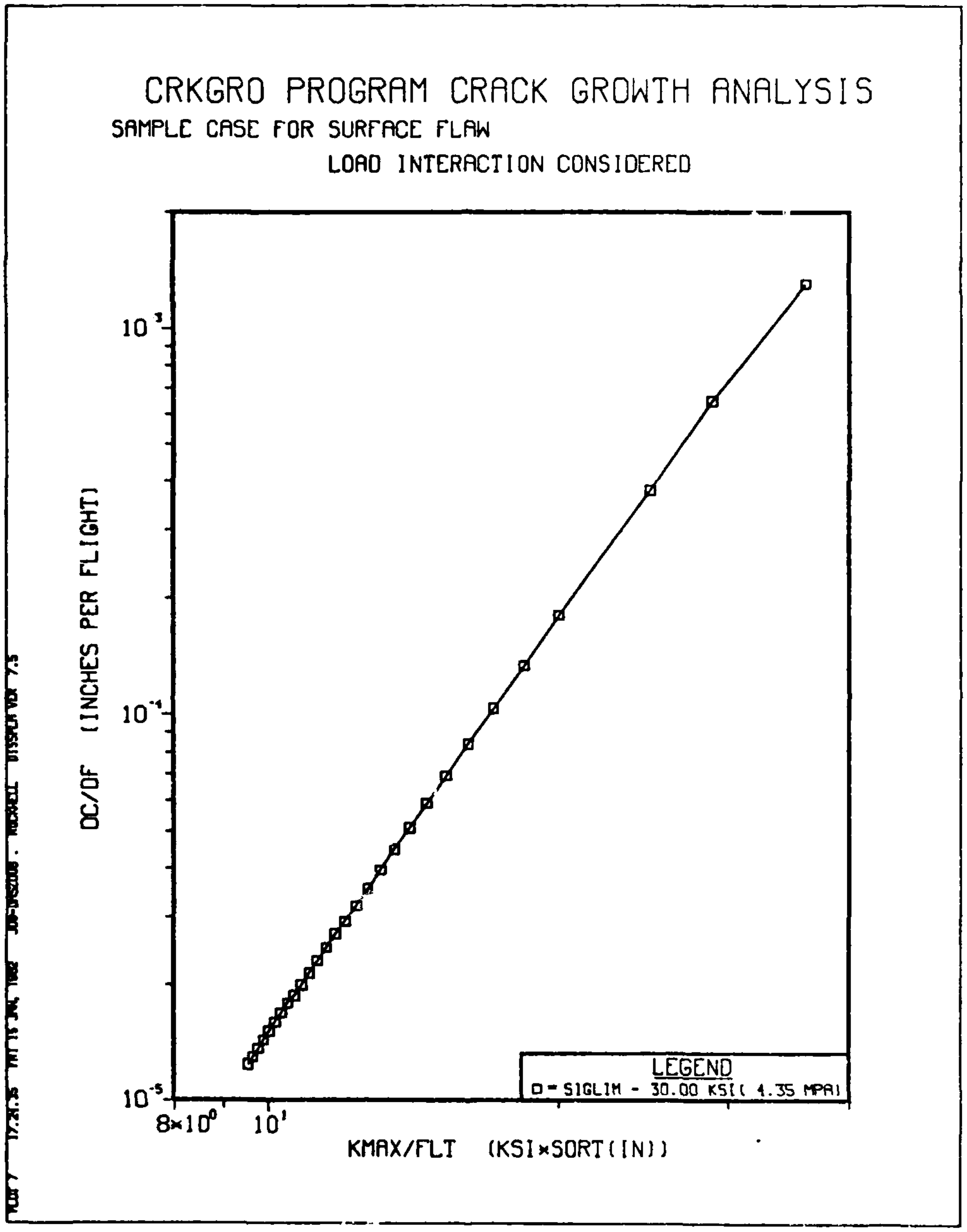


CRKGRO PROGRAM CRACK GROWTH ANALYSIS
SAMPLE CASE FOR SURFACE FLAW
LOAD INTERACTION CONSIDERED
DA/DF (INCHES PER FLIGHT)
LIFE (FLIGHTS)
LEGEND
SIGLIM - 30.00 KSI(4.35 MPA)
0.0
1000.0
2000.0
3000.0
4000.0
5000.0
6000.0

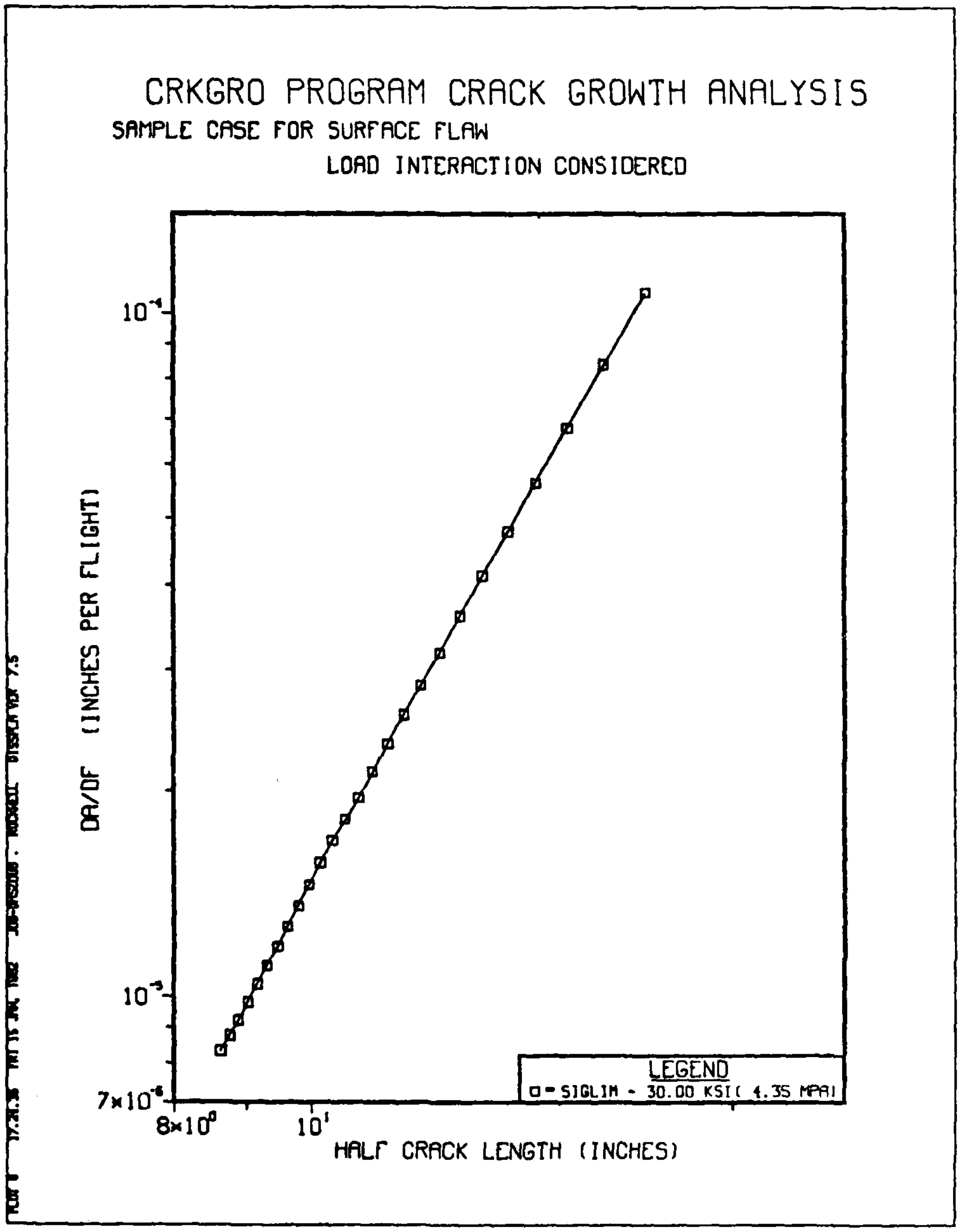

CRKGRO PROGRAM CRACK GROWTH ANALYSIS
SAMPLE CASE FOR SURFACE FLAW
LOAD INTERACTION CONSIDERED
DC/DF (INCHES PER FLIGHT)
HALF CRACK LENGTH (INCHES)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
LEGEND
□ = SIGLIM - 30.00 KSI(4.35 MPA)



CRKGRO PROGRAM CRACK GROWTH ANALYSIS
SAMPLE CASE FOR SURFACE FLAW
LOAD INTERACTION CONSIDERED
DA/DF (INCHES PER FLIGHT)
CRACK DEPTH (INCHES)
LEGEND
□ = SIGLIM - 30.00 KSI (4.35 MPA)



CRKGRO PROGRAM CRACK GROWTH ANALYSIS
SAMPLE CASE FOR SURFACE FLAW
LOAD INTERACTION CONSIDERED
DC/DF (INCHES PER FLIGHT)
KMAX/FLT (KSI×SQRT(IN))
LEGEND
□ = SIGLIM - 30.00 KSI(4.35 MPA)



CRKGRO PROGRAM CRACK GROWTH ANALYSIS
SAMPLE CASE FOR SURFACE FLAW
LOAD INTERACTION CONSIDERED
DA/DF (INCHES PER FLIGHT)
10^{-4}
10^{-5}
7×10^{-6}
8×10^{0}
10^{1}
HALF CRACK LENGTH (INCHES)
LEGEND
□ = SIGLIM - 30.00 KSI(4.35 MPA)

The second example is a test data correlation case. Test data were generated in Phase III experimental verification program (Ref. 12). The test specimen in this example case is shown in figure 5, which is a 2219-T851 aluminum center-crack-tension (CCT) specimen. It is a standard ASTM specimen used for da/dN testing. The initial half crack length was $c_i = 0.148$ in, which was the measured dimension after the application of 20,000 constant amplitude precracking cycles. The test specimen was the fighter air-to-ground (A-G) mission generated in Phase III of this research and development work. Appendix C contains the peaks and valleys of the test spectrum in the percentage of the design limit stress ($\% \ \sigma_{lim}$) format.

Since the crack was a center through-crack, crack code 2010 was called-out. The crack-growth-rate constants and load interaction model parameters used in the prediction were as follows. In this example, the single-slope crack growth rate data was used.

$C = 5.066 \times 10^{-10}$ (in ksi unit) $\qquad q = 1.0$

$n = 3.83 \qquad R^{+}_{cut} = +0.75$

$m = 0.6 \qquad R^{-}_{cut} = -0.75$

$K_{th_o} = 2.5 \text{ ksi} \sqrt{\text{in.}} \qquad A = 1.0$

$K_c = 65 \text{ ksi} \sqrt{\text{in.}} \qquad \sigma_{ty} = 48 \text{ ksi}$

$R_{so} = 3.0$

Both the load-interaction and no load-interaction options were executed in this example in order to illustrate the spectrum load interaction effects. For the load interaction solution option, CRKGRO predicted the crack-growth life was $N_p = 19 \times 263 + 1{,}452/19 = 5{,}073$ flights, or $19 \times 4{,}997 + 1452 = 96{,}395$ cycles. Compared to the test result ($N_T = 5{,}403$ flights), the prediction ratio is $N_p/N_T = 0.94$. The noload interaction prediction was $N_p = 3{,}948$ flights (75,016 cycles), compared to the test result, $N_p/N_T = 0.73$.

All the input echoes and the print-outs of the outputs are shown in the next few pages.

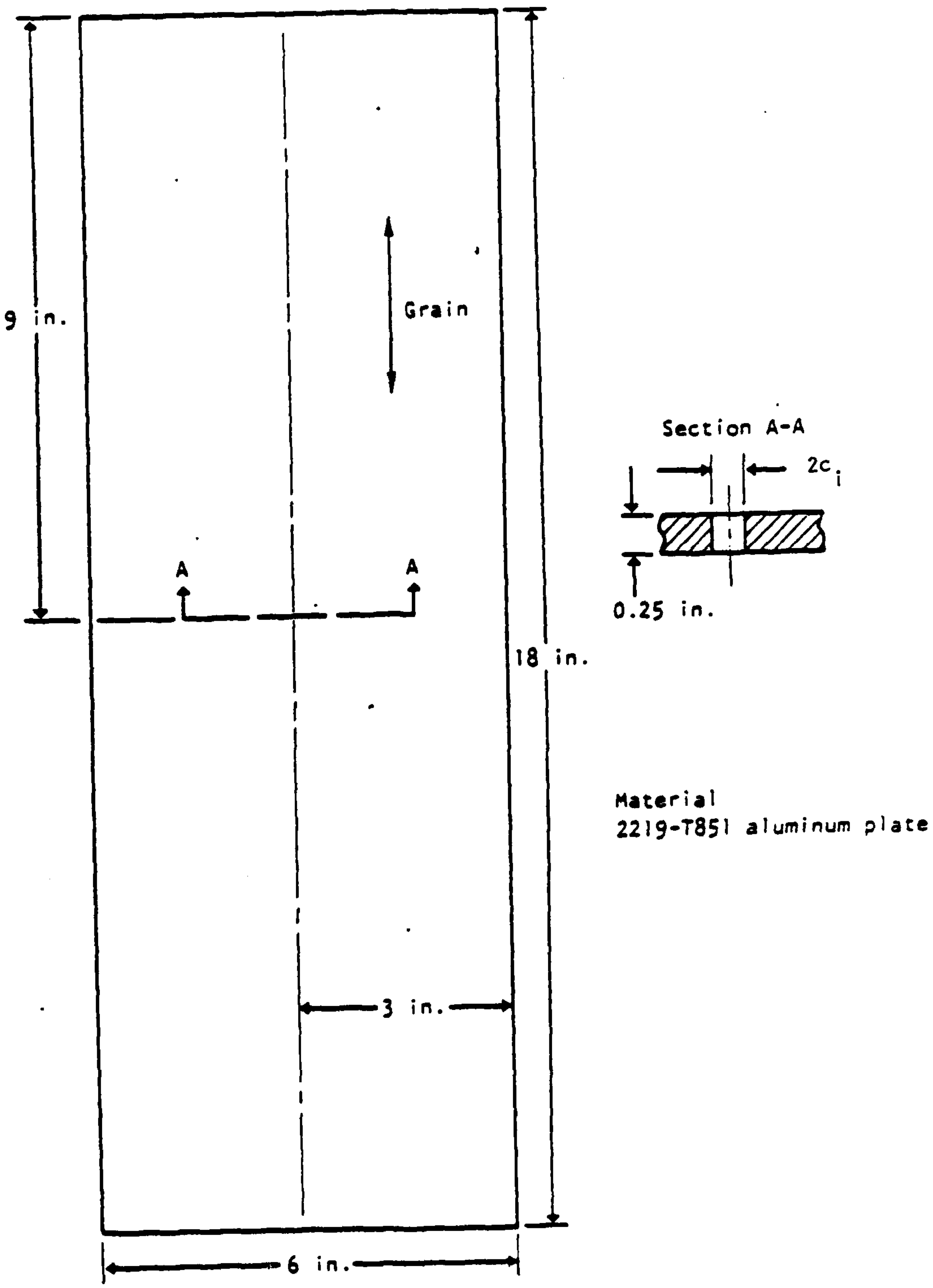


Figure 5. Test Specimen Configuration

```
TITLE
F-8-2        AIR-TO-GROUND SPECTRUM, BASELINE
END
MATERIAL
2219-T851 ALUMINUM
5.066  -10   3.83                              .6         1.0
  65.      45.        48.
THRESHOLD
2.5        1.
LIMITS
.145                                           .75        -.75
ANALYSIS
LOAD INTERACTION      BOTH       3.0
2010          6.       .25
          1 24.0      BY MAXIMUM
SPECTRUM
AIR TO GROUND SPECTRUM
0.30           1    12
MAX-MIN          PART1
END SPECTRUM
MISSION =200
  263
OUTPUT
         5                                       50
END DATA
```

```
DETAILED  FATIGUE  CRACK  GROWTH  ANALYSIS  PROGRAM      C R K G R O

F-B-2      AIR-TO-GROUND SPECTRUM, BASELINE

CRACK CODE      2010 --- THROUGH CRACK, CENTERED

LOAD INTERACTION :  WILLENBORG-CHANG

DAMAGE ACCUMULATION     VROMAN (LINEAR APPRX.)
CRACK GROWTH RATE EQ.     MODIFIED WALKER
ANALYSIS IS PERFORMED WITH A SPECTRUM THAT HAS BEEN RANGED PAIRED.

INSTABILITY WILL BE BASED ON MAXIMUM STRESS

MATERIAL :  2219-T851 ALUMINUM

                                          DEPTH          LENGTH
                                        DIRECTION       DIRECTION
FRACTURE TOUGHNESS                        45.000          65.000
GROWTH RATE EQ. CONST.  C          0.                 5.0660E-10
GROWTH RATE EQ. EXP.    N                  0.0000          3.8300

GROWTH RATE EQ. EXP.    M                  .6000
GROWTH RATE EQ. EXP.    Q                 1.0000

YIELD STRENGTH               48.000

DELTA KTH = (1 - 1.00 * R) *   2.500

+R CUT-OFF   =    .75
-R CUT-OFF   =   -.75

RETARDATION SHUT-OFF RATIO FOR CRACK ARREST = 3.0000

HALF PLATE WIDTH (B)   =  3.000
PLATE THICKNESS  (T)   =   .250

INITIAL HALF CRACK LENGTH (C)  =    .1450
```

```
M I S S I O N   M I

MAXIMUM NUMBER OF LOAD BLOCKS =   200
THE LOADING SPECTRUM HAS     1 MISSION(S)
DESIGN LIMIT STRESS =   24.000  (KSI)

     ******************  END OF INPUT  ******************
```

F-8-2 AIR-TO-GROUND SPECTRUM, BASELINE

02/06/81

ESTIMATION OF THE CRITICAL CRACK LENGTH
BASED ON KLIMIT AND CONSTANT ASPECT RATIO

ITERATION	CRACK SIZE	STRESS INTENSITY (LIMIT)	STRESS INTENSITY CORRECTION FACTOR
1	.1450	16.222	1.0014
2	2.9850	[illegible]29.317	11.2840
3	1.5650	64.4[illegible]9	1.2103
4	2.2750	105.4[illegible]2	1.6428
5	1.9200	80.524	1.3661
6	1.7425	71.766	1.2784
7	1.6538	67.959	1.2423
8	1.6094	66.153	1.2258
9	1.5872	65.274	1.2180

APPROXIMATE CRITICAL CRACK (A OR C) = 1.5E7
WHEN K-LIMIT IS WITHIN A 0.5% TOLERANCE OF K CRITICAL

F-6-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK 1 C = .145000 02/06/81

STEP	CYCLES	C	DC/DN	DELTCK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
2950	1.	.1492	7.844E-08	4.43	2.85	8.670	.26	4.141	-.56
2951	1.	.1492	2.691E-07	6.12	3.95	9.720	.08	5.740	-.55
2952	1.	.1492	4.452E-07	5.46	6.04	13.140	.39	9.520	.16
2953	1.	.1492	6.482E-08	3.20	4.15	10.770	.57	6.644	.23
2954	1.	.1492	2.831E-06	12.93	9.18	15.720	-.01	13.361	-.19
2955	1.	.1492	0.	2.87	.96	5.730	.27	1.398	-.75
2956	1.	.1492	9.502E-06	15.24	12.41	19.170	-.16	18.051	-.23
2957	1.	.1492	4.370E-08	4.33	2.11	7.050	.11	3.068	-.75
2958	1.	.1492	2.097E-07	5.34	4.74	11.040	.30	6.897	-.13
2959	1.	.1492	9.754E-07	8.64	6.50	12.720	.01	9.453	-.33
2960	1.	.1492	1.255E-06	8.83	7.43	13.830	.07	10.808	-.19
2961	1.	.1492	0.	2.12	.39	6.030	.49	.574	-.75
2962	1.	.1492	5.939E-06	12.56	11.44	18.120	-.01	16.636	-.10
2963	1.	.1492	6.817E-07	7.92	5.54	11.560	.01	8.060	-.43
2964	1.	.1492	1.179E-06	8.97	7.04	13.350	.02	10.243	-.27
2965	1.	.1492	5.519E-07	6.80	6.14	12.510	.21	8.926	-.11
2966	1.	.1492	1.557E-07	5.36	4.00	10.050	.22	5.819	-.34
2967	1.	.1492	2.554E-07	6.04	3.89	9.660	.09	5.664	-.55
2968	1.	.1492	8.821E-08	4.64	3.21	9.150	.26	4.673	-.44
2969	1.	.1492	4.898E-07	7.26	5.25	11.310	.07	7.634	-.38
2970	1.	.1492	0.	2.37	.68	4.710	.27	.994	-.75
2971	1.	.1492	2.742E-08	2.52	3.40	10.050	.64	4.942	.26
2972	1.	.1492	4.402E-07	7.05	5.15	11.220	.09	7.492	-.37
2973	1.	.1492	1.525E-08	2.85	1.76	7.830	.47	2.554	-.62
2974	1.	.1492	1.163E-08	2.74	1.45	7.410	.46	2.110	-.75
2975	1.	.1492	4.349E-06	12.85	9.07	15.690	-.19	13.201	-.42
2976	1.	.1492	0.	2.43	.64	4.980	.29	.933	-.75
2977	1.	.1492	3.473E-07	6.45	5.20	11.400	.18	7.561	-.24
2978	1.	.1492	2.827E-08	3.24	2.78	9.090	.48	4.047	-.16
2979	1.	.1492	1.710E-06	9.28	8.22	14.700	.08	11.951	-.13
2980	1.	.1492	1.993E-07	4.52	5.15	11.670	.44	7.489	.12
2981	1.	.1492	3.335E-08	3.57	2.34	8.310	.38	3.404	-.52
2982	1.	.1492	4.651E-07	6.89	5.10	11.190	.10	7.425	-.35
2983	1.	.1492	6.765E-07	7.90	5.47	11.490	0.00	7.963	-.44
2984	1.	.1492	2.121E-07	5.69	3.10	8.310	.00	4.503	-.75
2985	1.	.1492	5.55[illegible]E-06	13.63	10.16	16.830	-.18	14.782	-.34
2986	1.	.1492	9.067E-08	2.43	7.78	14.670	.76	11.323	.69
2987	1.	.1492	1.175E-06	8.72	7.27	13.650	.07	10.582	-.20
2988	1.	.1492	9.314E-07	8.41	6.65	12.930	.05	9.674	-.27
2989	1.	.1492	2.677E-07	5.94	4.94	11.160	.23	7.180	-.20
2990	1.	.1492	1.734E-06	9.71	8.01	14.430	.02	11.653	-.21
2991	1.	.1492	3.984E-07	5.11	6.71	13.350	.44	9.765	.24
2992	1.	.1492	1.507E-07	3.69	5.80	12.510	.57	6.443	.36
2993	1.	.1492	0.	3.07	1.16	6.180	.28	1.693	-.75
2994	1.	.1492	3.779E-08	3.71	2.53	8.520	.37	3.675	-.47
2995	1.	.1492	6.187E-07	7.71	5.58	11.670	.04	8.122	-.38

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK 1 C = .145000 02/06/81

STEP	CYCLES	C	DC/DN	DELTCK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
2996	1.	.1492	0.	3.03	1.30	6.780	.35	1.889	-.75
2997	1.	.1492	2.147E-06	10.25	8.48	14.940	.00	12.342	-.21
2998	1.	.1492	0.	2.08	1.65	8.100	.63	2.400	-.26
2999	1.	.1492	5.744E-07	7.53	5.01	10.920	-.00	7.287	-.50
4946	1.	.1522	7.485E-08	3.54	3.91	9.210	.45	5.635	.09
4947	1.	.1522	4.076E-06	10.60	10.46	15.990	.05	15.070	-.01
4948	1.	.1522	6.055E-08	4.21	2.94	7.560	.20	4.230	-.43
4949	1.	.1522	0.	2.35	1.53	6.390	.47	2.204	-.54
4950	1.	.1522	5.759E-08	3.42	3.48	8.700	.43	5.011	.02
4951	1.	.1522	1.569E-05	16.66	14.58	21.000	-.14	21.000	-.14
4952	1.	.1522	3.767E-07	5.98	5.59	11.160	.23	8.055	-.07
4953	1.	.1522	7.565E-07	6.12	7.79	13.620	.35	11.213	.21
4954	1.	.1522	2.341E-06	9.98	6.93	14.670	.02	12.863	-.12
4955	1.	.1522	3.250E-08	3.19	2.95	6.460	.46	4.243	-.08
4956	1.	.1522	1.569E-07	4.94	4.41	9.870	.28	6.348	-.12
4957	1.	.1522	7.771E-07	8.00	6.37	11.850	.03	9.181	-.25
4958	1.	.1522	1.653E-05	16.87	14.79	21.300	-.14	21.300	-.14
4959	1.	.1522	8.804E-08	2.21	9.76	15.870	.80	14.050	.75
4960	1.	.1522	4.145E-08	3.81	2.69	7.920	.31	3.876	-.42
4961	1.	.1522	9.033E-07	7.29	7.05	12.810	.18	10.147	-.03
4962	1.	.1522	9.391E-08	4.56	3.72	9.150	.26	5.355	-.23
4963	1.	.1522	2.365E-08	2.46	3.19	9.090	.61	4.591	.23
4964	1.	.1522	2.354E-08	3.27	2.45	7.830	.40	3.526	-.34
4965	1.	.1522	2.889E-06	9.19	10.16	16.110	.18	14.633	.10
4966	1.	.1522	4.183E-06	10.23	11.01	16.980	.13	15.860	.07
4967	1.	.1522	1.925E-07	4.92	4.71	10.350	.32	6.779	-.04
4968	1.	.1522	1.130E-06	8.67	7.18	12.840	.03	10.337	-.21
4969	1.	.1522	9.287E-07	8.40	6.66	12.240	.01	9.586	-.26
4970	1.	.1522	1.201E-07	3.81	4.77	10.620	.48	6.867	.20
4971	1.	.1522	2.279E-06	10.08	6.81	14.610	.01	12.680	-.15
4972	1.	.1523	5.669E-06	12.10	11.36	17.310	-.01	16.354	-.07
4973	1.	.1523	8.660E-08	2.54	7.08	13.200	.72	10.189	.64
4974	1.	.1523	4.977E-07	5.56	6.84	12.720	.37	9.846	.19
4975	1.	.1523	1.021E-07	4.77	3.10	8.070	.15	4.459	-.54
4976	1.	.1523	1.849E-09	3.08	2.12	7.410	.40	3.049	-.46
4977	1.	.1523	3.104E-07	4.25	7.54	13.560	.55	10.852	.44
4978	1.	.1523	1.930E-06	9.58	8.46	14.250	.03	12.167	-.13
4979	1.	.1523	0.	2.17	.93	6.090	.49	1.342	-.75
4980	1.	.1523	5.401E-06	11.94	11.22	17.160	-.00	16.151	-.06
4981	1.	.1523	4.325E-07	5.79	5.88	11.610	.28	8.463	.01
4982	1.	.1523	2.355E-07	4.81	5.22	10.980	.37	7.520	.08
4983	1.	.1523	0.	2.21	1.83	7.500	.58	2.639	-.21
4984	1.	.1523	1.38 E-06	8.13	7.68	13.680	.14	11.345	-.03
4985	1.	.1523	0.	2.15	.70	5.490	.44	1.005	-.75
4986	1.	.1523	2.444E-07	5.96	4.65	10.050	.15	6.699	-.28
4987	1.	.1523	9.827E-08	4.77	3.45	8.670	.21	4.968	-.38

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK 1 C = .145000 02/06/81

STEP	CYCLES	C	DC/DN	DELTCK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
4988	1.	.1523	2.35[illegible]E-06	9.67	8.63	14.430	.04	12.427	-.12
4989	1.	.1523	2.504E-07	6.06	4.05	9.120	.04	5.828	-.50
4990	1.	.1523	1.044E-07	4.81	3.18	8.190	.15	4.574	-.51
4991	1.	.1523	2.3[illegible]E-08	3.38	1.78	6.780	.35	2.565	-.73
4992	1.	.1523	7.61[illegible]E-06	14.38	11.71	17.700	-.17	16.868	-.23
4993	1.	.1523	4.72[illegible]E-08	3.90	2.09	5.850	.04	3.012	-.75
4994	1.	.1523	2.02[illegible]E-06	9.85	8.51	14.260	.01	12.250	-.16
4995	1.	.1523	0.	2.10	1.45	7.020	.57	2.085	-.45

THE CRACK AT THE END OF BLOCK 1 IS .152278

```
F-B-2        AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK     19      C = .875560     02/06/81

STEP CYCLES    C      DC/DN    DELTCK KMAX-C  SIGMAX    R     SIGMAX   R
                                                              (EFF)  (EFF)

***************************************************************************
AT FRACTIONAL (.7, .8, OR .9) KSUBC OF  45.500
KLIMIT= 45.503      C= .968189
IN BLOCK    19      SEGMT  1 (  1-TH TIME)    STEP  1832  CYCLE        0.0
***************************************************************************

***************************************************************************
AT FRACTIONAL (.7, .8, OR .9) KSUBC OF  52.000
KLIMIT= 52.000      C=  1.200111
IN BLOCK    19      SEGMT  1 (  1-TH TIME)    STEP  4101  CYCLE        0.0
***************************************************************************
```

```
F-B-2       AIR-TO-GROUND SPECTRUM, BASELINE
THE CRACK AT THE BEGINNING OF BLOCK     20      C =1.327377     02/06/81
 STEP CYCLES    C      DC/DN     DELTCK KMAX-C  SIGMAX    R     SIGMAX   R
                                                                 (EFF) (EFF)

*******************************************************************************
 AT FRACTIONAL (.7,.8, OR .9) KSUBC OF  58.500
 KLIMIT= 58.523      C=  1.396453
 IN BLOCK     20      SEGMT  1 (  1-TH TIME)    STEP   386  CYCLE       0.0
*******************************************************************************

*******************************************************************************
 KLIMIT=    65.006   IS GREATER THAN  KSUBC=     65.000
 VALUES BEFORE INSTABILITY WERE
 STEP  1103     CYCLE                  OF BLOCK     20      SEGMT  1 (  1-TH TIME)
  C= 1.572493
*******************************************************************************

*******************************************************************************
 **** INSTABILITY OCCURRED BY APPLIED KMAX NOT KLIMIT ****
 KMAX=      68.063   IS GREATER THAN KSUBC=      65.000
 VALUES BEFORE INSTABILITY WERE
 STEP  1452     CYCLE        0.        OF BLOCK     20      SEGMT  1 (  1-TH TIME)  C= 1.684931
*******************************************************************************
```

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE 02/06/81

ANALYSIS IS DONE WITH LOAD INTERACTION

CRACK GROWTH SUMMARY TABLE FOR EVERY 1 BLOCKS

INITIAL CRACK LENGTH WAS C= .1450

C	.1523	.1603	.1691	.1790	.1899	.2023	.2162	.2322	.2506	.2721
C	.2975	.3287	.3652	.4120	.4726	.5553	.6759	.8756	1.3274	

CRITICAL CRACK IS: C=1.6849IN BLOCK 20 STEP 1452 CYCLE 0.

****

AD-A118 968 ROCKWELL INTERNATIONAL EL SEGUNDO CA NORTH AMERICAN --ETC F/G 9/2
A USER'S MANUAL FOR A DETAILED LEVEL FATIGUE CRACK GROWTH ANALY--ETC(U)
NOV 81 J B CHANG, M SZAMOSSI, K LIU F33615-77-C-3121
UNCLASSIFIED NA-81-148 AFWAL-TR-81-3093-VOL-1 NL

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     RERUN CASE WITH NO LOAD INTERACTION FOR SIGMA-LIMIT =    24.00

*******************************************************************************
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F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK 1 C = .145000 02/06/81

STEP	CYCLES	C	DC/DN	DELTCK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
2950	1.	.1505	2.430E-07	4.45	8.98	8.670	.26	8.670	.26
2951	1.	.1505	6.083E-07	6.15	8.71	9.720	.08	9.720	.08
2952	1.	.1505	7.425E-07	5.49	9.07	13.140	.39	13.140	.39
2953	1.	.1505	1.597E-07	3.21	7.43	10.770	.57	10.770	.57
2954	1.	.1505	4.684E-06	10.85	10.85	15.720	0.00	15.720	0.00
2955	1.	.1505	4.729E-08	2.88	3.96	5.730	.27	5.730	.27
2956	1.	.1505	1.002E-05	13.23	13.23	19.170	0.00	19.170	0.00
2957	1.	.1505	1.577E-07	4.35	4.87	7.050	.11	7.050	.11
2958	1.	.1505	5.394E-07	5.36	7.62	11.040	.30	11.040	.30
2959	1.	.1505	2.026E-06	8.68	8.78	12.720	.01	12.720	.01
2960	1.	.1505	2.418E-06	8.86	9.55	13.830	.07	13.830	.07
2961	1.	.1505	2.569E-08	2.13	4.16	6.030	.49	6.030	.49
2962	1.	.1505	8.073E-06	12.51	12.51	18.120	0.00	18.120	0.00
2963	1.	.1505	1.436E-06	7.95	7.99	11.580	.01	11.580	.01
2964	1.	.1505	2.376E-06	9.01	9.22	13.350	.02	13.350	.02
2965	1.	.1505	1.141E-06	6.83	8.64	12.510	.21	12.510	.21
2966	1.	.1505	4.718E-07	5.38	6.94	10.050	.22	10.050	.22
2967	1.	.1505	5.843E-07	6.07	6.67	9.660	.09	9.660	.09
2968	1.	.1505	2.931E-07	4.66	6.32	9.150	.26	9.150	.26
2969	1.	.1505	1.134E-06	7.29	7.81	11.310	.07	11.310	.07
2970	1.	.1505	2.267E-08	2.38	3.25	4.710	.27	4.710	.27
2971	1.	.1505	8.291E-08	2.53	6.94	10.050	.64	10.050	.64
2972	1.	.1505	1.049E-06	7.08	7.75	11.220	.09	11.220	.09
2973	1.	.1505	7.505E-08	2.86	5.41	7.830	.47	7.830	.47
2974	1.	.1505	6.339E-08	2.75	5.12	7.410	.46	7.410	.46
2975	1.	.1505	4.652E-06	10.83	10.83	15.690	0.00	15.690	0.00
2976	1.	.1505	2.619E-08	2.44	3.44	4.980	.29	4.980	.29
2977	1.	.1505	8.765E-07	6.48	7.87	11.400	.18	11.400	.18
2978	1.	.1505	1.269E-07	3.25	6.28	9.090	.48	9.090	.48
2979	1.	.1505	2.961E-06	9.32	10.15	14.700	.08	14.700	.08
2980	1.	.1505	3.999E-07	4.54	8.06	11.670	.44	11.670	.44
2981	1.	.1505	1.383E-07	3.58	5.74	8.310	.38	8.310	.38
2982	1.	.1505	9.891E-07	6.92	7.73	11.190	.10	11.190	.10
2983	1.	.1505	1.411E-06	7.93	7.93	11.490	0.00	11.490	0.00
2984	1.	.1505	4.041E-07	5.72	5.74	8.310	.00	8.310	.00
2985	1.	.1505	6.087E-06	11.62	11.62	16.830	0.00	16.830	0.00
2986	1.	.1505	1.299E-07	2.44	10.13	14.670	.76	14.670	.75
2987	1.	.1505	2.301E-06	8.76	9.42	13.650	.07	13.650	.07
2988	1.	.1505	1.957E-06	8.45	8.93	12.930	.05	12.930	.05
2989	1.	.1505	7.001E-07	5.97	7.71	11.160	.23	11.160	.23
2990	1.	.1505	3.214E-06	9.76	9.96	14.430	.02	14.430	.02
2991	1.	.1505	6.541E-07	5.14	9.22	13.350	.44	13.350	.44
2992	1.	.1505	2.793E-07	3.71	8.64	12.510	.57	12.510	.57
2993	1.	.1505	6.234E-08	3.09	4.27	6.180	.28	6.180	.28
2994	1.	.1505	1.574E-07	3.73	5.88	8.520	.37	8.520	.37
2995	1.	.1505	1.361E-06	7.75	8.06	11.670	.04	11.670	.04

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK 1 C = .145000 02/06/81

STEP	CYCLES	C	DC/DN	DELTCK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
2996	1.	.1505	6.965E-08	3.04	4.68	6.780	.35	6.780	.35
2997	1.	.1505	3.841E-06	10.29	10.32	14.940	.00	14.940	.00
2998	1.	.1505	3.861E-08	2.09	5.59	8.100	.63	8.100	.63
2999	1.	.1505	1.161E-06	7.54	7.54	10.920	0.00	10.920	0.00
4946	1.	.1543	1.632E-07	3.57	6.44	9.210	.45	9.210	.45
4947	1.	.1543	4.724E-06	10.68	11.18	15.990	.05	15.990	.05
4948	1.	.1543	1.793E-07	4.24	5.29	7.560	.20	7.560	.20
4949	1.	.1543	3.64[illegible]E-08	2.37	4.47	6.390	.47	6.390	.47
4950	1.	.1543	1.377E-07	3.44	6.08	8.700	.43	8.700	.43
4951	1.	.1544	1.492E-05	14.68	14.68	21.000	0.00	21.000	0.00
4952	1.	.1544	7.309E-07	6.02	7.80	11.160	.23	11.160	.23
4953	1.	.1544	1.047E-06	6.17	9.52	13.620	.35	13.620	.35
4954	1.	.1544	3.601E-06	10.05	10.26	14.670	.02	14.670	.02
4955	1.	.1544	1.125E-07	3.21	5.92	8.460	.46	8.460	.46
4956	1.	.1544	3.996E-07	4.97	6.90	9.870	.28	9.870	.28
4957	1.	.1544	1.563E-06	8.06	8.29	11.850	.03	11.850	.03
4958	1.	.1544	1.575E-05	14.89	14.89	21.300	0.00	21.300	0.00
4959	1.	.1544	9.044E-08	2.22	11.10	15.870	.80	15.870	.75
4960	1.	.1544	1.535E-07	3.84	5.54	7.920	.31	7.920	.31
4961	1.	.1544	1.423E-06	7.34	8.96	12.810	.18	12.810	.18
4962	1.	.1544	2.894E-07	4.59	6.40	9.150	.28	9.150	.28
4963	1.	.1544	6.917E-08	2.48	6.36	9.090	.61	9.090	.61
4964	1.	.1544	1.361E-07	3.29	5.48	7.830	.40	7.830	.40
4965	1.	.1544	3.437E-06	9.25	11.27	16.110	.18	16.110	.18
4966	1.	.1544	4.771E-06	10.30	11.87	16.980	.13	16.980	.13
4967	1.	.1544	4.151E-07	4.95	7.24	10.350	.32	10.350	.32
4968	1.	.1544	2.125E-06	8.73	8.98	12.840	.03	12.840	.03
4969	1.	.1544	1.833E-06	8.46	8.56	12.240	.01	12.240	.01
4970	1.	.1544	2.407E-07	3.84	7.43	10.620	.48	10.620	.48
4971	1.	.1544	3.567E-06	10.15	10.22	14.610	.01	14.610	.01
4972	1.	.1544	7.121E-06	12.11	12.11	17.310	0.00	17.310	0.00
4973	1.	.1544	1.323E-07	2.56	9.23	13.200	.72	13.200	.72
4974	1.	.1544	7.562E-07	5.60	8.90	12.720	.37	12.720	.37
4975	1.	.1544	2.646E-07	4.80	5.64	8.070	.15	8.070	.15
4976	1.	.1544	8.517E-08	3.11	5.18	7.410	.40	7.410	.40
4977	1.	.1544	4.493E-07	4.28	9.48	13.560	.55	13.560	.55
4978	1.	.1544	3.141E-06	9.65	9.97	14.250	.03	14.250	.03
4979	1.	.1544	2.803E-08	2.18	4.26	6.090	.49	6.090	.49
4980	1.	.1544	6.88[illegible]E-06	12.00	12.00	17.160	0.00	17.160	0.00
4981	1.	.1544	7.214E-07	5.83	8.12	11.610	.28	11.610	.28
4982	1.	.1544	4.327E-07	4.85	7.68	10.980	.37	10.980	.37
4983	1.	.1544	4.028E-08	2.22	5.25	7.500	.58	7.500	.58
4984	1.	.1544	2.014E-06	8.18	9.57	13.680	.14	13.680	.14
4985	1.	.1544	2.339E-08	2.16	3.84	5.490	.44	5.490	.44
4986	1.	.1544	6.177E-07	6.00	7.03	10.050	.15	10.050	.15
4987	1.	.1544	2.954E-07	4.81	6.06	8.670	.21	8.670	.21

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK 1 C = .145000 02/06/81

STEP	CYCLES	C	DC/DN	DELTCK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
4988	1.	.1544	3.267E-06	9.74	10.09	14.430	.04	14.430	.04
4989	1.	.1544	5.53[illegible]E-07	6.11	6.38	9.120	.04	9.120	.04
4990	1.	.1544	2.76[illegible]E-07	4.85	5.73	8.190	.15	8.190	.15
4991	1.	.1544	7.433E-08	3.11	4.74	6.780	.35	6.780	.35
4992	1.	.1544	7.75[illegible]E-06	12.38	12.38	17.700	0.00	17.700	0.00
4993	1.	.1544	1.01[illegible]E-07	3.92	4.09	5.850	.04	5.850	.04
4994	1.	.1544	3.36[illegible]E-06	9.93	9.99	14.280	.01	14.280	.01
4995	1.	.1544	3.25[illegible]E-08	2.12	4.91	7.020	.57	7.020	.57

THE CRACK AT THE END OF BLOCK 1 IS .154443

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK 15 C = .883082 02/06/81

****
AT FRACTIONAL (.7,.8, OR .9) KSUBC OF 45.500
KLIMIT= 45.504 C= .988406
IN BLOCK 15 SEGMT 1 (1-TH TIME) STEP 1323 CYCLE 0.0
****

STEP	CYCLES	C	DC/DN	DELTCK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
2950	1.	1.1754	1.833E-05	13.77	18.50	8.670	.26	8.670	.26
2951	1.	1.1755	4.588E-05	19.02	20.75	9.720	.08	9.720	.08
2952	1.	1.1755	5.604E-05	16.97	28.05	13.140	.39	13.140	.39
2953	1.	1.1755	1.205E-05	9.92	22.99	10.770	.57	10.770	.57
2954	1.	1.1759	3.534E-04	33.55	33.55	15.720	0.00	15.720	0.00
2955	1.	1.1759	3.570E-06	8.90	12.23	5.730	.27	5.730	.27
2956	1.	1.1767	7.562E-04	40.93	40.93	19.170	0.00	19.170	0.00
2957	1.	1.1767	1.269E-05	13.46	15.06	7.050	.11	7.050	.11
2958	1.	1.1767	4.087E-05	16.60	23.58	11.040	.30	11.040	.30
2959	1.	1.1769	1.532E-04	26.85	27.17	12.720	.01	12.720	.01
2960	1.	1.1770	1.831E-04	27.43	29.54	13.830	.07	13.830	.07
2961	1.	1.1770	1.944E-06	6.60	12.88	6.030	.49	6.030	.49
2962	1.	1.1777	6.111E-04	38.71	38.71	18.120	0.00	18.120	0.00
2963	1.	1.1778	1.083E-04	24.62	24.75	11.580	.01	11.580	.01
2964	1.	1.1779	1.803E-04	27.89	28.53	13.350	.02	13.350	.02
2965	1.	1.1780	8.654E-05	21.16	26.74	12.510	.21	12.510	.21
2966	1.	1.1781	3.574E-05	16.67	21.48	10.050	.22	10.050	.22
2967	1.	1.1781	4.432E-05	18.79	20.65	9.660	.09	9.660	.09
2968	1.	1.1781	2.224E-05	14.43	19.56	9.150	.26	9.150	.26
2969	1.	1.1782	8.505E-05	22.56	24.18	11.310	.07	11.310	.07
2970	1.	1.1782	1.721E-06	7.38	10.07	4.710	.27	4.710	.27
2971	1.	1.1782	6.291E-06	7.82	21.49	10.050	.64	10.050	.64
2972	1.	1.1783	7.957E-05	21.94	23.99	11.220	.09	11.220	.09
2973	1.	1.1783	5.694E-06	8.85	16.74	7.830	.47	7.830	.47
2974	1.	1.1783	4.811E-06	8.53	15.84	7.410	.46	7.410	.46
2975	1.	1.1787	3.531E-04	33.55	33.55	15.690	0.00	15.690	0.00
2976	1.	1.1787	1.993E-06	7.57	10.65	4.980	.29	4.980	.29
2977	1.	1.1787	6.654E-05	20.08	24.38	11.400	.18	11.400	.18
2978	1.	1.1787	9.542E-06	10.07	19.44	9.090	.48	9.090	.48
2979	1.	1.1790	2.264E-04	29.67	31.44	14.700	.08	14.700	.08
2980	1.	1.1790	3.041E-05	14.05	24.96	11.670	.44	11.670	.44
2981	1.	1.1790	1.051E-05	11.10	17.77	8.310	.38	8.310	.38
2982	1.	1.1791	7.514E-05	21.43	23.93	11.190	.10	11.190	.10
2983	1.	1.1792	1.077E-04	24.58	24.58	11.490	0.00	11.490	0.00
2984	1.	1.1792	3.074E-05	17.71	17.78	8.310	.00	8.310	.00
2985	1.	1.1797	4.624E-04	36.00	36.00	16.830	0.00	16.830	0.00
2986	1.	1.1797	9.887E-06	7.58	31.39	14.670	.76	14.670	.75
2987	1.	1.1799	1.757E-04	27.15	29.21	13.650	.07	13.650	.07
2988	1.	1.1800	1.488E-04	26.19	27.67	12.930	.05	12.930	.05

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK 15 C = .883082 02/06/81

STEP	CYCLES	C	DC/DN	DELTCK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
2989	1.	1.1801	5.34[illegible]E-05	18.49	23.89	11.160	.23	11.160	.23
2990	1.	1.1803	2.452E-04	30.24	30.89	14.430	.02	14.430	.02
2991	1.	1.1804	4.986E-05	15.93	28.58	13.350	.44	13.350	.44
2992	1.	1.1804	2.134E-05	11.50	26.78	12.510	.57	12.510	.57
2993	1.	1.1804	4.753E-06	9.57	15.23	6.180	.28	6.180	.28
2994	1.	1.1804	1.20[illegible]E-05	11.56	18.24	8.520	.37	8.520	.37
2995	1.	1.1805	1.043E-04	24.02	24.98	11.670	.04	11.670	.04
2996	1.	1.1805	5.31[illegible]E-06	9.44	14.52	6.780	.35	6.780	.35
2997	1.	1.1808	2.924E-04	31.92	31.99	14.940	.00	14.940	.00
2998	1.	1.1808	2.947E-06	6.49	17.34	8.100	.63	8.100	.63
2999	1.	1.1809	6.863E-05	23.38	23.38	10.920	0.00	10.920	0.00

****
AT FRACTIONAL (.7,.8, OR .9) KSUBC OF 52.000
KLIMIT= 52.010 C= 1.209578
IN BLOCK 15 SEGMT 1 (1-TH TIME) STEP 3139 CYCLE 0.0
****

****
AT FRACTIONAL (.7,.8, OR .9) KSUBC OF 58.500
KLIMIT= 58.530 C= 1.397151
IN BLOCK 15 SEGMT 1 (1-TH TIME) STEP 4197 CYCLE 0.0
****

****
KLIMIT= 65.016 IS GREATER THAN KSUBC= 65.000
VALUES BEFORE INSTABILITY WERE
STEP 4780 CYCLE 0. OF BLOCK 15 SEGMT 1 (1-TH TIME)
C= 1.572758
****

STEP	CYCLES	C	DC/DN	DELTCK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
4946	1.	1.6422	3.434E-05	14.41	26.03	9.210	.45	9.210	.45
4947	1.	1.6432	9.94[illegible]E-04	43.15	45.19	15.990	.05	15.990	.05
4948	1.	1.6433	3.781E-05	17.14	21.38	7.560	.20	7.560	.20
4949	1.	1.6433	7.693E-06	9.59	18.07	6.390	.47	6.390	.47
4950	1.	1.6433	2.90[illegible]E-05	13.91	24.60	8.700	.43	8.700	.43
4951	1.	1.6464	3.14[illegible]E-0[illegible]	55.38	55.38	21.000	0.00	21.000	0.00
4952	1.	1.6466	1.551E-04	24.39	31.62	11.160	.23	11.160	.23
4953	1.	1.6468	2.225E-04	24.99	38.59	13.620	.35	13.620	.35
4954	1.	1.6476	7.65[illegible]E-04	40.72	41.57	14.670	.02	14.670	.02
4955	1.	1.6476	2.397E-05	13.01	23.99	8.460	.46	8.460	.46
4956	1.	1.6477	8.29[illegible]E-05	20.16	27.98	9.870	.28	9.870	.28
4957	1.	1.6490	3.32[illegible]E-04	32.66	33.60	11.850	.03	11.850	.03
4958	1.	1.6514	3.359E-03	60.41	60.41	21.300	0.00	21.300	0.00
4959	1.	1.6514	1.944E-05	9.04	45.10	15.870	.80	15.870	.75

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK 15 C = .683082 02/06/81

STEP	CYCLES	C	CC/DN	DELTCK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
4960	1.	1.6514	3.299E-05	15.60	22.51	7.920	.31	7.920	.31
4961	1.	1.6517	3.055E-04	29.84	36.41	12.810	.18	12.810	.18
4962	1.	1.6518	6.223E-05	18.68	26.01	9.150	.28	9.150	.28
4963	1.	1.6518	1.486E-05	19.06	25.84	9.090	.61	9.090	.61
4964	1.	1.6518	2.282E-05	13.39	22.26	7.830	.40	7.830	.40
4965	1.	1.6526	7.397E-04	37.61	45.80	16.110	.18	16.110	.18
4966	1.	1.6536	1.024E-03	41.89	48.29	16.980	.13	16.980	.13
4967	1.	1.6537	8.964E-05	20.15	29.45	10.350	.32	10.350	.32
4968	1.	1.6542	4.589E-04	35.52	36.54	12.840	.03	12.840	.03
4969	1.	1.6546	3.969E-04	34.42	34.84	12.240	.01	12.240	.01
4970	1.	1.6546	5.200E-05	15.63	30.24	10.620	.48	10.620	.48
4971	1.	1.6554	7.933E-04	41.35	41.60	14.610	.01	14.610	.01
4972	1.	1.6569	1.544E-03	49.31	49.31	17.310	0.00	17.310	0.00
4973	1.	1.6570	2.877E-05	10.44	37.64	13.200	.72	13.200	.72
4974	1.	1.6571	1.645E-04	22.84	36.27	12.720	.37	12.720	.37
4975	1.	1.6572	5.761E-05	19.59	23.01	8.070	.15	8.070	.15
4976	1.	1.6572	1.854E-05	12.66	21.13	7.410	.40	7.410	.40
4977	1.	1.6573	9.783E-05	17.45	38.67	13.560	.55	13.560	.55
4978	1.	1.6580	6.841E-04	39.36	40.64	14.250	.03	14.250	.03
4979	1.	1.6580	6.114E-06	8.90	17.38	6.090	.49	6.090	.49
4980	1.	1.6595	1.503E-03	48.96	48.96	17.160	0.00	17.160	0.00
4981	1.	1.6597	1.579E-04	23.82	33.16	11.610	.28	11.610	.28
4982	1.	1.6598	9.476E-05	19.79	31.36	10.980	.37	10.980	.37
4983	1.	1.6598	8.824E-06	9.08	21.42	7.500	.58	7.500	.58
4984	1.	1.6602	4.423E-04	33.42	39.08	13.680	.14	13.680	.14
4985	1.	1.6602	5.128E-06	8.83	15.69	5.490	.44	5.490	.44
4986	1.	1.6604	1.353E-04	24.52	28.72	10.050	.15	10.050	.15
4987	1.	1.6604	6.479E-05	19.63	24.77	8.670	.21	8.670	.21
4988	1.	1.6611	7.166E-04	39.78	41.24	14.430	.04	14.430	.04
4989	1.	1.6613	1.215E-04	24.96	26.07	9.120	.04	9.120	.04
4990	1.	1.6613	6.377E-05	19.81	23.42	8.190	.15	8.190	.15
4991	1.	1.6613	1.634E-05	12.70	19.39	6.780	.35	6.780	.35
4992	1.	1.6630	1.706E-03	50.61	50.61	17.700	0.00	17.700	0.00
4993	1.	1.6631	2.243E-05	16.06	16.74	5.850	.04	5.850	.04
4994	1.	1.6638	7.416E-04	40.62	40.87	14.280	.01	14.280	.01
4995	1.	1.6638	7.204E-06	8.68	20.10	7.020	.57	7.020	.57

THE CRACK AT THE END OF BLOCK 15 IS 1.663810

```
F-B-2       AIR-TO-GROUND SPECTRUM, BASELINE
THE CRACK AT THE BEGINNING OF BLOCK     16      C =1.663810      02/06/81
 STEP CYCLES    C       DC/DN     DELTCK KMAX-C  SIGMAX    R      SIGMAX   R
                                                                   (EFF)  (EFF)

*************************************************************************
 **** INSTABILITY OCCURRED BY APPLIED KMAX NOT KLIMIT ****
 KMAX=       66.339    IS GREATER THAN KSUEC=       65.000
 VALUES BEFORE INSTABILITY WERE
 STEP     61     CYCLE        1.      OF BLOCK     16      SEGMT  1 (  1-TH TIME)  C= 1.687350
*************************************************************************
```

```
F-B-2        AIR-TO-GROUND SPECTRUM, BASELINE
                                                        02/06/81

ANALYSIS IS DONE WITHOUT LOAD INTERACTION

CRACK GROWTH SUMMARY TABL: FOR EVERY    1 BLOCKS
INITIAL CRACK LENGTH WAS    C=    .1450

C       .1544    .1651    .1774    .1915    .2080    .2274    .2507    .2792    .3148    .3606
C       .4218    .5083    .6415    .8831   1.6638
CRITICAL CRACK IS:  C=1.6873IN BLOCK    16 STEP    61 CYCLE    0.
*************************************************************************
```

Appendix A

SUGGESTED PROCEDURES FOR DETERMINING CRACK-GROWTH-RATE PARAMETERS

To use the CRKGRO program for fatigue crack growth life predictions, a set of crack-growth-rate parameters should be determined for each material. The following paragraphs briefly describe a procedure for determining those parameters.

BASELINE CRACK-GROWTH-RATE CONSTANTS

Fatigue crack-growth-rate constants for the baseline (constant-amplitude) crack-growth-rate equations used in CRKGRO are the coefficient C, exponents n and m, in the following equation:

$$da/dN = C\ [(1-R)^m\ K_{max}]^n \quad \text{for}\ \ R \geq 0$$

plotting the dependent variable da/dN against the independent variable $(1-R)^m\ K_{max}$ on a double logarithmic scale, the preceding equation represents a straight line; i.e.,

$$\ell n\ (da/dN) = \ell n\ C + n\ \ell n\ [(1-R)^m\ K_{max}]$$

where n is the tangent of the angle of inclination and $\ell n C$ is the distance of intersection with the $\ell n(da/dN)$ axis from the origin.

The procedures to determine the coefficient C and exponents n and m of the preceding baseline crack-growth-rate equation for a specific material are as follows:

1. Perform constant-amplitude fatigue crack growth test per ASTM standard E-647 or equivalent specification. It is recommended to perform the test with minimum four stress ratios R = 0, 0.3, 0.5 and 0.7.

2. Convert the crack size, a, versus the number of the elapsed cycles, N, to the fatigue crack growth rate, da/dN, using any of the two ASTM recommended data reduction techniques: the second method or the incremental polynomial method.

3. Plot the independent variable $[(1-R)^m\ K_{max}]$ versus the dependent variable, da/dN, on log-log coordinates with assigned m-values, either by hand or by a graphical routine such as PLOTRATE, developed

by Chang et al (reference 11). It is recommended, in general, to input the following set of m-values:

$$m = 0.4,\ 0.5,\ 0.6,\ 0.7,\ 0.8,\ 0.9 \text{ and } 1.0$$

Note that if $m = 1$, the independent variable $(1\text{-}R)K_{max} = \Delta K$.

4. Examine each da/dN versus $(1\text{-}R)^m K_{max}$ plot. The m-value of a plot which shows the best stress ratio layer collapsing is the proper value to be used in the analysis. A straight line is then drawn either by eye-balling or computer, with least-square routine through all the collapsing data points. The intersection of this straight line with the $\ln(da/dN)$ axis gives the C-value, while the tangent of the angle of inclination of the straight line gives the value of n. A typical plot generated by PLOTRATE for 2219-T851 aluminum is shown in figure A-1. It shows that $m \approx 0.6$ has the best collapsing on all the data points at various stress ratios ($R = 0.01$, 0.2, 0.3, 0.5 and 0.7). The corresponding C- and n-values are

$$C = 5.063 \times 10^{-10} \quad \text{(in ksi unit)}$$

$$n = 3.83$$

LOAD INTERACTION MODEL PARAMETERS

Fatigue crack growth parameters to be used in the load interaction model built into CRKGRO are the overload shutoff ratio, R_{so}, the acceleration index, q, and the threshold intensity factor range at $R = 0$, ΔK_{th_o}.

The overload shutoff ratio, R_{so}, and the threshold stress intensity factor, K_{th_o}, are the parameters used in the generalized Willenborg retardation model for calculating the retardation coefficient, Φ, which is defined as:

$$\Phi = \frac{1 - \left(K_{max_{th}} \Big/ K_{max}\right)}{R_{so} - 1}$$

where $K_{max_{th}}$ is the threshold stress-intensity-factor value corresponding to the ΔK_{th} value in the following form:

$$K_{max_{th}} = \Delta K_{th}/(1 - R) = (1 - A|R|)\,\Delta K_{th_o}/(1 - R)$$

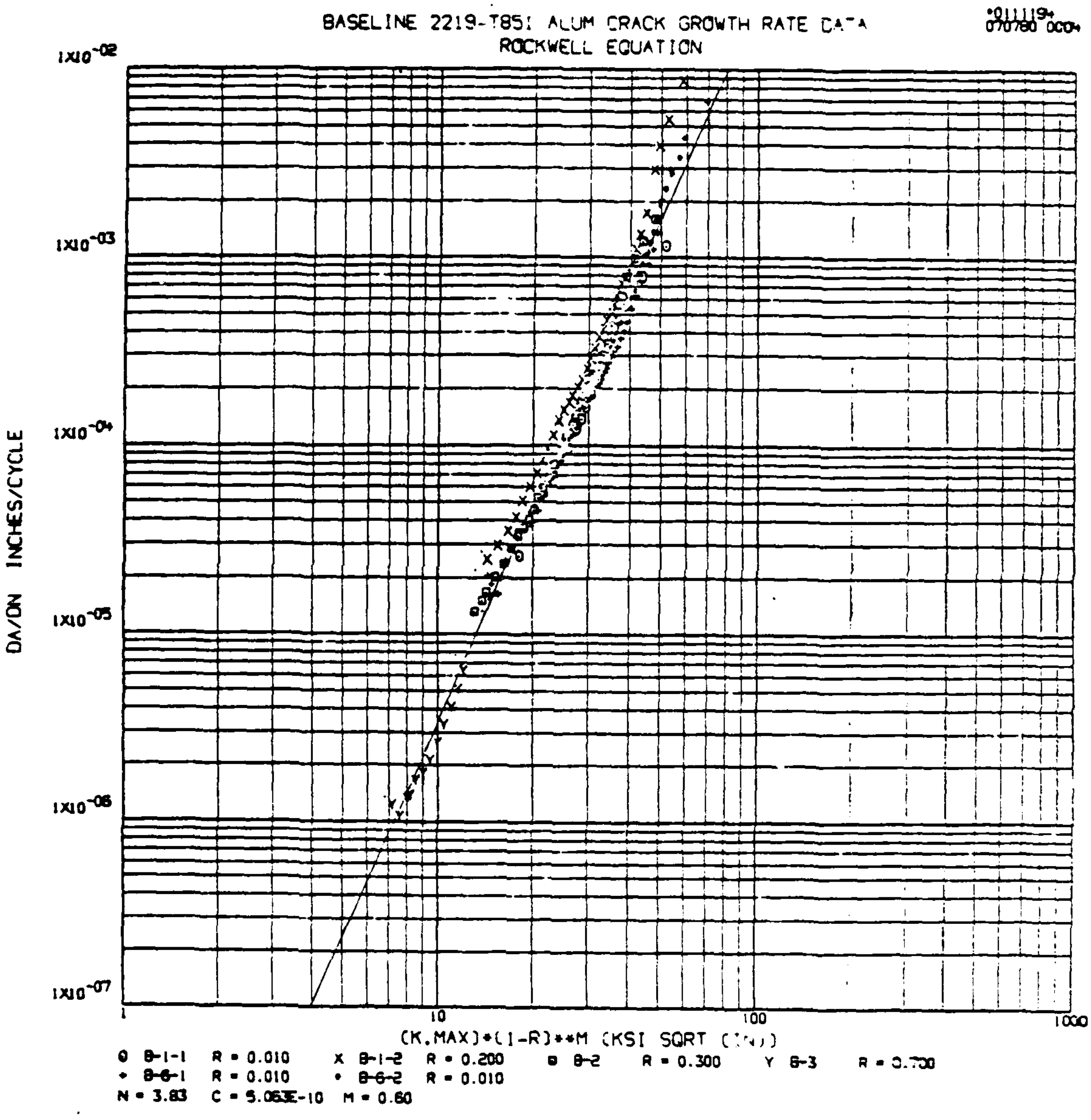


Figure A-1. Baseline 2219-T851 Aluminum Crack-Growth-Rate Data, M = 0.60

To determine the overload shutoff ratio, a series of single overload variable-amplitude cyclic tests are required. This is because, for a given material, the overload shutoff ratio is dependent upon the stress ratio and the magnitude of the compressive stresses. But, to be practical, it is recommended to test only the R = 0 condition to obtain the $R_{so}(o)$ value. This value is then to be calibrated using a typical spectrum which has similar characteristics to the one to be predicted.

The acceleration index, q, is the exponent in Chang's crack-growth-rate equation for negative stress ratio, which is expressed as:

$$da/dN = C \; [(1 + R^2)^q \; K_{max}]^n, \quad R < 0$$

The value of q is determined using the following relationship:

$$q = [\ell n(\gamma)/\ell n(1 + R^2)]/n, \quad R < 0$$

where γ is the ratio of the crack growth rate at a specific negative stress ratio to its R = 0 counterpart obtained from test data. Hence, based on the preceding metholology for a specific negative stress ratio, there should be a specific q value. However, for spectrum loading application, it is not very practical to generate such q-values. The average q-value approach was adopted by CRKGRO. The average q-value for a material can be selected by correlation with the test data obtained from a spectrum loading test while the spectrum is similar to the one to be predicted.

OTHER PARAMETERS USED IN THE METHODOLOGY

There are several other parameters needed to be input into CRKGRO for crack growth predictions, including the cutoff values of the positive and negative stress rations, $R^{\pm}_{cut}$, and the critical values of the stress intensity factors under cyclic loadings, K_{cr}.

R^{+}_{cut} is the cutoff value of the positive stress ratio, R^+, above which the material is assumed to have no further stress ratio layering effect on the crack growth. R^{-}_{cut} is the cutoff value of the negative stress ratio, R^-. below which the material is assumed to have no further acceleration effect on the crack growth. These values are, in general, able to be determined from multiple stress ratios constant-amplitude tests. Yet, for the spectrum load application, because the effective stress ratio is used in the load interaction model, again, the calibrated value should be obtained using the spectrum test data.

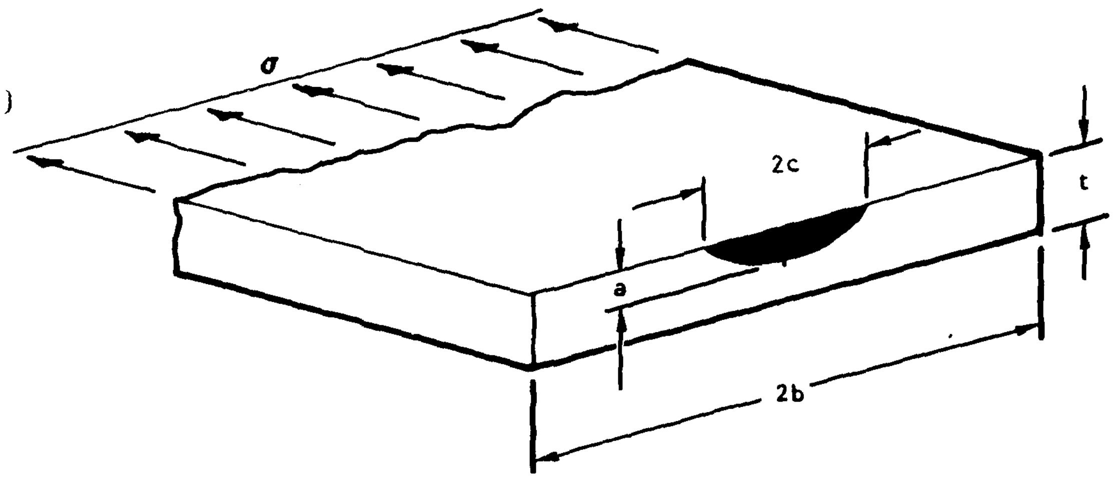
There are two types of K_{cr} values: $K_{cr(a)}$ and $K_{cr(c)}$. $K_{cr(a)}$ is the critical value of the stress intensity factor under cyclic loading at the maximum depth point A of a PTC. In general, the value of $K_{cr(a)}$ is considered approximately equal to material plane-strain toughness. $K_{cr(c)}$ is the critical value of the stress intensity factor under cyclic loading at the maximum length point c of a PTC or TC. The value of $K_{cr(c)}$ is considered approximately equal to material plane-stress toughness.

Appendix B

CRKGRO STRESS INTENSITY FACTORS LIBRARY

Crack code: 1010

Shallow surface crack ($a/c \leq 1$)



$$K_{(a)} = \left\{\left[1.13 - 0.09\left(\frac{a}{c}\right)\right] + \left[\frac{0.89}{\left(0.2 + \frac{a}{c}\right)} - 0.54\right]\left(\frac{a}{t}\right)^2 + \left[0.5 - \frac{1}{\left(0.65 + \frac{a}{c}\right)} + 14\left(1 - \frac{a}{c}\right)^{24}\right]\left(\frac{a}{t}\right)^4\right\}\sqrt{\sec\left(\frac{\pi c}{2b}\sqrt{\frac{a}{t}}\right)}\,\sigma\sqrt{\frac{\pi a}{Q}}$$

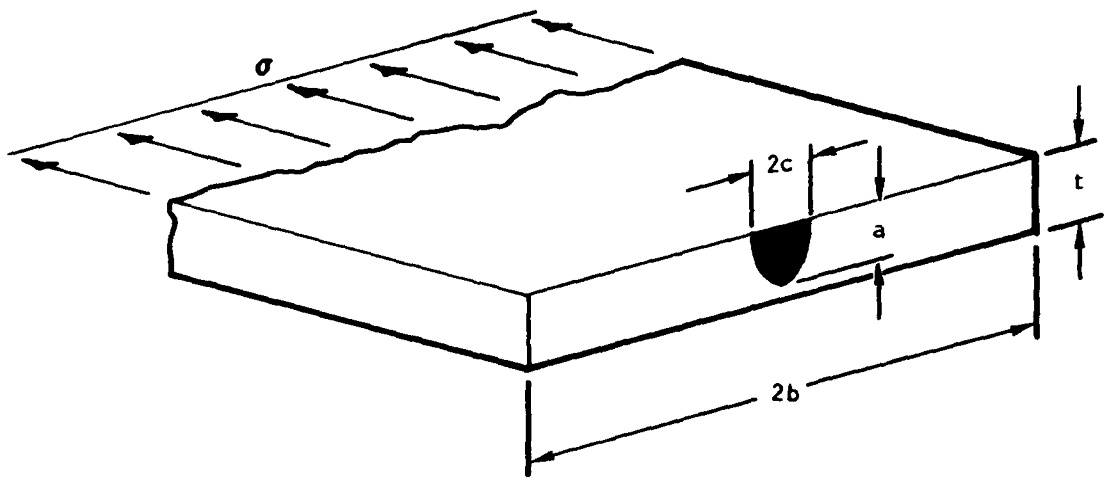
$$K_{(c)} = \left\{\left[1.13 - 0.09\left(\frac{a}{c}\right)\right] + \left[\frac{0.89}{\left(0.2 + \frac{a}{c}\right)} - 0.54\right]\left(\frac{a}{t}\right)^2 + \left[0.5 - \frac{1}{\left(0.65 + \frac{a}{c}\right)} + 14\left(1 - \frac{a}{c}\right)^{24}\right]\left(\frac{a}{t}\right)^4\right\}$$

$$\left[1.07 + 0.24\left(\frac{a}{t}\right)^2\right]\left[0.97\left(\frac{a}{c}\right)^2 + 0.03\right]^{1/4}\left[\sqrt{\sec\left(\frac{\pi c}{2b}\sqrt{\frac{a}{t}}\right)}\right]\sqrt{\frac{a}{c}}\;\sigma\sqrt{\frac{\pi c}{Q}}$$

where $$Q = \left[1 + 1.464\left(\frac{a}{c}\right)^{1.65}\right]$$

Crack code: 1010 (cont.)

Deep surface crack $\left(\frac{a}{c}\right) > 1$



$$K_{(a)} = \left\{\left[\sqrt{\frac{c}{a}}\left(1 + 0.04\,\frac{c}{a}\right) + 0.2\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^2 - 0.11\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^4\right]\sqrt{\frac{c}{a}}\left[\sqrt{\sec\left(\frac{\pi c}{2b}\sqrt{\frac{a}{t}}\right)}\right]\right\}\sigma\sqrt{\frac{\pi a}{Q}}$$

$$K_{(c)} = \left\{\left[\sqrt{\frac{c}{a}}\left(1 + 0.04\,\frac{c}{a}\right) + 0.2\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^2 - 0.11\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^4\right]\left[1.07 + 0.239\left(\frac{c}{a}\right)\left(\frac{a}{t}\right)^2\right]\left[0.03\left(\frac{c}{a}\right)^2 + 0.97\right]^{1/4}\right.$$

$$\left.\left[\sqrt{\sec\left(\frac{\pi c}{2b}\sqrt{\frac{a}{t}}\right)}\right]\sqrt{\frac{a}{c}}\right\}\sigma\sqrt{\frac{\pi c}{Q}}$$

where $Q = 1 + 1.464\left(\frac{c}{a}\right)^{1.65}$

Crack Code: 1010

Surface Crack (one-dimension solution)

• Shallow Surface Crack ($a/2c \le 0.5$)

$$K = \left\{ 1.13 - 0.1\,(a/c) + \left[\sqrt{Q\,(c/a)} - 1.13 + 0.1\,(a/c) \right] \left(\frac{a}{t}\right)^{\sqrt{\pi}} + \sqrt{Q\,(c/a)} \left(\sqrt{\frac{\pi}{4}} - 1 \right) \left(\frac{a}{t}\right)^{2\sqrt{\pi}} \right\} \left[\sqrt{\sec\left(\frac{\pi c}{2b} \sqrt{\frac{a}{t}} \right)} \right] \sigma \sqrt{\frac{\pi a}{Q}}$$

where $Q = 1 + 1.464\,(a/c)^{1.65}$

• Deep Surface Crack ($(a/2c) > 0.5$)

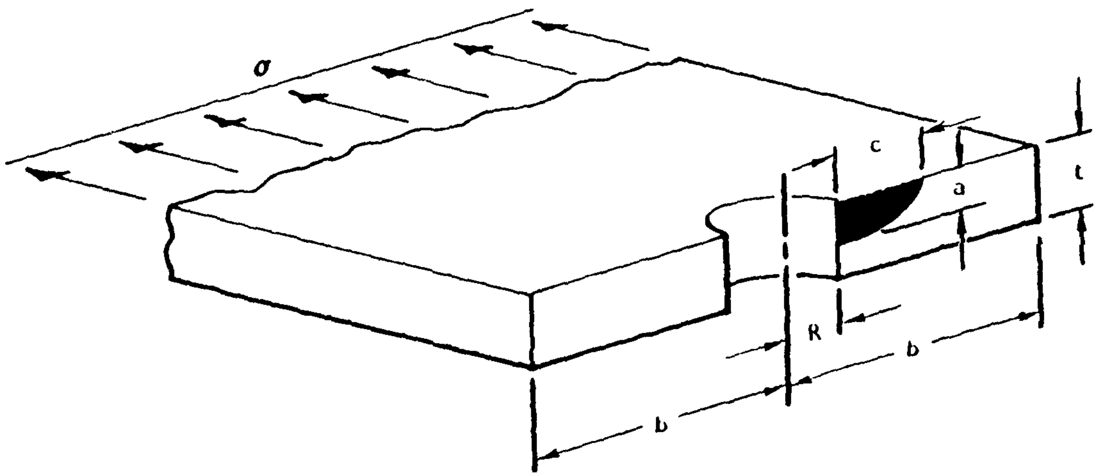
$$K = \left\{ \sqrt{\frac{c}{a}}\,(1 + 0.03\,c/a) + \left[\sqrt{Q\,(c/a)} - \sqrt{c/a}\,(1 + 0.03\,c/a) \right] \left(\frac{a}{t}\right)^{\sqrt{\pi}} + \sqrt{Q\,(c/a)} \left[\frac{c}{a} \left(\sqrt{\frac{\pi}{4}} - 1 \right) \right] \left(\frac{a}{t}\right)^{2\sqrt{\pi}} \right\} \left[\sqrt{\sec\left(\frac{\pi c}{2b} \sqrt{\frac{a}{t}} \right)} \right] \sigma \sqrt{\frac{\pi a}{Q}}$$

where $Q = 1 + 1.464\,(c/a)^{1.65}$

CRKGRO Stress Intensity Factor Library

Crack code: 1030

Single, shallow corner crack at open hole $(a/c \le 1)$



$$K_{(a)} = \left\{\left[1.13 - 0.09\left(\frac{a}{c}\right) + \left(\frac{0.89}{0.2 + \frac{a}{c}} - 0.54\right)\left(\frac{a}{t}\right)^2 + \left(0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14\left(1 - \frac{a}{c}\right)^{24}\right)\left(\frac{a}{t}\right)^4\right]\left[0.9698 + 0.0302\left(\frac{a}{c}\right)^2\right]^{1/4}\right.$$

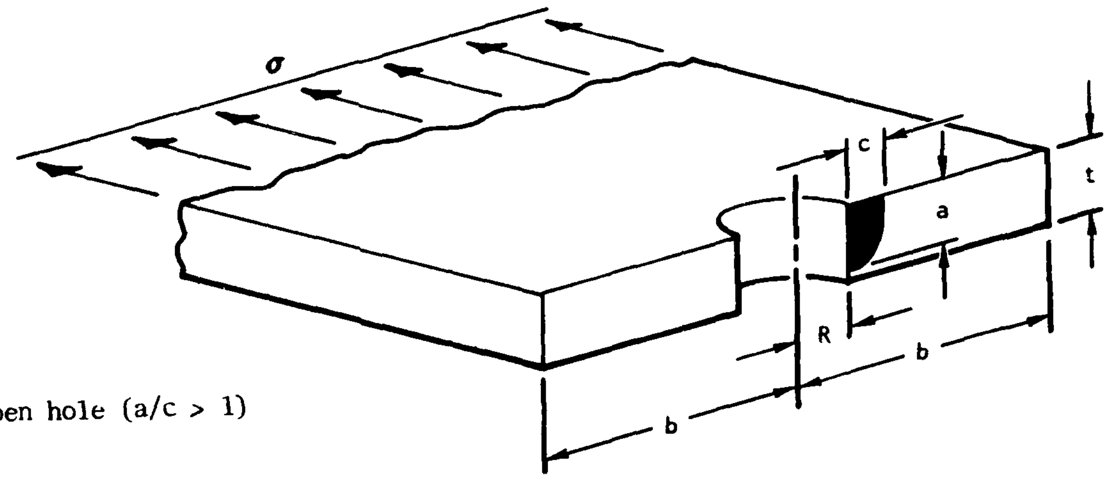
$$\left[\frac{1 - 0.15\lambda' + 3.46\lambda'^2 - 4.47\lambda'^3 + 3.52\lambda'^4}{1 + 0.13\lambda'^2}\right]\left[1.07\left(1 + 0.04\frac{a}{c}\right)\left(0.8 + 0.2\left(\frac{a}{t}\right)^{1/4}\right)\right]\left[\sqrt{\sec\left(\frac{\pi}{2}\frac{R}{b}\right)\sec\left(\frac{\pi(2R + c)}{2(2b - c)}\sqrt{\frac{a}{t}}\right)}\right]\left.\sqrt{\frac{8tR + \pi ac}{8tR + 2\pi ac}}\right\}\sigma\sqrt{\frac{\pi a}{Q}}$$

$$K_{(c)} = \left\{\left[1.13 - 0.09\left(\frac{a}{c}\right) + \left(\frac{0.89}{0.2 + \frac{a}{c}} - 0.54\right)\left(\frac{a}{t}\right)^2 + \left(0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14\left(1 - \frac{a}{c}\right)^{24}\right)\left(\frac{a}{t}\right)^4\right]\left[1.07 + 0.24\left(\frac{a}{t}\right)^2\right]\right.$$

$$\left[\frac{1 - 0.15\lambda + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4}{1 + 0.13\lambda^2}\right]\left[\left(1 + 0.04\frac{a}{c}\right)\left(0.8 + 0.2\left(\frac{a}{t}\right)^{1/4}\right)\right]\left[0.9698\left(\frac{a}{c}\right)^2 + 0.0302\right]^{1/4}$$

$$\left[\sqrt{\sec\left(\frac{\pi}{2}\frac{R}{b}\right)\sec\left(\frac{\pi}{2}\frac{(2R + c)}{(2b - c)}\sqrt{\frac{a}{t}}\right)}\right]\sqrt{\frac{8tR + \pi ac}{8tR + 2\pi ac}}\left.\sqrt{\frac{a}{c}}\right\}\sigma\sqrt{\frac{\pi c}{Q}}$$

where $\lambda' = \dfrac{1}{1 + 0.375\frac{c}{R}}$, $\lambda = \dfrac{1}{1 + 0.989\frac{c}{R}}$, $Q = 1 + 1.464\left(\frac{a}{c}\right)^{1.65}$



Crack code: 1030 (cont.)

Single, deep corner crack at open hole (a/c > 1)

$$K_{(a)} = \left\{\left[\sqrt{\frac{c}{a}}\left(1 + 0.04\,\frac{c}{a}\right) + 0.2\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^2 - 0.11\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^4\right]\left[\frac{1 - 0.15\lambda' + 3.46\lambda'^2 - 4.47\lambda'^3 + 3.52\lambda'^4}{1 + 0.13\lambda'^2}\right]\right.$$

$$\left[1.07\left(1.13 - 0.09\,\frac{c}{a}\right)\left(0.8 + 0.2\left(\frac{a}{t}\right)^{1/4}\right)\right]\left[\sqrt{\sec\left(\frac{\pi R}{2b}\right)\sec\left(\frac{\pi}{2}\,\frac{(2R + c)}{(2b - c)}\sqrt{\frac{a}{t}}\right)}\right]\left[\sqrt{\frac{8tR + \pi ac}{8tR + 2\pi ac}}\right]$$

$$\left.\left[0.9698\left(\frac{c}{a}\right)^2 + 0.0302\right]^{1/4}\right\}\sigma\sqrt{\frac{\pi a}{Q}}$$

$$K_{(c)} = \left\{\left[\sqrt{\frac{c}{a}}\left(1 + 0.04\,\frac{c}{a}\right) + 0.2\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^2 - 0.11\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^4\right]\left[1.07 + 0.24\left(\frac{c}{a}\right)\left(\frac{a}{t}\right)^2\right]\left[0.9698 + 0.0302\left(\frac{c}{a}\right)^2\right]^{1/4}\right.$$

$$\left[\frac{1 - 0.15\lambda + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4}{1 + 0.13\lambda^2}\right]\left[\left(1.13 - 0.09\,\frac{c}{a}\right)\left(0.8 + 0.2\left(\frac{a}{t}\right)^{1/4}\right)\right]$$

$$\left.\left[\sqrt{\sec\left(\frac{\pi R}{2b}\right)\sec\left(\frac{\pi}{2}\,\frac{(2R + c)}{(2b - c)}\sqrt{\frac{a}{t}}\right)}\right]\sqrt{\frac{8tR + \pi ac}{8tR + 2\pi ac}}\;\sqrt{\frac{a}{c}}\right\}\sigma\sqrt{\frac{\pi c}{Q}}$$

where $\lambda' = \dfrac{1}{1 + 0.375\,\frac{c}{R}}$, $\lambda = \dfrac{1}{1 + 0.989\,\frac{c}{R}}$, $Q = 1 + 1.464\left(\frac{c}{a}\right)^{1.65}$

CRKGRO Stress Intensity Factor Library

Crack Code: 1030

Single corner crack at open hole (one-dimension solution)

- Shallow corner crack ($a/c \le 1$)

$$K = \left\{1.13 - 0.09\,(a/c) + \left(\frac{0.89}{0.2 + a/c} - 0.54\right)\left(\frac{a}{t}\right)^2 + \left[0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14\left(1 - \frac{a}{c}\right)^{24}\right]\left(\frac{a}{t}\right)^4\right\}$$

$$\sqrt{\sec\left[\frac{\pi}{2}\left(\frac{2R + c}{2b - c}\right)\sqrt{\frac{a}{t}}\right]}\sqrt{\sec\left(\frac{\pi}{2}\,\frac{2R}{2b}\right)}\left(0.707 - 0.18\lambda + 6.55\lambda^2 - 10.54\lambda^3 + 6.85\lambda^4\right)\sigma\sqrt{\frac{\pi a}{Q}}$$

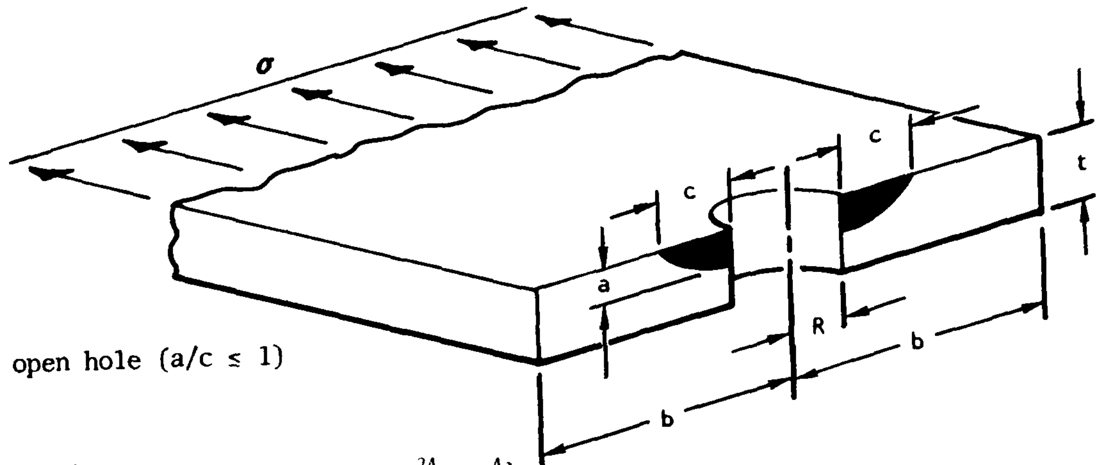
where $Q = 1 + 1.464\,(a/c)^{1.65}$; $\lambda = \frac{1}{1 + c/R}$

- Deep corner crack ($a/c > 1$)

$$K = \left\{\sqrt{\frac{c}{a}}\,(1 + 0.03\,c/a) + \left[\sqrt{Q\,\frac{c}{a}} - \sqrt{\frac{c}{a}}\left(1 + \frac{0.03c}{a}\right)\right]\left(\frac{a}{t}\right)^{\sqrt{\pi}} + \sqrt{Q\,\frac{c}{a}}\left[\frac{c}{a}\left(\sqrt{\frac{\pi}{4}} - 1\right)\right]\left(\frac{a}{t}\right)^{2\sqrt{\pi}}\right\}$$

$$\sqrt{\sec\left[\frac{\pi}{2}\left(\frac{2R + c}{2b - c}\right)\sqrt{\frac{a}{t}}\right]}\sqrt{\sec\left(\frac{\pi}{2}\,\frac{2R}{2b}\right)}\left(0.707 - 0.18\lambda + 6.55\lambda^2 - 10.54\lambda^3 + 6.85\lambda^4\right)\sigma\sqrt{\frac{\pi a}{Q}}$$

where $Q = 1 + 1.464\,(c/a)^{1.65}$; $\lambda = \frac{1}{1 + c/R}$



Crack code: 1050

Double, shallow corner cracks at open hole ($a/c \le 1$)

$$K_{(a)} = \left\|\left[1.13 - 0.09\left(\frac{a}{c}\right) + \left(\frac{0.89}{0.2 + \frac{a}{c}} - 0.54\right)\left(\frac{a}{t}\right)^2 + \left(0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14\left(1 - \frac{a}{c}\right)^{24}\right)\left(\frac{a}{t}\right)^4\right]\right.$$

$$\left[\frac{1 - 0.15\lambda' + 3.46\lambda'^2 - 4.47\lambda'^3 + 3.52\lambda'^4}{1 + 0.13\lambda'^2}\right]\left[1.07\left(1 + 0.04\,\frac{a}{c}\right)\left(0.8 + 0.2\left(\frac{a}{t}\right)^{1/4}\right)\right]\left[0.9698 + 0.0302\left(\frac{a}{c}\right)^2\right]^{1/4}$$

$$\left.\left[\sqrt{\sec\left(\frac{\pi}{2}\frac{R}{b}\right)\sec\left(\frac{\pi}{2}\frac{(R + c)}{b}\sqrt{\frac{a}{t}}\right)}\right]\right\|\ \sigma\sqrt{\frac{\pi a}{Q}}$$

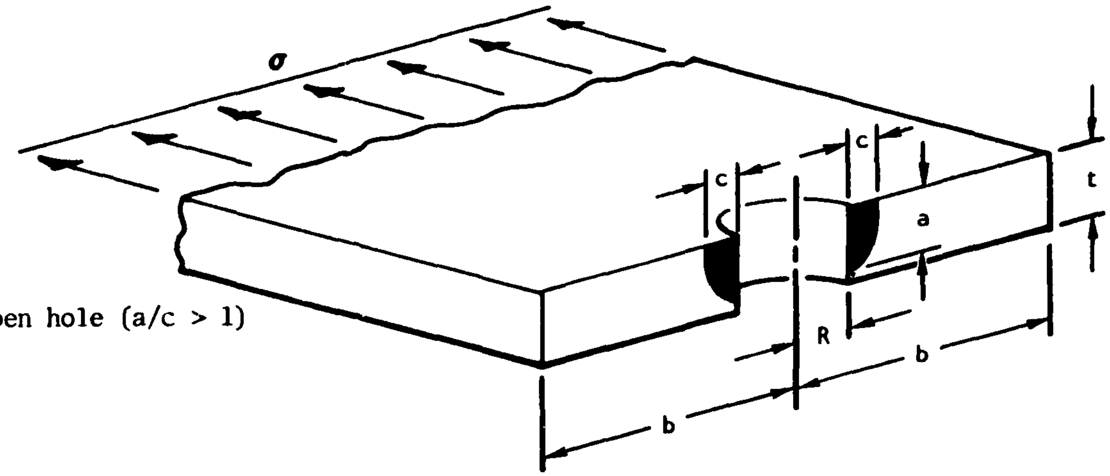
$$K_{(c)} = \left\|\left[1.13 - 0.09\left(\frac{a}{c}\right) + \left(\frac{0.89}{0.2 + \frac{a}{c}} - 0.54\right)\left(\frac{a}{t}\right)^2 + \left(0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14\left(1 - \frac{a}{c}\right)^{24}\right)\left(\frac{a}{t}\right)^4\right]\right.$$

$$\left[1.07 + 0.24\left(\frac{a}{t}\right)^2\right]\left[\frac{1 - 0.15\lambda + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4}{1 + 0.13\lambda^2}\right]\left[\left(1 + 0.04\,\frac{a}{c}\right)\left(0.8 + 0.2\left(\frac{a}{t}\right)^{1/4}\right)\right]$$

$$\left.\left[\sqrt{\sec\left(\frac{\pi}{2}\frac{R}{b}\right)\sec\left(\frac{\pi}{2}\frac{(R + c)}{b}\sqrt{\frac{a}{t}}\right)}\right]\left|0.9698\left(\frac{a}{c}\right)^2 + 0.0302\right|^{1/4}\sqrt{\frac{a}{c}}\right\|\ \sigma\sqrt{\frac{\pi c}{Q}}$$

where $\lambda' = \dfrac{1}{1 + 0.375\,\frac{c}{R}}$, $\lambda = \dfrac{1}{1 + 0.989\,\frac{c}{R}}$, $Q = 1 + 1.464\left(\frac{a}{c}\right)^{1.65}$

CRKGRO Stress Intensity Factor Library



Crack code: 1050 (cont.)

Double deep corner cracks at open hole (a/c > 1)

$$K_{(a)} = \left\{\left[\sqrt{\frac{c}{a}}\left(1 + 0.04\,\frac{c}{a}\right) + 0.2\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^2 - 0.11\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^4\right]\left[\frac{1 - 0.15\lambda' + 3.46\lambda'^2 - 4.47\lambda'^3 + 3.52\lambda'^4}{1 + 0.13\lambda'^2}\right]\right.$$

$$\left.\left[1.07\left(1.13 - 0.09\,\frac{c}{a}\right)\left(0.8 + 0.2\left(\frac{a}{t}\right)^{1/4}\right)\right]\left[\sqrt{\sec\left(\frac{\pi R}{2b}\right)\sec\left(\frac{\pi}{2}\,\frac{(R + c)}{b}\,\sqrt{\frac{a}{t}}\right)}\right]\left[0.9698\left(\frac{c}{a}\right)^2 + 0.0302\right]^{1/4}\right\}\sigma\sqrt{\frac{\pi a}{Q}}$$

$$K_{(c)} = \left\{\left[\sqrt{\frac{c}{a}}\left(1 + 0.04\,\frac{c}{a}\right) + 0.2\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^2 - 0.11\left(\frac{c}{a}\right)^4\left(\frac{a}{t}\right)^4\right]\left[1.07 + 0.24\left(\frac{c}{a}\right)\left(\frac{a}{t}\right)^2\right]\left[0.9698 + 0.0302\left(\frac{c}{a}\right)^2\right]^{1/4}\right.$$

$$\left[\frac{1 - 0.15\lambda + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4}{1 + 0.13\lambda^2}\right]\left[\left(1.13 - 0.09\,\frac{c}{a}\right)\left(0.8 + 0.2\left(\frac{a}{t}\right)^{1/4}\right)\right]$$

$$\left.\left[\sqrt{\sec\left(\frac{\pi R}{2b}\right)\sec\left(\frac{\pi}{2}\,\frac{(R + c)}{b}\,\sqrt{\frac{a}{t}}\right)}\right]\sqrt{\frac{a}{c}}\right\}\sigma\sqrt{\frac{\pi c}{Q}}$$

where $\lambda' = \dfrac{1}{1 + 0.375\,\frac{c}{R}}$, $\lambda = \dfrac{1}{1 + 0.989\,\frac{c}{R}}$, $Q = 1 + 1.464\left(\frac{c}{a}\right)^{1.65}$

CRKGRO Stress Intensity Factor Library

Crack Code: 1050

Double corner cracks at open hole (one-dimension solution)

- Shallow corner crack ($a/c \le 1$)

$$K = \left\{ 1.13 - 0.09\,(a/c) + \left(\frac{0.89}{0.2 + a/c} - 0.54\right)\left(\frac{a}{t}\right)^2 + \left[0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14\left(1 - \frac{a}{c}\right)^{24}\right]\left(\frac{a}{t}\right)^4\right\}$$

$$\sqrt{\sec\left[\frac{\pi}{2}\,\frac{2\,(R + c)}{2b}\,\sqrt{\frac{a}{t}}\right]}\,\sqrt{\sec\left(\frac{\pi}{2}\,\frac{2R}{2b}\right)}\left(1 - 0.15\lambda + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4\right)\sigma\sqrt{\frac{\pi a}{Q}}$$

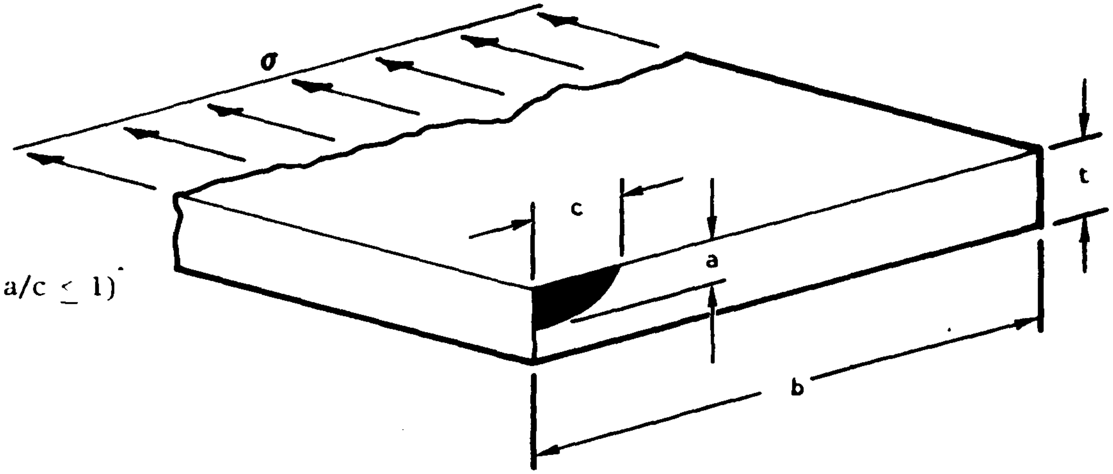
where $Q = 1 + 1.464\,(a/c)^{1.65}$; $\lambda = \frac{1}{1 + c/R}$

- Deep corner crack ($a/c > 1$)

$$K = \left[\sqrt{\frac{c}{a}}\,(1 + 0.03\,c/a) + \left[\sqrt{Q\,\frac{c}{a}} - \sqrt{\frac{c}{a}}\left(1 + \frac{0.03c}{a}\right)\right]\left(\frac{a}{t}\right)^{\sqrt{\pi}} + \sqrt{Q\,\frac{c}{a}}\left[\frac{c}{a}\left(\sqrt{\frac{\pi}{4}} - 1\right)\right]\left(\frac{a}{t}\right)^{2\sqrt{\pi}}\right]$$

$$\sqrt{\sec\left[\frac{\pi}{2}\,\frac{2\,(R + c)}{2b}\,\sqrt{\frac{a}{t}}\right]}\,\sqrt{\sec\left(\frac{\pi}{2}\,\frac{2R}{2b}\right)}\left(1 - 0.15\lambda + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4\right)\sigma\sqrt{\frac{\pi a}{Q}}$$

where $Q = 1 + 1.464\,(c/a)^{1.65}$; $\lambda = \frac{1}{1 + c/R}$



Crack Code: 1070

Single, shallow corner crack $(a/c \le 1)$

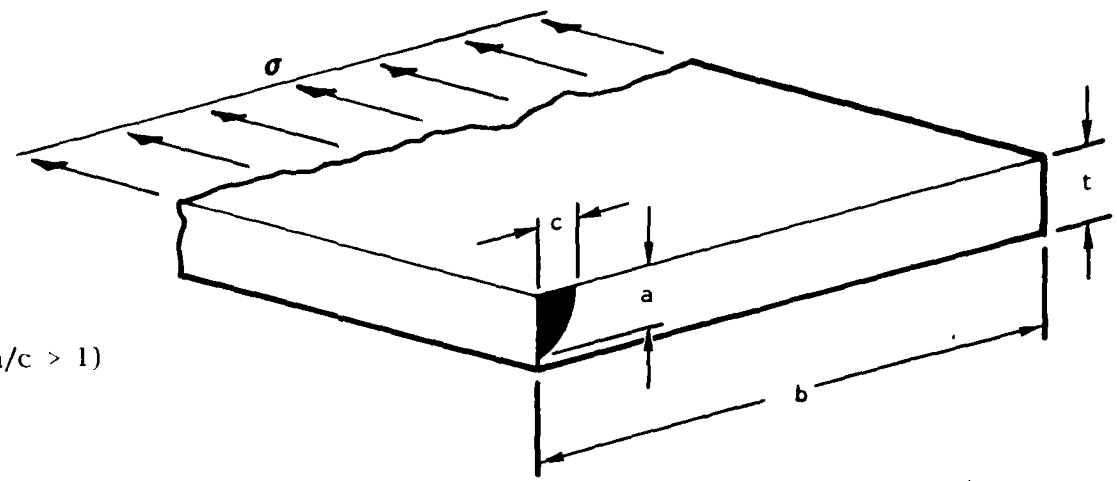
$$K_{(a)} = \left\{\left[1.08 - 0.03\left(\frac{a}{c}\right) + \left(\frac{1.06}{0.3 + \left(\frac{a}{c}\right)} - 0.44\right)\left(\frac{a}{t}\right)^2 + \left(0.25\left(\frac{a}{c}\right) + 14.8\left(1 - \frac{a}{c}\right)^{15} - 0.5\right)\left(\frac{a}{t}\right)^4\right]\left[0.03\left(\frac{a}{c}\right)^2 + 0.97\right]^{1/4}\right.$$

$$\left.\left[1.045 + 0.085\left(\frac{a}{t}\right)^2\right]\left[\frac{1.12 - 0.231\,(c/b) + 10.55\,(c/b)^2 - 21.72\,(c/b)^3 + 30.39\,(c/b)^4}{1.12}\right]\right\}\sigma\sqrt{\frac{\pi a}{Q}}$$

$$K_{(c)} = \left\{\left[1.08 - 0.03\left(\frac{a}{c}\right) + \left(\frac{1.06}{0.3 + \left(\frac{a}{c}\right)} - 0.44\right)\left(\frac{a}{t}\right)^2 + \left(0.25\left(\frac{a}{c}\right) + 14.8\left(1 - \frac{a}{c}\right)^{15} - 0.5\right)\left(\frac{a}{t}\right)^4\right]\left[0.97\left(\frac{a}{c}\right)^2 + 0.03\right]^{1/4}\right.$$

$$\left.\left[1.045 + 0.226\left(\frac{a}{t}\right)^2\right]\sqrt{\frac{a}{c}}\left[\frac{1.12 - 0.231\,(c/b) + 10.55\,(c/b)^2 - 21.72\,(c/b)^3 + 30.39\,(c/b)^4}{1.12}\right]\right\}\sigma\sqrt{\frac{\pi c}{Q}}$$

where $Q = 1 + 1.464\left(\frac{a}{c}\right)^{1.65}$



Crack code: 1070 (cont.)

Single, deep corner crack (a/c > 1)

$$K_{(a)} = \left\| \sqrt{\frac{c}{a}} \left(1.08 - 0.03 \frac{c}{a}\right) + 0.375 \left(\frac{c}{a}\right)^2 \left(\frac{a}{t}\right)^2 - 0.25 \left(\frac{c}{a}\right)^2 \left(\frac{a}{t}\right)^4 \right| \left|1.045 + 0.085 \left(\frac{c}{t}\right)^2\right| \left|0.970 \left(\frac{c}{a}\right)^2 + 0.03\right|^{1/4}$$

$$\left|\frac{1.12 - 0.231\,(c/b) + 10.55\,(c/b)^2 - 21.72\,(c/b)^3 + 30.39\,(c/b)^4}{1.12}\right\| \sigma \sqrt{\frac{\pi a}{Q}}$$

$$K_{(a)} = \left\| \sqrt{\frac{c}{a}} \left(1.08 - 0.03 \frac{c}{a}\right) + 0.375 \left(\frac{c}{a}\right)^2 \left(\frac{a}{t}\right)^2 - 0.25 \left(\frac{c}{a}\right)^2 \left(\frac{a}{t}\right)^4 \right| \left|1.045 + 0.226 \left(\frac{c}{t}\right)^2\right| \left|0.03 \left(\frac{c}{a}\right)^2 + 0.97\right|^{1/4} \sqrt{\frac{a}{c}}$$

$$\left|\frac{1.12 - 0.231\,(c/b) + 10.55\,(c/b)^2 - 21.72\,(c/b)^3 + 30.39\,(c/b)^4}{1.12}\right\| \sigma \sqrt{\frac{\pi c}{Q}}$$

where $Q = 1 + 1.464 \left(\frac{c}{a}\right)^{1.65}$

CRKGRO Stress Intensity Factor Library

Crack Code: 1070

Single edge corner crack (one-dimension solution)

- Shallow corner crack ($a/c \leq 1$)

$$K = \left\{ 1.13 - \frac{0.09a}{c} + \left[\frac{0.89}{0.2 + (a/c)} - 0.54\right]\left(\frac{a}{t}\right)^2 + \left[0.5 - \frac{1}{0.65 + (a/c)} + 14\,(1 - a/c)^{24}\right]\left(\frac{a}{t}\right)^4 \right\}$$

$$\left[\sqrt{\frac{2b}{\pi c}\tan\left(\frac{\pi c}{2b}\right)}\right]\left[\frac{0.752 + 2.02\,(c/b) + 0.37\left(1 - \sin\left(\frac{\pi c}{2b}\right)\right)^3}{\cos\left(\frac{\pi c}{2b}\right)}\right]\sigma\sqrt{\frac{\pi a}{Q}}$$

where $Q = 1 + 1.464\,(a/c)^{1.65}$

- Deep corner crack ($a/c > 1$)

$$K = \left\{ \sqrt{\frac{c}{a}}\,(1 + 0.03\,c/a) + \left[\sqrt{Q}\,\frac{c}{a} - \sqrt{\frac{c}{a}}\,(1 + 0.03\,c/a)\right]\left(\frac{a}{t}\right)^{\sqrt{\pi}} + \sqrt{Q}\,\frac{c}{a}\left[\frac{c}{a}\left(\sqrt{\frac{\pi}{4}} - 1\right)\right]\left(\frac{a}{t}\right)^{2\sqrt{\pi}} \right\}$$

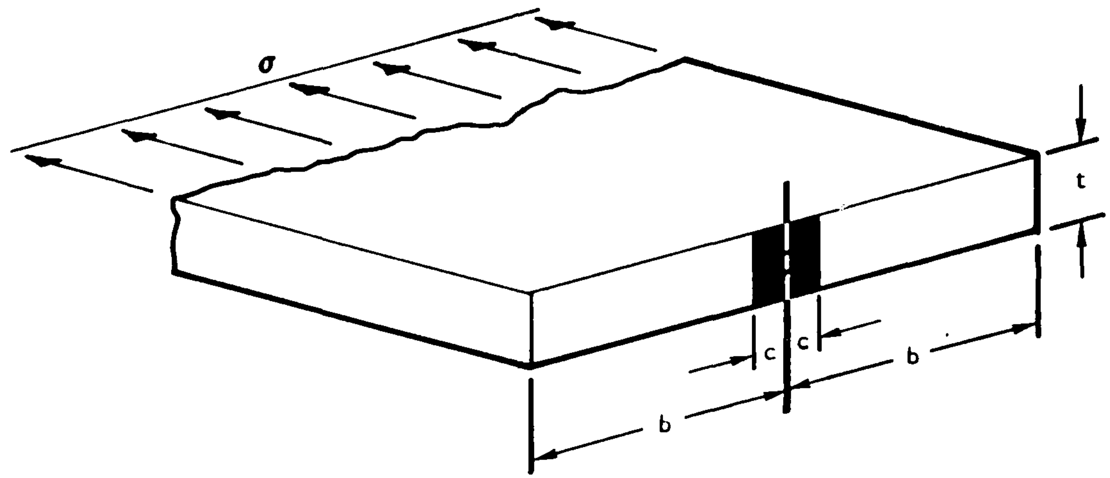
$$\left[\sqrt{\frac{2b}{\pi c}\tan\left(\frac{\pi c}{2b}\right)}\right]\left[\frac{0.752 + 2.02\,(c/b) + 0.37\left(1 - \sin\left(\frac{\pi c}{2b}\right)\right)^3}{\cos\left(\frac{\pi c}{2b}\right)}\right]\sigma\sqrt{\frac{\pi a}{Q}}$$

where $Q = 1 + 1.464\,(c/a)^{1.65}$

CRKGRO Stress Intensity Factor Library*

Crack code: 2010

Center through crack



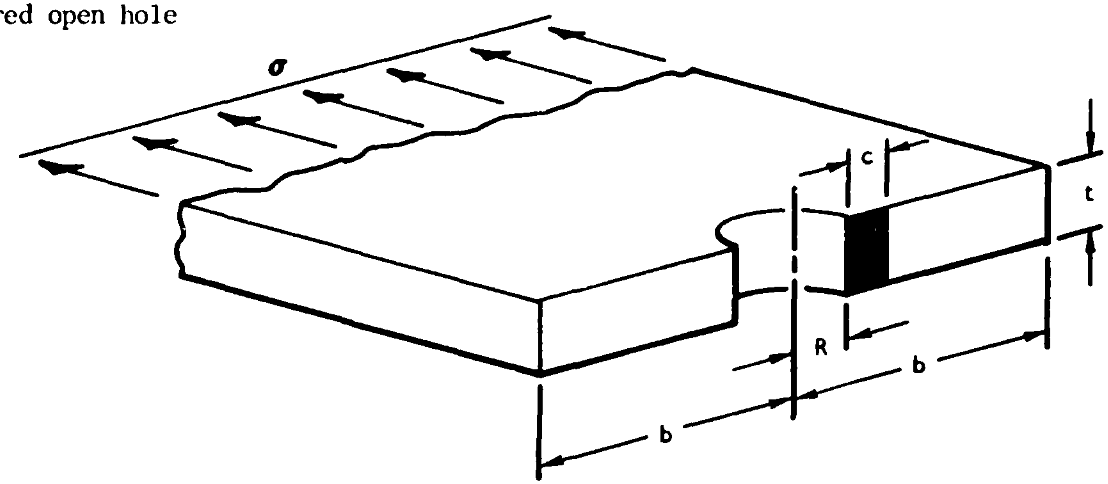
$$K = \left(\sqrt{\sec\left(\frac{\pi c}{2b}\right)}\right)\sigma\sqrt{\pi c}$$

*Reference: ASTM E647 78T, "Tentative Test Method for Constant Load Amplitude Fatigue Crack Growth Rate Above 10^{-8} m/cyc," 1978 Annual Book of ASTM Standard, Vol 10

CRKGRO Stress Intensity Factor Library*

Crack code: 2020

Single through crack at centered open hole



$$K = \left\{ (0.707 - 0.18\lambda + 6.55\lambda^2 - 10.54\lambda^3 + 6.85\lambda^4) \sqrt{\sec\left[\frac{\pi}{2}\left(\frac{2R + c}{2b - c}\right)\right]} \sqrt{\sec\left(\frac{\pi}{2}\,\frac{2R}{2b}\right)} \right\} \sigma \sqrt{\pi c}$$

where

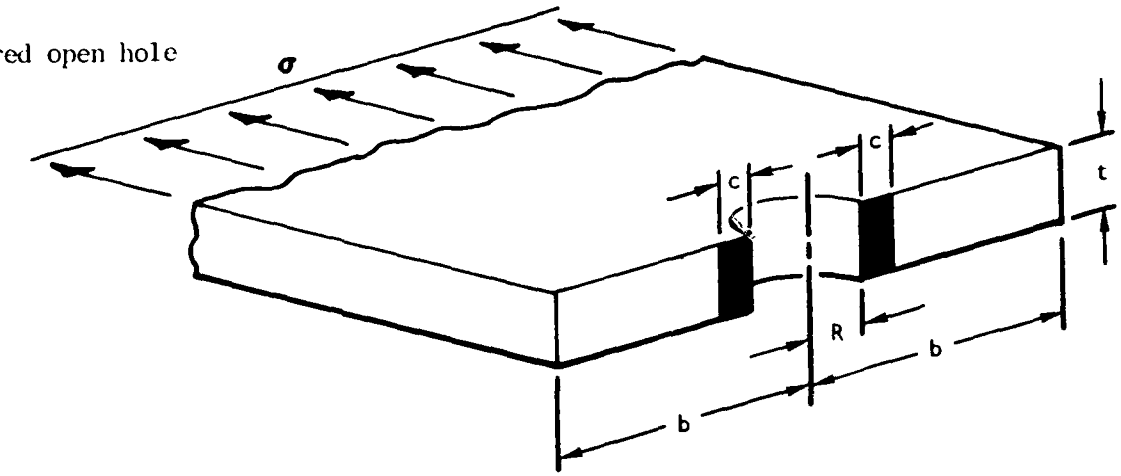
$$\lambda = \frac{1}{1 + \frac{c}{R}}$$

*Reference: Newman, J. C., "Predicting Failure of Specimens with Either Surface Cracks or Corner Cracks at *Holes*," NASA TN D-8244, June 1976, p 7

CRKGRO Stress Intensity Factor Library*

Crack code: 2030

Double through crack at centered open hole



$$K = \left\{ (1.0 - 0.15\lambda + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4) \sqrt{\sec\left[\frac{\pi}{2}\left(\frac{2R + 2c}{2b}\right)\right]} \sqrt{\sec\left(\frac{\pi}{2}\frac{2R}{2b}\right)} \right\} \sigma \sqrt{\pi c}$$

where

$$\lambda = \frac{1}{1 + \frac{c}{R}}$$

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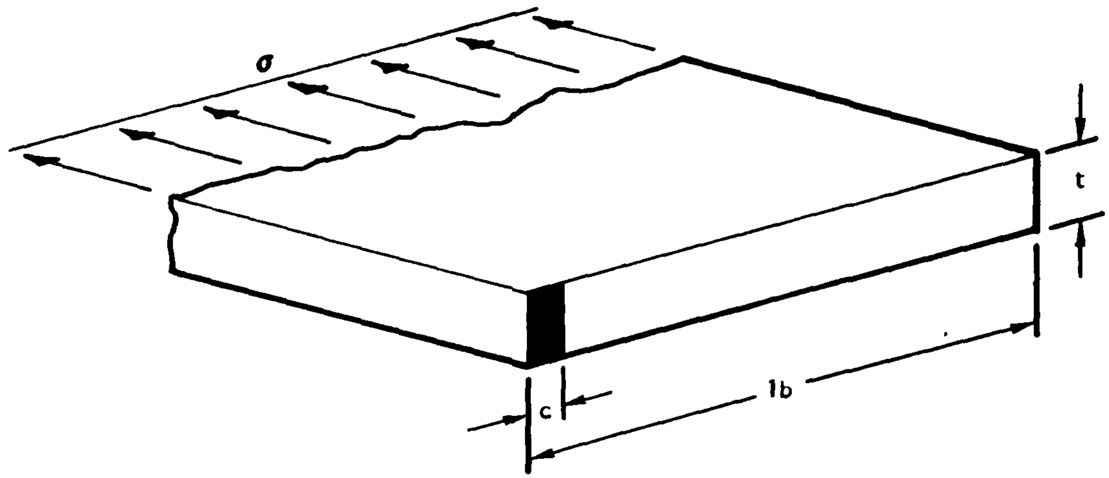
*Reference: Newman, J. C., "Predicting Failure of Specimens with Either Surface Cracks or Corner Cracks at Holes," NASA TN D 8244, June 1976, p 7

CRKGRO Stress Intensity Factor Library*

Crack code: 2040

Single edge through crack

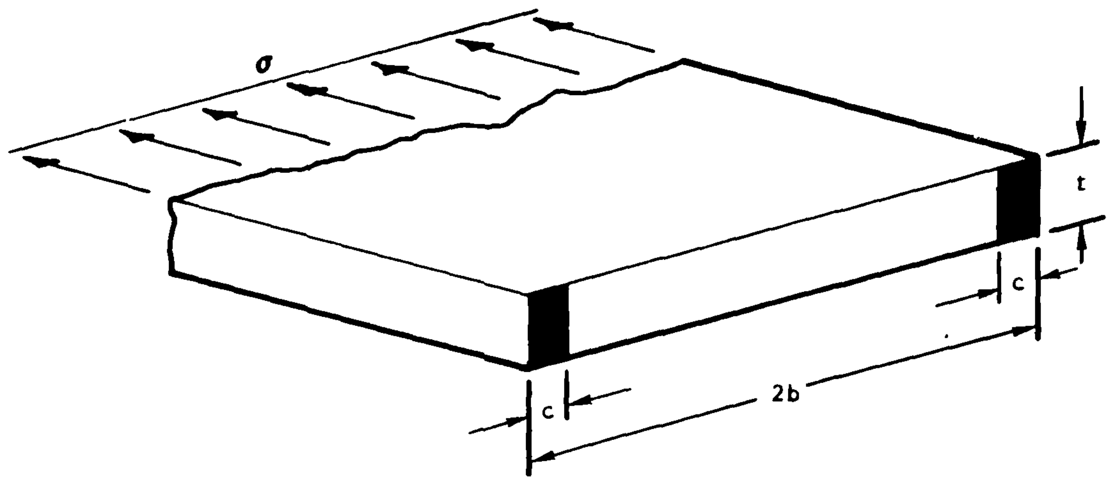


$$K = \left\{ \left[\frac{0.752 + 2.02\left(\frac{c}{b}\right) + 0.37\left[1 - \sin\left(\frac{\pi c}{2b}\right)\right]^3}{\cos\left(\frac{\pi c}{2b}\right)} \right] \sqrt{\frac{2b}{\pi c} \tan\left(\frac{\pi c}{2b}\right)} \right\} \sigma \sqrt{\pi c}$$

*Reference: Tada, H., Paris, P., and Irwin, I., The Stress Analysis of Cracks Handbook, Del Research Corp, 1973, pp 2-10

Crack code: 2050

Double edge through crack



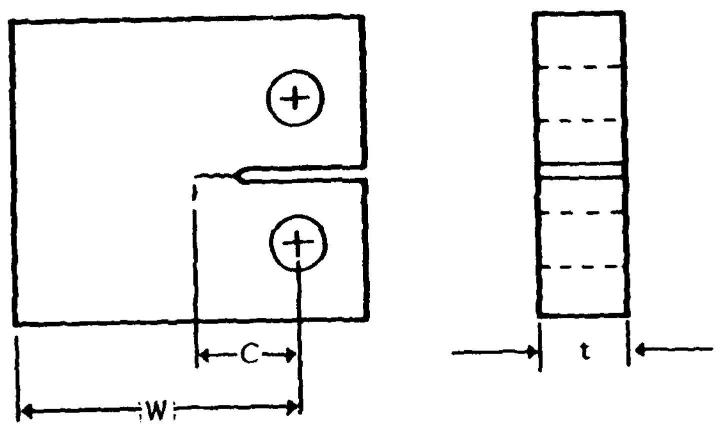
$$K = \left\{\left(1 + 0.122 \cos^4\left(\frac{\pi c}{2b}\right)\right)\sqrt{\frac{2b}{\pi c} \tan \frac{\pi c}{2b}}\right\} \sigma \sqrt{\pi c}$$

*Reference: Tada, H., Paris, P., and Irwin, G., The Stress Analysis of Cracks Handbook, Del Research Corp, 1973, pp 2.7

CRKGRO Stress Intensity Factor Library

Crack code: 2060

ASTM Compact Tension Specimen



$$K = \frac{P}{t\sqrt{w}} \frac{(2+\alpha)}{(1-\alpha)^{1.5}} (0.886 + 4.64\alpha - 13.32\alpha^2 + 14.72\alpha^3 - 5.6\alpha^4)$$

where $\alpha = \frac{c}{w}$

Appendix C

A TYPICAL FIGHTER AIR-TO-GROUND BASELINE MISSION SPECTRUM TABLE

Appendix C

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

1	-10.0★	39.1	29.6	41.9	4.2	20.1	7.8	48.9	6.3	37.1
2	8.4	37.8	16.4	28.6	17.8	49.5	13.8	26.9	4.0	42.9
3	11.4	74.1	20.3	34.5	1.5	21.0	7.8	39.5	11.9	23.8
4	2.1	71.5	11.3	43.6	5.5	33.1	11.9	56.3	-10.0	51.4
5	.6	18.9	7.0	[illegible]	31.7	46.6	3.0	17.3	5.9	44.1
6	30.6	42.4	25.3	44.3	2.9	31.2	4.9	28.6	5.6	29.7
7	18.0	28.4	14.4	44.2	16.4	35.2	8.0	51.8	8.1	23.5
8	2.8	21.7	6.7	59.5	12.3	47.3	-10.0	67.1	42.2	57.2
9	14.5	35.4	11.8	27.8	5.5	19.6	[illegible]	27.7	6.3	31.1
10	.6	28.8	9.2	22.6	12.5	41.6	.5	26.4	15.3	39.3
11	-.1	19.5	5.1	28.7	5.7	31.4	4.3	22.3	10.7	24.5
12	1.6	12.0	0.0	48.2	-10.0	31.1	7.1	23.7	6.6	35.2
13	12.1	49.2	11.0	76.9	4.4	29.2	5.2	29.5	6.7	30.6
14	16.1	26.3	11.0	37.8	5.8	17.2	-1.2	23.6	3.2	42.5
15	22.8	40.3	6.5	33.6	8.5	49.9	21.0	43.2	22.5	45.2
16	13.1	33.6	-10.0	25.1	6.4	78.6	11.3	42.4	5.5	34.6
17	10.6	71.7	5.1	35.1	11.2	32.1	1.4	46.3	15.4	37.3
18	5.4	46.9	.1	24.1	6.5	40.8	21.2	42.7	5.4	23.3
19	3.8	28.4	5.1	48.1	25.2	38.5	4.4	40.0	3.8	28.0
20	-10.0	19.0	7.0	35.6	5.2	31.1	4.0	28.6	0.0	53.1
21	7.2	36.8	11.1	35.7	11.3	40.1	9.0	29.8	16.0	51.3
22	-5.6	25.4	14.3	36.9	6.5	30.1	17.0	38.5	14.5	32.3
23	6.5	38.1	8.6	35.2	0.0	37.7	18.1	37.0	-10.0	50.5
24	6.5	23.8	5.7	37.7	3.0	30.6	18.3	62.8	1.9	36.7
25	10.6	39.3	3.6	38.0	4.0	32.3	7.2	35.1	15.6	55.2
26	0.0	47.4	3.0	38.1	14.6	32.0	7.5	21.2	2.7	29.6
27	12.2	37.9	.3	33.8	15.3	45.0	-10.0	32.5	8.6	46.5
28	-.4	75.6	-.3	33.5	10.8	27.1	14.8	48.9	17.9	35.1
29	2.8	37.0	10.8	[illegible]	2.2	48.3	25.3	64.1	12.6	34.4
30	-14.7	53.9	17.3	62.1	27.3	39.1	8.7	38.5	6.6	45.3
31	23.4	47.6	10.3	33.8	-10.0	70.0	-.5	35.3	1.7	50.0
32	3.1	41.4	.8	25.8	13.9	30.7	15.9	53.5	1.3	38.9
33	.2	28.1	10.0	25.0	2.2	58.8	1.6	36.8	4.5	33.2
34	1.3	48.7	.3	26.9	2.5	18.9	2.5	58.5	17.3	27.6
35	4.5	33.0	-10.0	32.8	3.0	35.7	7.5	41.9	27.2	39.7
36	6.2	19.5	8.2	32.1	11.4	31.7	-.4	18.6	2.5	60.7
37	12.3	64.0	5.0	29.6	18.9	41.6	1.3	36.2	3.9	28.9
38	9.2	34.1	7.4	32.0	14.8	37.9	13.5	26.1	6.8	25.7
39	-10.0	46.1	22.5	38.5	3.2	33.0	13.9	25.3	15.3	30.8
40	2.5	69.4	5.2	34.4	17.5	30.2	10.0	36.3	16.1	45.6
41	11.8	36.5	11.8	35.7	12.0	24.8	5.8	[illegible]	1.0	54.0
42	11.8	42.4	1.5	59.3	24.6	47.9	6.2	25.6	-10.0	36.9
43	3.7	20.9	6.3	47.2	16.9	63.4	1.1	15.5	.8	48.6
44	3.6	68.2	.7	46.1	16.9	43.4	12.6	20.2	3.7	45.9
45	5.8	49.5	10.8	35.5	16.7	44.8	3.4	34.2	1.3	16.6
46	5.1	53.6	3.8	45.6	4.6	34.8	-10.0	63.2	6.6	19.7
47	6.2	33.9	2.9	44.9	19.5	40.1	-1.2	37.2	.6	40.0
48	22.3	58.4	23.3	46.6	1.7	54.0	3.0	28.2	11.0	38.3
49	-1.7	12.3	.8	33.7	2.4	30.8	5.0	27.0	.4	39.0
50	12.2	45.2	10.1	29.5	-10.0	38.9	15.8	31.7	6.3	18.9
51	6.5	19.6	0.0	53.7	.9	25.0	13.8	28.7	2.2	32.1
52	.1	49.5	-4.5	29.5	5.8	21.5	5.2	21.5	5.4	46.0
53	9.6	28.3	9.3	[illegible]	19.3	44.9	5.9	[illegible]	[illegible]	24.7
54	12.3	38.7	-10.0	29.5	15.6	35.7	1.2	27.5	6.6	50.4
55	21.5	31.8	7.7	46.9	14.3	46.1	3.4	32.2	.3	37.8
56	-.8	24.9	14.0	43.6	10.2	37.5	7.9	36.1	.9	67.2
57	13.9	51.4	4.0	25.9	15.2	54.6	7.7	54.2	.5	69.2
58	-10.0	68.4	2.5	35.4	13.6	42.3	15.1	27.0	6.1	30.1
59	11.9	33.9	7.6	58.4	7.3	24.5	11.9	39.5	6.4	54.6
60	25.4	74.1	-.8	60.3	21.8	44.7	7.8	43.6	[illegible]	34.4
61	20.4	60.9	6.0	34.3	19.3	41.3	27.0	37.7	[illegible]	24.5
62	2.0	31.5	.2	57.5	9.4	41.5	7.9	45.4	5.1	19.0

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

63	.4	37.8	27.0	43.1	6.0	21.9	6.4	23.4	11.2	34.7
64	9.3	42.2	8.2	40.7	17.5	46.7	.3	41.1	19.1	49.3
65	11.9	24.8	12.3	42.9	.7	23.8	-10.0	45.0	16.3	62.5
66	2.2	40.2	14.0	34.1	3.2	52.3	4.0	24.4	11.9	48.6
67	-3.8	34.7	23.2	38.9	9.5	25.3	10.1	25.0	7.4	21.2
68	-.1	31.6	.9	18.9	1.4	36.4	0.0	32.5	4.9	35.9
69	7.1	33.5	2.0	40.0	-10.0	22.4	13.1	36.3	10.8	55.1
70	34.6	49.6	1.9	28.3	7.3	35.7	8.3	50.6	13.3	57.1
71	2.3	54.5	14.2	36.6	14.2	39.5	21.6	41.5	10.5	48.9
72	9.5	41.6	19.7	47.7	11.3	59.6	6.1	51.4	10.7	28.5
73	3.7	57.1	-10.0	30.4	11.7	41.0	8.3	23.2	.7	24.9
74	-.1	49.3	6.4	24.5	.5	30.6	12.4	33.0	16.2	40.0
75	14.4	42.4	3.6	31.9	.1	49.5	2.2	29.4	.8	44.5
76	3.7	46.6	.2	58.4	9.1	44.5	5.4	25.6	10.5	31.7
77	-10.0	20.5	8.3	44.4	22.2	34.1	16.6	38.9	0.0	78.9
78	-.7	25.1	-2.0	63.6	3.5	62.1	15.4	27.9	12.2	31.0
79	18.7	40.8	21.9	41.0	11.2	28.5	12.7	23.6	12.2	35.6
80	2.9	49.9	5.3	46.9	5.4	29.2	7.8	35.1	-10.0	26.7
81	5.0	49.3	15.3	41.5	5.0	46.0	1.6	43.3	.5	45.7
82	5.0	47.8	12.0	26.2	-.4	18.9	-2.3	31.1	10.4	38.6
83	5.6	47.6	4.0	73.0	-1.7	35.5	.2	27.0	16.4	70.0
84	0.0	34.9	18.4	52.3	9.1	49.6	-10.0	40.3	6.4	30.4
85	12.5	47.7	6.0	27.2	4.3	17.7	4.2	19.6	4.2	22.5
86	-.1	51.6	5.3	19.1	-1.0	23.0	6.4	24.1	13.3	50.7
87	12.3	46.0	11.8	30.9	-1.5	37.6	7.4	50.7	2.9	34.1
88	21.3	36.1	13.5	35.7	-10.0	28.0	4.9	25.2	14.2	25.3
89	10.2	45.1	20.0	58.0	15.3	30.9	6.2	53.2	.5	33.2
90	12.5	38.3	-.9	35.1	4.8	62.4	-.8	26.0	11.3	47.7
91	29.8	41.5	0.0	50.5	.6	22.5	-1.8	31.9	14.7	44.9
92	.7	37.9	-10.0	24.8	2.3	29.9	5.1	46.6	.3	14.5
93	-1.5	16.9	2.0	45.5	20.0	50.8	-.5	17.8	5.4	39.6
94	22.9	57.9	9.6	25.2	6.9	36.2	8.0	27.6	9.5	47.3
95	11.3	27.7	.4	28.9	18.5	34.5	6.6	75.1	7.4	21.2
96	-10.0	69.0	8.1	35.0	14.4	52.9	.6	26.2	4.1	28.0
97	14.2	53.4	10.1	35.6	4.3	38.1	-.9	56.0	23.9	45.6
98	7.1	37.1	8.3	31.2	1.5	22.9	7.9	32.1	10.9	65.9
99	4.4	24.4	12.5	31.8	14.9	27.7	14.1	41.1	-10.0	[illegible]
100	32.4	55.2	7.6	40.9	1.5	54.3	11.0	40.8	20.5	36.5
101	4.6	35.7	14.7	25.6	7.7	24.0	9.1	33.3	11.2	46.6
102	16.1	37.1	5.5	49.5	11.9	35.8	.2	21.1	8.1	31.8
103	6.0	17.9	6.5	18.4	2.4	33.8	-17.0	52.3	.7	36.3
104	.1	24.6	7.5	37.1	5.1	56.4	21.0	33.7	19.5	39.3
105	29.1	40.1	8.6	60.3	9.2	68.0	23.7	37.9	15.1	38.4
106	4.9	21.3	6.7	54.9	21.4	58.2	8.2	23.5	.9	44.3
107	11.7	29.6	5.4	26.2	-10.0	54.0	1.5	29.8	5.6	43.9
108	3.6	30.5	5.8	54.9	.8	40.7	27.2	36.8	22.9	52.3
109	13.6	39.5	7.9	32.5	7.4	49.2	6.3	27.7	1.8	49.1
110	8.9	36.0	16.0	47.7	11.1	30.0	6.0	45.9	15.8	28.9
111	10.4	28.9	-10.0	35.4	3.0	70.0	25.2	46.6	0.0	19.5
112	6.3	26.4	12.4	34.8	2.1	18.5	.2	35.0	12.5	29.8
113	2.8	26.8	2.8	17.3	5.7	39.5	.2	44.0	21.5	49.0
114	9.3	56.5	15.8	30.6	5.0	42.6	9.1	39.2	12.9	32.2
115	-10.0	25.9	8.4	7.0	14.6	19.9	13.9	45.7	6.0	42.8
116	6.1	29.7	7.9	33.7	14.4	41.2	21.9	56.4	10.7	40.2
117	2.7	49.3	34.3	48.0	8.0	26.1	9.8	29.9	7.6	15.8
118	-5.5	38.4	11.0	28.7	6.7	28.7	1.7	24.9	-10.0	15.1
119	4.4	35.9	21.0	34.3	5.7	47.2	2.5	25.9	4.9	42.8
120	21.7	32.0	15.0	69.2	11.9	53.0	15.5	38.1	5.1	50.6
121	13.2	37.0	13.7	33.0	8.6	35.4	15.2	46.3	22.9	72.9
122	14.8	35.3	5.6	43.2	3.1	22.0	-10.0	39.2	[illegible]	12.5
123	1.1	39.4	11.0	23.7	6.9	27.6	14.0	42.6	12.2	[illegible]
124	3.7	44.8	4.7	21.1	.8	47.3	6.6	21.0	3.0	29.4

*% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

125	2.6	24.[illegible]	5.1	65.0	.7	21.5	.1	46.8	.1	37.1
126	3.9	38.7	1.0	27.1	-10.0	19.6	0.0	35.4	18.7	37.2
127	0.0	25.1	1.9	45.5	2.0	37.2	10.2	27.7	3.4	44.6
128	32.6	45.9	8.9	35.1	15.4	51.3	23.2	54.1	.2	40.2
129	8.9	61.9	1.6	27.0	40.9	65.0	6.5	31.6	.3	25.9
130	3.8	57.9	-10.0	40.8	30.1	49.7	9.7	40.9	17.9	31.0
131	.8	47.9	10.4	24.1	2.1	13.9	1.2	17.1	3.9	52.1
132	36.8	53.2	-.2	65.2	13.3	30.8	3.7	39.2	4.3	47.5
133	15.8	46.3	15.3	33.9	9.2	43.1	6.4	49.6	5.6	33.3
134	-10.0	31.4	.2	24.1	13.4	42.0	23.1	66.0	-2.5	13.3
135	1.4	34.3	11.2	45.2	9.6	40.2	.9	30.7	11.2	47.7
136	1.1	40.6	13.2	30.6	6.0	30.2	.4	67.9	11.4	37.5
137	14.1	46.3	7.4	29.1	17.6	54.0	21.6	40.2	-1[illegible]	29.1
138	8.5	55.8	27.1	46.0	2.9	31.0	8.0	22.0	3.6	63.9
139	4.1	50.7	11.4	60.9	-.7	46.1	5.7	20.5	.3	46.6
140	3.3	25.5	-.2	70.2	2.0	32.4	19.8	31.5	12.0	34.3
141	1.3	33.5	19.1	44.1	9.7	55.8	-10.0	40.0	4.6	25.5
142	8.3	45.3	10.4	35.9	9.3	32.7	6.0	64.3	18.7	47.0
143	13.4	37.0	8.6	42.4	6.3	45.4	16.5	30.2	15.8	58.0
144	7.1	49.5	11.5	74.8	8.5	34.8	11.9	48.8	5.2	71.6
145	28.4	50.1	3.6	28.8	-10.0	44.1	13.1	58.0	11.3	32.7
146	20.4	33.3	17.6	46.8	11.2	45.2	18.0	31.4	1.2	50.3
147	6.4	20.3	6.3	48.5	2.9	35.9	4.3	27.5	13.0	23.8
148	-10.2	20.2	3.6	24.5	12.3	28.6	13.0	29.5	14.1	36.1
149	.3	49.9	-10.0	53.1	10.7	50.9	8.4	41.6	15.3	29.9
150	9.7	47.0	14.6	41.9	21.7	35.9	7.3	52.3	.7	45.0
151	2.7	26.0	7.0	29.6	2.5	34.6	6.8	40.4	6.8	36.3
152	9.0	29.4	4.2	38.4	1.3	16.4	-1.4	15.8	4.4	29.2
153	-10.0	21.[illegible]	2.0	32.3	.2	30.4	5.9	55.7	7.2	20.8
154	6.5	40.2	17.1	35.5	9.1	22.5	11.5	77.7	5.5	32.4
155	10.3	41.3	1.7	59.7	5.2	25.4	5.6	23.3	8.7	76.7
156	7.5	23.4	6.1	38.6	11.5	63.2	2.2	18.1	-10.0	35.0
157	1.4	48.8	35.1	63.2	4.2	28.4	-.1	21.6	1.9	48.6
158	12.7	56.1	19.4	35.1	-2.3	60.0	10.8	25.4	3.0	39.5
159	1.3	25.7	12.2	32.9	8.9	19.4	5.4	29.0	0.0	41.3
160	7.8	24.0	10.4	37.0	0.0	25.7	-10.0	33.5	18.2	58.0
161	11.5	32.[illegible]	2.3	45.4	16.5	29.8	.3	45.5	2.1	39.7
162	8.2	30.9	.3	49.1	6.7	37.5	17.9	34.3	7.5	47.2
163	24.7	37.9	-3.1	32.4	14.9	60.1	28.6	68.8	14.3	27.8
164	7.6	39.5	3.9	53.3	-10.0	31.5	11.9	63.8	15.4	68.5
165	15.6	34.7	2.3	28.3	1.2	19.0	4.0	67.3	11.1	34.9
166	4.6	27.3	15.6	64.3	20.4	32.3	6.0	32.6	21.3	55.6
167	24.5	54.4	.6	24.2	2.5	20.8	6.6	41.4	3.4	41.7
168	11.9	44.9	-10.0	24.6	14.3	34.5	17.0	35.1	14.4	62.1
169	23.5	43.9	6.3	34.4	9.5	71.3	2.3	36.5	9.9	26.7
170	1.7	36.4	16.4	39.2	1.0	38.0	24.6	37.2	0.0	28.5
171	7.3	27.4	15.5	35.2	14.5	38.9	3.3	44.8	2.6	51.0
172	-10.0	37.2	9.5	27.1	3.3	26.1	6.5	26.6	10.6	24.1
173	13.7	49.1	-.5	51.4	26.2	53.0	9.9	38.4	5.7	15.3
174	13.8	59.9	7.9	20.8	0.0	16.7	4.3	33.0	-1.2	23.2
175	.4	14.2	3.7	56.0	1.2	52.7	29.8	42.2	-10.0	15.7
176	.3	63.3	16.5	30.5	3.2	34.5	1.9	62.0	1.4	29.8
177	-1.7	34.0	3.7	38.3	33.3	47.5	.7	25.8	12.3	42.1
178	9.9	21.3	10.9	42.6	18.5	49.1	26.2	40.4	12.0	39.5
179	4.0	43.3	12.0	44.5	7.4	33.8	-10.0	36.2	.5	15.6
180	-.9	40.9	-.6	28.6	3.9	17.0	.1	52.9	-1.1	25.4
181	11.1	41.3	9.2	32.8	3.7	33.0	0.0	43.7	8.5	[illegible]
182	5.3	50.0	1.7	17.1	.3	20.2	6.5	39.3	20.3	34.3
183	4.4	17.1	3.0	56.9	-10.0	35.3	6.8	73.5	16.2	46.3
184	7.4	34.0	.4	69.5	1.6	36.0	2.3	36.5	15.5	35.4
185	[illegible]	34.4	2.3	26.3	4.7	[illegible]	14.6	43.[illegible]	.7	37.8
186	17.0	36.6	6.7	58.9	21.8	59.5	1.8	43.1	-.4	43.4

*% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

187	22.6	33.2	-10.0	26.6	9.4	40.2	2.1	56.5	2.2	40.2
188	3.5	22.5	10.7	21.3	4.8	70.5	25.5	45.3	.1	22.5
189	9.2	57.0	7.0	29.0	6.6	45.1	-.4	69.8	4.7	37.5
190	6.3	37.7	27.3	40.4	11.5	25.1	6.5	28.1	11.5	57.0
191	-10.0	56.9	19.4	32.7	6.3	22.5	7.9	35.5	11.6	46.4
192	26.2	40.1	4.7	41.5	6.4	59.2	4.2	42.4	15.2	35.5
193	7.8	22.1	0.0	13.4	1.2	41.4	-2.5	16.1	5.8	43.6
194	11.2	36.0	1.6	73.6	12.0	45.5	11.3	54.4	-10.0	25.7
195	.2	37.7	.2	27.6	16.5	56.5	8.8	[illegible]	[illegible]	37.4
196	5.0	50.3	4.6	17.3	.4	41.4	5.1	26.8	7.8	30.0
197	2.7	34.2	5.7	19.2	5.1	36.4	17.5	54.9	.4	32.4
198	13.2	54.0	13.2	35.2	6.4	29.6	-10.0	49.6	.2	15.8
199	.3	42.8	16.8	39.6	15.0	37.2	4.3	30.2	12.5	46.4
200	21.3	44.9	2.6	41.1	12.4	50.3	10.8	26.8	8.1	60.1
201	15.1	38.1	4.2	36.7	2.5	34.6	16.4	26.5	15.2	51.6
202	1.0	38.4	8.3	29.3	-10.0	53.2	1.9	34.1	-.2	49.6
203	5.4	38.9	17.5	34.5	.3	43.4	0.0	45.2	23.3	45.0
204	2.4	24.2	7.4	47.2	2.9	25.1	2.1	46.4	4.7	53.3
205	23.9	41.2	7.3	26.1	10.8	27.0	2.3	58.9	10.5	27.8
206	12.5	32.0	-10.0	27.4	10.6	56.5	10.5	26.2	5.6	29.9
207	17.8	59.4	-1.3	62.9	10.3	46.6	10.8	28.8	8.1	47.9
208	33.6	61.3	8.6	28.3	1.9	23.5	2.7	24.4	6.0	34.9
209	22.4	40.6	29.2	42.4	3.9	26.8	.6	49.0	1.8	14.3
210	-10.0	28.5	1.2	45.6	6.5	42.0	1.9	14.7	3.7	17.3
211	1.3	15.1	.4	49.9	0.0	29.1	14.1	24.8	-1.4	58.6
212	.7	34.5	13.1	26.6	5.6	30.6	15.3	39.0	.8	21.7
213	4.6	55.9	4.7	67.7	-4.3	41.4	21.2	54.2	-10.0	37.5
214	4.9	38.3	3.4	47.1	1.7	37.8	3.7	52.7	14.5	35.9
215	14.7	32.7	3.4	42.3	2.6	42.8	7.3	44.2	12.4	40.0
216	2.7	41.7	2.2	34.6	19.6	32.6	7.8	35.2	3.2	49.9
217	.7	50.2	9.9	39.8	4.8	38.1	-10.0	37.5	12.7	38.7
218	4.3	31.7	12.3	71.3	-1.9	53.4	31.4	41.6	1.8	51.2
219	9.8	35.0	15.5	60.4	1.7	28.0	14.2	48.5	12.3	32.5
220	16.3	43.1	4.4	32.3	-.2	30.5	16.1	32.9	10.1	42.6
221	12.7	34.3	-.8	34.0	-10.0	52.1	16.2	36.6	22.5	41.2
222	-.1	44.6	13.3	38.0	20.9	34.7	-.1	24.0	10.2	36.4
223	17.9	58.2	3.6	37.3	2.8	15.5	3.7	43.5	22.8	45.2
224	6.1	19.5	1.3	24.7	11.7	37.0	2.7	44.8	6.6	26.9
225	1.1	50.2	-10.0	36.8	21.2	34.9	10.1	27.4	4.5	40.7
226	27.7	52.7	2.1	38.4	8.6	33.9	18.8	32.4	2.9	28.9
227	1.3	47.8	1.3	17.0	1.8	31.0	16.6	35.0	-.7	28.5
228	10.9	62.7	6.3	28.5	2.3	48.5	20.2	36.8	8.0	26.3
229	-10.0	44.7	15.5	43.4	12.8	24.9	6.4	38.0	1.5	32.0
230	17.2	56.8	4.7	21.5	.4	25.4	7.4	20.0	8.3	32.4
231	17.7	33.4	-.5	28.0	3.5	55.2	13.4	37.6	[illegible]	15.5
232	1.2	34.8	10.6	28.7	4.5	39.4	.1	63.4	-10.0	79.7
233	2.7	21.6	[illegible]	13.5	1.2	60.9	0.0	14.0	[illegible]	33.6
234	12.7	52.3	[illegible]	41.4	3.6	38.7	15.4	55.4	[illegible]	[illegible]
235	9.9	47.7	28.6	40.0	4.6	39.4	5.6	34.6	1.0	31.0
236	13.7	25.0	.4	36.0	6.0	38.6	-10.0	32.6	2.7	45.6
237	6.0	37.2	15.3	33.7	14.0	49.7	19.1	31.2	5.8	52.6
238	10.6	20.6	-.1	42.2	2.6	19.3	5.7	48.2	[illegible]	29.7
239	9.1	21.5	4.3	32.0	7.6	40.1	11.6	52.0	6.7	26.9
240	10.7	36.8	2.6	26.0	-10.0	34.6	1.7	22.6	4.4	36.4
241	10.2	30.6	.2	14.7	2.4	50.8	16.3	38.5	.2	21.6
242	5.4	29.0	.7	25.5	3.5	61.2	1.0	41.3	3.2	27.8
243	.5	62.9	8.6	26.0	14.1	32.3	7.4	46.7	17.3	[illegible]
244	3.2	26.2	-10.0	25.2	5.5	38.7	3.7	53.5	8.3	32.5
245	7.8	39.1	1.1	41.9	6.2	38.9	3.5	41.9	12.0	26.2
246	-3.6	18.4	8.2	54.9	2.1	31.2	11.0	26.8	1.4	35.4
247	12.8	27.8	7.6	35.2	12.2	28.5	12.7	30.6	13.7	37.3
248	-10.0	40.7	7.7	41.6	14.2	41.4	8.3	29.6	13.4	32.2

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

249	16.9	61.9	2.4	27.7	8.5	31.3	15.3	29.[illegible]	5.2	35.6
250	17.0	64.7	20.7	42.9	11.2	27.7	5.4	23.9	4.0	24.1
251	9.5	31.9	15.3	47.4	14.7	33.6	12.4	29.1	-10.0	37.1
252	22.9	48.3	-.7	36.4	10.2	30.8	10.3	45.3	16.5	37.1
253	3.9	41.3	22.[illegible]	35.3	2.7	20.7	5.6	41.[illegible]	9.4	47.0
254	18.6	44.2	2.7	37.8	11.6	44.5	11.6	69.[illegible]	15.1	37.7
255	7.6	24.9	3.0	27.2	8.6	34.6	-10.0	31.8	7.6	32.5
256	17.9	33.4	11.6	39.1	6.8	31.9	8.9	23.1	11.2	28.4
257	6.7	30.4	11.9	40.6	1.7	27.1	6.1	30.1	6.8	31.6
258	7.5	50.5	2.1	26.9	12.3	46.7	12.9	26.5	4.3	36.3
259	15.8	40.2	7.4	27.0	-10.0	56.1	8.2	45.9	12.4	54.7
260	3.0	26.4	9.7	33.0	8.5	50.6	2.6	29.2	-.8	16.0
261	1.1	44.4	16.6	34.1	1.3	41.6	.1	47.[illegible]	.7	39.5
262	15.1	28.4	0.0	20.2	.1	48.6	8.7	20.2	4.7	49.7
263	10.9	44.5	-10.0	21.3	.6	34.7	.6	30.5	5.4	39.5
264	5.9	39.8	18.6	45.0	22.9	35.8	-.5	41.7	.8	21.2
265	8.0	29.2	5.5	51.9	3.3	36.9	-2.3	38.3	2.3	41.2
266	17.7	51.8	10.4	48.0	-.1	42.5	29.1	40.5	27.2	57.6
267	-10.0	26.8	4.8	36.8	21.4	69.7	2.4	25.3	7.0	52.2
268	15.5	40.3	.7	30.0	5.6	63.1	14.5	41.9	1.1	41.8
269	21.2	35.0	5.4	39.3	12.8	53.1	-2.1	68.8	3.0	55.5
270	2.4	63.9	16.0	54.2	4.5	59.5	32.6	43.0	-10.0	30.5
271	19.9	52.9	14.0	58.6	10.1	24.3	5.9	27.2	1.2	21.4
272	6.8	40.9	5.0	36.9	.5	32.2	1.8	43.9	7.8	23.4
273	12.4	34.1	8.9	40.9	7.3	71.6	3.8	18.4	4.5	29.7
274	13.4	69.4	7.5	39.6	1.3	26.0	-10.0	70.3	35.3	46.5
275	1.8	73.2	5.2	27.7	2.3	39.2	13.4	40.0	11.5	43.4
276	1.8	33.4	11.3	23.3	3.0	18.6	3.4	35.9	12.5	42.9
277	.1	67.4	3.7	42.4	-.7	41.7	12.7	33.5	12.5	25.4
278	15.1	39.8	2.0	47.5	-10.0	42.8	28.2	40.5	13.4	36.3
279	14.9	53.2	2.1	52.7	33.7	59.0	23.1	34.3	-4.0	17.1
280	4.7	20.1	3.7	50.3	19.8	36.6	5.7	18.6	6.7	55.4
281	17.2	31.3	8.2	54.9	29.9	54.5	17.5	44.3	10.9	42.2
282	10.2	43.6	-10.0	43.8	15.8	46.5	17.0	56.1	15.3	56.7
283	21.2	44.5	9.4	32.5	15.5	56.2	14.4	28.7	6.8	34.3
284	7.6	37.0	-.8	50.1	.6	37.5	9.5	41.0	2.8	55.6
285	17.9	29.4	-6.3	32.3	5.5	27.9	6.2	42.0	8.8	23.4
286	-10.0	45.8	5.2	42.8	5.9	35.7	17.8	33.6	1.1	45.9
287	4.1	31.6	9.6	37.4	17.1	51.9	6.1	22.3	7.0	29.2
288	9.9	29.5	14.1	42.2	1.3	32.0	9.0	50.2	1.2	25.2
289	13.5	31.9	4.2	42.0	1.3	46.7	.4	42.0	-10.0	49.1
290	3.9	65.4	13.3	52.3	18.5	35.2	5.8	49.1	34.6	46.4
291	6.5	38.4	3.4	53.3	-.3	78.2	21.6	47.9	1.9	18.6
292	3.6	23.0	1.5	45.7	2.3	44.8	2.9	17.9	-1.7	36.2
293	18.8	36.2	7.0	27.0	2.9	39.3	-10.0	61.7	19.0	36.3
294	7.0	41.4	16.4	27.9	16.5	32.1	17.2	27.8	4.2	43.2
295	9.1	23.3	5.4	32.3	8.1	30.7	.4	24.0	1.8	32.9
296	3.0	30.7	17.1	35.6	11.1	34.9	.2	42.9	23.8	37.5
297	7.5	29.5	1.9	31.4	-10.0	41.3	25.5	39.7	[illegible].1	20.1
298	4.3	45.7	31.6	57.5	5.1	15.1	-.1	53.4	.3	33.7
299	5.2	47.2	1.4	38.5	18.5	41.6	10.2	33.4	6.1	42.7
300	24.2	44.9	10.8	31.0	7.7	65.3	23.6	33.8	3.6	21.7
301	6.7	50.1	-10.0	54.0	11.9	28.8	3.2	42.9	29.1	39.8
302	22.3	40.1	2.0	36.6	4.9	20.3	0.0	53.2	4.8	43.3
303	7.1	42.4	16.3	54.4	4.5	45.9	-2.0	28.7	4.6	62.9
304	3.6	51.1	10.9	38.6	10.7	46.0	18.5	37.5	3.0	13.4
305	-10.0	56.[illegible]	[illegible]	38.2	1.0	33.3	3.2	33.3	17.3	57.9
306	1.4	45.2	14.8	32.3	14.4	29.5	2.0	64.4	10.5	46.4
307	.2	43.3	6.1	47.8	8.9	21.6	4.1	34.8	4.5	32.6
308	3.2	38.8	14.1	34.7	-.4	41.0	13.3	32.8	-10.0	29.4
309	3.5	23.5	13.3	30.8	2.6	47.2	5.3	25.9	7.0	27.1
310	6.1	45.1	12.1	27.4	-.6	49.8	5.3	36.7	13.5	31.9

*% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

311	11.7	43.3	13.6	29.0	8.9	31.3	1.3	35.9	16.4	51.8
312	18.3	37.2	14.3	31.4	16.6	47.3	-13.0	45.6	27.4	38.2
313	14.1	42.1	7.1	26.0	11.1	57.5	16.1	34.4	6.4	25.9
314	2.3	49.3	24.9	43.5	17.8	37.2	21.6	55.6	18.7	29.7
315	5.8	17.3	.1	29.0	6.3	44.2	19.4	36.1	.5	37.3
316	4.3	29.2	8.9	22.2	-10.0	28.8	18.2	36.8	6.5	48.0
317	17.3	51.7	-.1	52.5	20.2	34.5	3.2	37.8	8.2	22.9
318	1.0	41.0	1.4	16.4	.4	40.8	5.7	28.2	.3	36.0
319	11.6	27.3	13.3	24.0	6.1	40.3	2.9	53.9	5.5	38.3
320	.3	52.5	-10.0	24.3	11.5	48.2	0.0	32.6	6.6	40.0
321	11.6	28.1	1.2	39.2	28.0	38.7	5.8	25.5	1.3	38.8
322	16.0	47.7	2.6	43.1	6.5	30.4	2.4	23.0	8.3	36.9
323	20.3	39.7	13.3	30.9	6.3	38.4	7.4	38.3	22.4	62.3
324	-10.0	38.7	23.2	41.6	6.1	32.4	2.8	40.8	16.9	57.0
325	.8	14.8	.1	53.9	5.6	25.0	11.9	52.1	19.2	60.2
326	3.2	26.3	1.8	39.5	14.4	32.7	18.9	30.4	14.4	54.9
327	8.3	54.8	24.3	50.4	14.2	45.2	-2.1	21.2	-10.0	23.1
328	9.2	57.2	10.0	22.8	9.1	53.4	0.0	26.0	11.4	58.2
329	1.9	18.4	4.3	37.5	19.6	38.9	.9	41.7	7.3	28.5
330	10.5	43.8	14.3	29.6	1.6	35.9	10.4	51.6	11.2	58.3
331	6.9	64.8	7.1	71.5	24.9	33.0	-10.0	35.8	5.5	57.7
332	8.4	39.1	1.2	36.8	7.3	22.8	4.3	26.6	5.3	32.0
333	10.9	34.3	6.1	26.3	10.5	24.3	-.3	19.9	9.7	19.8
334	4.3	24.2	4.5	43.4	16.3	29.4	10.5	45.8	26.1	39.9
335	19.4	42.3	4.7	36.7	-10.0	38.4	6.0	36.6	3.7	46.7
336	6.7	45.4	21.7	48.9	4.4	26.8	9.3	55.4	27.5	43.6
337	.4	37.2	16.5	30.1	14.1	34.4	.2	31.7	4.9	33.8
338	22.1	52.6	24.4	44.2	.8	24.0	10.7	66.8	-4.7	50.0
339	21.0	61.1	-10.0	41.9	9.0	22.2	13.0	20.1	7.3	33.0
340	2.7	27.8	9.9	28.6	6.1	28.4	13.6	35.4	9.3	25.8
341	12.6	70.4	19.3	32.2	-2.6	57.2	-2.0	31.1	1.2	41.2
342	13.9	29.5	10.4	27.7	3.4	49.1	7.8	24.6	8.9	71.1
343	-10.0	32.8	13.5	32.8	2.6	20.8	7.2	23.4	10.8	33.9
344	16.7	27.3	8.7	43.2	1.8	15.1	-2.2	25.2	.2	15.9
345	2.5	33.5	-.6	29.4	8.7	26.3	3.6	21.8	11.4	47.8
346	26.8	40.5	4.1	43.1	2.4	40.5	7.0	34.9	-10.0	24.9
347	5.8	39.7	32.9	36.7	1.3	31.5	12.9	25.8	13.0	34.5
348	3.5	40.6	22.3	34.0	13.8	34.3	19.1	56.7	2.0	71.6
349	3.4	42.1	16.1	31.4	5.2	40.0	2.1	48.1	24.4	38.4
350	12.7	38.2	11.0	28.9	7.3	52.5	-10.0	29.8	14.9	26.4
351	3.9	42.0	6.2	39.3	18.9	32.2	5.4	19.7	8.3	35.4
352	19.0	46.8	-.6	42.5	23.9	44.2	10.1	40.9	12.1	28.3
353	14.4	29.3	4.0	39.2	16.0	34.3	19.2	33.7	5.9	29.5
354	16.9	42.6	16.6	43.3	-10.0	38.8	2.7	62.4	2.9	26.2
355	4.9	42.6	15.0	39.4	.7	21.1	2.7	44.4	17.0	[illegible]
356	.7	28.6	.4	26.7	6.3	44.8	4.7	55.0	6.2	31.3
357	9.7	37.4	14.9	32.0	6.0	56.4	4.4	31.6	15.1	36.5
358	10.1	36.3	-10.0	47.9	9.9	24.5	4.5	39.6	6.2	23.2
359	.1	47.8	3.6	36.7	4.8	30.0	[illegible]	45.8	31.5	42.7
360	-2.2	26.1	4.7	47.1	4.8	55.3	17.1	28.7	5.2	25.1
361	9.3	39.2	11.3	47.4	0.0	31.2	18.6	30.0	6.5	61.5
362	-10.0	24.4	.7	41.3	3.0	44.1	.9	27.6	7.9	43.6
363	11.0	29.4	10.6	33.3	5.8	37.4	11.1	46.1	14.7	37.3
364	-.2	49.3	20.6	58.1	22.0	33.3	19.4	32.7	7.6	36.6
365	1.5	38.4	1.6	49.6	13.8	47.4	13.0	32.7	-10.0	46.8
366	16.1	35.1	-2.8	33.4	4.0	62.3	11.6	25.3	6.9	28.2
367	11.1	49.7	13.3	43.1	.5	30.4	11.8	46.9	[illegible]	[illegible]
368	4.6	31.3	5.4	51.8	7.7	49.7	25.6	35.5	6.3	27.0
369	12.5	41.0	2.5	45.6	2.5	49.4	-10.0	33.7	15.9	41.7
370	-.1	33.9	18.3	35.1	17.9	41.8	27.3	38.1	4.5	49.3
371	27.9	40.9	6.1	39.3	9.1	34.4	8.5	23.0	[illegible]	44.0
372	2.9	20.2	.1	49.3	-5.0	27.7	14.2	43.6	19.2	48.1

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

373	1.4	41.0	-.5	35.9	-10.0	14.1	2.1	48.5	23.1	46.2
374	7.3	39.1	6.0	43.7	17.2	33.1	.6	26.4	16.2	28.5
375	11.4	44.5	19.6	60.0	9.1	22.7	6.1	25.6	9.8	39.2
376	0.0	59.2	8.1	42.1	0.0	70.9	12.1	25.5	0.0	34.9
377	1.0	68.6	-10.0	37.0	1.9	50.8	20.1	34.3	14.6	51.0
378	.2	40.3	15.1	42.5	.8	59.8	2.4	73.6	9.6	26.6
379	6.7	36.4	8.0	21.7	11.3	29.6	10.1	20.7	13.1	51.6
380	17.7	38.8	3.8	20.9	4.0	16.9	5.7	24.2	8.0	31.8
381	-10.0	40.8	-.1	36.2	16.8	54.0	16.5	54.3	11.6	44.8
382	5.3	25.2	-3.0	38.7	27.5	50.7	17.0	33.4	-.1	41.3
383	28.0	70.0	0.0	39.5	26.7	45.6	11.0	38.9	6.9	24.6
384	1.0	33.6	11.7	29.8	9.3	19.9	3.2	26.6	-10.0	32.8
385	3.8	28.7	-.1	43.2	9.8	34.9	12.8	23.0	-.3	26.2
386	-1.5	40.9	7.6	41.2	6.5	30.1	.9	32.3	11.9	42.0
387	9.0	30.6	3.7	60.4	5.3	17.1	2.1	27.3	.3	48.0
388	12.4	48.7	12.7	41.2	6.5	41.4	-10.0	61.8	-.9	32.8
389	1.6	43.2	14.9	32.3	6.8	16.9	1.6	32.7	10.6	30.3
390	3.9	31.4	18.0	31.7	12.0	47.4	6.0	26.0	8.9	35.3
391	7.1	51.7	0.0	41.3	14.1	27.7	7.1	63.1	2.0	40.5
392	5.1	26.6	-11.4	65.2	-10.0	43.9	29.7	42.6	3.0	21.4
393	10.5	53.0	4.4	69.5	4.7	42.9	3.1	32.4	7.3	43.0
394	24.1	43.0	25.4	46.1	5.1	39.6	0.0	44.0	28.5	40.4
395	10.7	40.9	19.6	38.0	19.0	25.5	9.2	29.3	12.6	29.6
396	2.7	60.6	-10.0	48.2	19.5	49.4	-2.3	46.7	13.1	28.0
397	2.9	18.7	-2.5	20.5	4.4	18.3	5.2	25.2	10.5	52.4
398	2.1	22.0	6.4	23.6	8.7	42.7	23.4	61.9	1.9	15.1
399	5.0	42.1	1.6	32.2	19.1	34.8	3.8	37.9	8.3	56.2
400	-10.0	39.5	4.1	31.2	19.2	31.1	6.5	37.5	26.0	40.3
401	3.7	31.4	8.9	47.1	8.9	32.9	16.0	38.0	13.2	51.0
402	8.9	51.1	9.6	32.9	14.8	64.4	14.0	26.9	13.9	33.9
403	-.7	28.1	5.1	24.9	9.1	57.7	29.5	46.9	-10.0	40.3
404	2.3	49.7	3.2	21.3	6.2	34.9	2.6	43.2	23.1	33.2
405	16.4	38.1	11.2	43.1	4.9	30.4	3.5	57.4	17.6	42.4
406	-2.1	43.3	20.5	37.8	13.8	47.0	1.1	41.7	3.5	13.7
407	1.2	25.7	5.5	19.4	5.2	37.4	-10.0	30.9	11.4	29.5
408	6.1	58.0	34.3	74.2	13.6	31.7	1.6	25.7	10.7	34.8
409	13.7	61.8	2.4	46.1	7.4	56.8	.9	22.1	4.0	18.3
410	7.4	40.3	6.6	22.4	.3	31.3	15.6	26.1	4.7	14.8
411	3.4	38.5	9.0	60.2	-10.0	74.6	14.9	52.0	5.6	42.3
412	12.0	25.6	-.8	52.7	32.2	56.0	.7	16.9	6.8	55.7
413	23.2	38.7	27.8	38.7	11.1	44.7	9.7	40.5	14.4	43.6
414	1.3	29.5	5.7	58.9	32.4	52.5	-5.8	64.4	18.1	68.6
415	2.2	32.8	-10.0	26.5	.1	29.2	12.3	42.4	1.3	30.2
416	5.7	17.9	6.1	30.3	5.0	16.4	5.7	24.9	10.1	37.9
417	12.1	70.0	7.2	25.1	.9	62.6	-.1	14.3	2.6	32.9
418	9.7	26.6	13.4	41.1	4.3	35.2	16.0	45.5	32.0	47.0
419	-10.0	56.5	4.9	76.3	4.5	46.2	1.1	25.8	15.3	38.7
420	.5	48.5	1.7	36.8	4.4	23.3	4.5	27.2	4.1	20.3
421	6.7	25.4	-.8	46.5	1.6	15.1	4.1	32.4	7.8	30.7
422	-.9	38.1	21.2	37.0	4.4	29.5	8.0	57.1	-10.0	22.9
423	4.3	25.8	4.0	26.2	3.9	38.2	3.8	19.6	-2.8	43.3
424	22.8	34.7	1.6	34.2	5.1	33.2	3.8	17.5	4.5	70.2
425	11.1	34.0	1.2	30.1	7.6	43.1	29.9	48.2	19.2	29.4
426	-.2	46.3	28.1	46.2	3.1	40.7	-10.0	42.6	21.8	52.6
427	4.9	27.3	2.1	52.1	.1	25.6	5.5	47.4	12.0	29.7
428	7.8	29.3	1.1	24.3	11.1	68.9	11.5	47.8	7.2	23.2
429	12.9	27.8	1.0	32.1	7.5	28.9	13.7	31.5	18.8	41.4
430	1.7	70.4	-.4	36.0	-10.0	54.5	26.9	38.4	10.0	51.3
431	16.7	32.4	14.0	43.7	76.5	53.4	29.6	46.9	4.1	21.1
432	6.6	55.6	7.3	24.1	4.1	59.4	8.1	25.7	2.4	16.3
433	.4	26.7	16.6	41.6	6.7	25.5	6.9	17.4	2.1	69.3
434	9.0	34.6	-10.0	24.5	14.3	39.4	.3	39.1	.3	31.8

*% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

435	-1.6	30.9	16.2	28.3	8.2	38.5	1.0	35.1	12.2	37.1
436	12.9	26.4	-.2	34.6	-8.9	50.7	10.6	78.9	5.2	50.1
437	2.8	23.6	7.0	72.6	7.2	29.9	14.2	30.5	2.1	49.6
438	-10.0	68.8	7.1	56.5	10.8	33.1	23.1	39.9	3.0	49.4
439	9.7	70.0	5.3	55.2	32.1	42.3	15.2	25.4	1.1	36.9
440	19.1	42.4	.2	70.0	5.8	31.9	8.2	52.6	17.2	35.6
441	.1	28.8	13.3	51.3	18.5	60.3	3.0	47.0	-10.9	42.7
442	7.4	40.2	9.8	77.5	17.5	33.0	1.6	24.5	3.7	40.5
443	.5	59.0	20.3	48.6	25.4	50.7	.4	44.3	2.3	17.8
444	4.6	26.6	5.6	21.3	8.7	25.9	7.6	33.0	3.7	28.9
445	3.6	28.8	8.7	53.9	13.3	28.8	-10.0	25.8	11.6	23.0
446	3.3	28.5	5.0	62.6	8.0	21.4	.4	53.6	11.5	56.6
447	3.8	46.3	1.2	43.4	8.1	43.0	3.9	9.6	2.0	31.3
448	14.9	28.9	.1	54.1	6.2	24.1	.1	55.0	12.6	46.8
449	1.3	37.0	5.9	43.9	-10.0	33.9	5.2	16.6	2.2	40.8
450	-5.1	27.0	13.3	41.2	4.0	23.9	2.9	35.2	5.5	18.2
451	2.7	35.1	3.1	45.3	6.6	34.9	20.6	35.2	1.9	38.5
452	-.1	46.1	2.6	32.0	3.3	24.1	8.0	30.9	17.0	37.0
453	18.1	52.9	-10.0	56.9	1.3	64.0	-.4	50.8	4.7	33.8
454	11.6	28.4	.3	24.1	.3	38.7	7.0	22.7	5.6	38.1
455	10.7	51.5	10.0	38.5	6.4	36.2	14.7	36.7	2.2	29.9
456	-.1	32.5	.8	31.1	16.0	32.8	3.6	30.7	5.7	42.9
457	-10.0	36.9	7.6	43.1	12.2	45.6	9.8	32.7	4.6	43.4
458	28.2	40.2	20.7	66.3	.2	23.9	11.5	56.9	10.4	44.6
459	2.4	36.9	-2.3	63.6	6.7	23.4	.4	36.3	2.7	20.9
460	6.0	18.2	-1.1	37.1	-.7	51.3	7.3	30.8	-10.0	35.5
461	12.0	47.5	-.4	36.5	13.4	51.5	17.1	34.1	-2.5	58.1
462	6.3	41.0	4.2	40.6	12.6	32.1	2.4	42.4	3.5	37.6
463	7.6	45.3	5.1	62.3	19.4	35.6	3.1	43.1	11.0	55.9
464	16.5	54.5	1.0	60.4	.5	31.5	-10.0	36.0	12.9	37.5
465	16.5	31.0	16.4	54.0	5.2	26.5	9.1	27.2	13.9	31.7
466	21.5	49.3	6.3	28.5	9.1	32.1	9.1	54.8	-5.6	20.4
467	.7	32.3	2.3	51.0	36.3	49.7	11.2	27.3	3.0	24.6
468	13.7	37.4	-.2	28.1	-10.0	49.9	5.3	51.7	1.2	15.0
469	3.7	33.7	14.2	33.4	14.8	29.4	1.0	62.7	-2.3	31.8
470	5.1	60.5	6.9	35.0	1.8	55.1	.8	33.9	1.2	27.7
471	2.1	35.7	-1.4	55.1	17.5	48.3	5.0	37.3	10.1	53.0
472	11.5	30.9	-10.0	34.4	15.5	30.7	5.8	39.2	6.4	54.3
473	21.2	39.8	2.3	35.3	14.9	31.3	17.4	41.7	-.3	20.2
474	.2	61.8	-1.0	24.6	6.1	49.1	-4.3	37.2	20.9	37.4
475	8.9	39.9	7.0	49.0	6.5	35.2	8.7	37.4	[illegible]	35.4
476	-10.0	46.4	-.3	37.3	1.1	56.5	1.2	43.7	14.1	24.9
477	3.1	46.6	21.6	36.0	1.9	31.2	14.0	31.5	-.7	39.0
478	12.0	40.5	-.1	45.4	7.4	57.2	34.9	47.2	4.5	28.9
479	10.4	21.1	2.3	33.4	24.7	48.8	3.7	14.9	-10.0	38.9
480	4.5	70.5	0.0	49.6	19.0	65.3	1.9	46.1	3.6	75.3
481	5.3	17.4	-.2	43.8	20.8	35.3	13.4	30.0	12.2	41.6
482	7.9	31.5	12.0	33.7	7.4	57.8	2.6	44.1	17.2	44.2
483	10.5	43.0	5.7	53.1	10.5	27.2	-13.3	23.1	4.8	37.8
484	12.5	44.1	6.2	34.2	2.3	56.2	-.9	30.4	11.5	32.6
485	10.0	61.3	5.3	43.2	9.7	21.5	7.4	40.3	10.2	56.8
466	25.5	39.0	.1	59.4	-1.3	24.3	8.4	23.6	7.7	21.4
487	4.9	21.8	9.5	33.9	-10.0	32.0	3.7	26.7	-2.2	43.4
488	.1	31.5	4.1	29.2	2.5	36.0	18.0	33.6	3.3	17.4
489	0.0	54.9	5.5	29.1	.9	57.7	4.1	40.7	26.2	46.4
490	13.1	59.0	.5	30.8	15.8	35.9	.3	69.2	43.1	55.8
491	14.2	28.8	-10.0	27.7	5.1	31.2	30.0	47.9	14.7	36.6
492	-.3	47.7	27.3	59.2	11.2	35.4	4.1	64.7	.8	60.5
493	3.1	31.7	20.5	39.8	12.1	53.2	10.2	52.1	16.9	55.1
494	4.9	37.3	.6	21.3	7.2	17.4	-7.1	29.3	11.5	31.3
495	-10.0	52.3	42.8	57.4	2.8	34.8	1.6	34.0	18.3	45.2
456	22.4	41.2	1.4	26.4	9.4	41.8	9.3	37.7	11.9	22.0

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

497	2.0	46.5	24.3	39.0	18.2	42.1	0.0	17.3	4.5	20.6
498	3.9	25.3	7.5	62.0	20.9	46.6	-1.7	41.1	-10.0	49.4
499	2.0	23.9	1.1	19.9	5.5	22.3	.7	22.4	2.5	18.3
500	7.2	37.4	8.3	27.8	0.0	45.5	5.3	22.8	5.6	34.4
501	1.0	19.2	6.8	27.7	.2	23.1	5.1	25.4	9.3	20.1
502	9.9	28.8	11.1	42.9	8.5	23.0	-10.0	32.7	12.8	40.6
503	14.4	37.5	1.3	60.1	1.7	13.9	-1.3	35.1	9.1	41.5
504	14.9	61.9	5.5	39.5	23.4	44.1	15.3	44.5	26.7	43.7
505	5.0	35.5	7.3	23.8	-4.5	46.5	12.0	28.6	.5	28.0
506	4.5	28.0	5.8	33.6	-10.0	43.5	22.5	41.2	4.3	39.1
507	9.7	34.7	9.9	35.9	10.4	29.7	.2	41.2	1.7	22.7
508	9.8	25.1	-4.0	50.3	3.2	21.4	2.5	35.9	-10.9	37.7
509	19.1	34.4	13.0	37.8	18.3	40.6	14.1	39.7	1.4	23.8
510	1.2	60.3	-10.0	39.2	11.7	28.4	.8	71.6	12.0	43.7
511	20.1	36.8	2.2	52.7	9.9	47.4	6.0	43.7	2.4	49.2
512	12.7	61.3	2.3	56.0	3.4	35.8	17.7	37.2	2.2	20.6
513	.2	21.1	2.5	35.0	18.3	35.6	1.4	29.8	3.4	37.1
514	-10.0	51.3	36.6	47.4	12.9	49.2	5.0	59.2	14.4	43.6
515	19.9	39.6	19.5	45.4	-.8	46.1	7.6	38.1	19.7	42.6
516	.4	38.3	18.8	32.4	3.5	24.5	3.4	47.3	31.2	42.4
517	2.9	39.8	6.1	33.4	1.9	24.2	10.6	37.4	-11.0	29.8
518	4.7	48.8	3.7	30.1	7.3	35.1	2.0	40.1	14.0	31.7
519	15.6	45.4	6.8	43.1	3.8	32.5	2.3	52.8	3.5	24.9
520	11.4	30.0	7.8	49.7	.3	58.8	8.5	45.5	14.6	32.1
521	2.9	70.4	8.3	25.3	14.7	45.1	-10.0	37.9	19.7	35.2
522	6.4	39.5	7.9	36.1	8.0	48.1	19.6	67.7	5.6	25.2
523	3.1	25.3	6.7	37.1	10.4	30.4	1.5	24.4	7.5	25.1
524	4.9	32.7	8.7	66.1	11.0	37.4	11.7	29.6	4.3	23.5
525	2.7	21.9	6.3	42.7	-10.0	38.5	13.7	40.1	.7	31.5
526	5.0	43.9	4.1	17.8	6.7	19.8	.6	46.6	6.3	30.5
527	3.6	36.5	10.3	33.6	8.5	53.1	1.9	26.7	3.9	33.8
528	10.6	39.9	12.4	34.1	13.4	46.5	17.2	32.0	15.6	46.7
529	8.9	47.4	-10.0	40.3	20.5	32.6	7.0	29.6	11.0	34.5
530	5.3	33.0	11.1	35.0	17.7	49.9	9.1	39.3	12.0	53.5
531	.9	61.3	5.8	38.9	22.8	77.2	1.1	65.2	11.6	24.5
532	5.3	67.6	-1.2	56.9	-1.0	44.3	19.5	54.5	33.5	58.3
533	-11.0	40.9	.6	49.0	.5	22.3	19.8	24.5	4.0	31.5
534	12.6	28.0	10.0	38.6	23.0	40.8	23.3	45.4	3.5	29.1
535	8.3	52.0	6.4	44.0	1.4	32.0	8.0	42.4	13.5	39.1
536	22.7	40.5	.3	27.9	16.2	28.3	6.5	27.2	-10.0	37.9
537	.4	31.8	.5	33.8	2.2	35.5	15.6	42.6	3.1	44.1
538	21.7	42.2	1.5	25.8	.7	60.9	33.6	45.5	9.2	25.0
539	0.0	26.9	8.9	48.4	20.3	34.3	.6	29.4	16.3	47.2
540	18.6	48.5	16.8	44.8	12.4	25.8	-10.0	60.4	17.5	34.0
541	.2	31.8	2.1	37.0	-1.4	41.7	10.3	27.7	1.3	17.6
542	6.6	35.2	24.1	36.2	-.4	33.0	11.9	23.8	1.1	23.9
543	9.5	32.7	8.1	38.5	12.3	40.3	6.4	33.2	5.9	66.4
544	3.6	25.3	.2	14.1	-10.0	23.8	11.4	25.7	7.8	24.3
545	.5	32.8	1.7	20.1	9.7	46.7	11.3	41.4	.1	40.3
546	0.0	14.6	4.4	41.5	1.7	29.1	9.8	42.9	3.7	31.5
547	19.5	38.7	9.8	24.8	9.6	33.6	12.4	23.4	7.0	22.0
548	1.8	68.3	-10.0	60.0	21.2	48.2	11.9	41.8	3.6	53.5
549	29.8	71.7	38.8	49.0	6.9	32.6	1.2	29.2	1.8	44.4
550	5.0	67.3	25.0	45.6	28.4	38.6	4.9	26.4	2.5	17.4
551	3.2	23.4	1.1	41.6	7.8	29.0	2.7	32.5	10.3	28.8
552	-10.0	39.7	18.3	[illegible]	1.4	56.2	1.7	33.0	.2	49.6
553	12.9	41.8	.3	21.2	6.6	23.8	1.9	51.5	3.4	19.0
554	.1	20.0	4.6	37.7	8.5	24.0	5.9	54.8	11.6	23.2
555	7.8	60.6	5.7	20.6	9.2	24.9	11.6	39.2	-10.0	36.9
556	1.7	24.0	.4	24.1	3.2	16.2	2.4	29.0	0.0	61.5
557	10.9	33.3	.9	17.9	3.0	26.9	15.1	37.5	11.9	48.5
558	5.4	20.6	3.8	26.0	7.3	33.3	17.0	29.8	5.7	20.6

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

559	4.4	35.6	4.4	51.3	5.2	70.0	-10.0	37.5	11.9	25.5
560	8.3	45.5	13.9	25.4	0.0	37.1	12.3	28.7	-.1	41.3
561	11.0	63.5	2.3	46.7	7.0	40.1	14.3	47.6	[illegible]	36.5
562	15.7	29.1	6.2	33.0	21.5	41.2	7.1	39.3	28.4	42.0
563	1.7	33.3	19.5	24.7	-10.0	25.3	14.4	39.8	-.5	35.1
564	-.1	35.8	-4.4	31.5	7.0	53.2	.8	44.6	8.5	47.2
565	1.2	29.9	.9	44.6	16.8	36.2	2.1	34.6	7.4	46.8
566	.9	23.6	5.7	42.4	1.8	18.4	6.4	32.8	3.8	17.9
567	-.5	51.3	-10.0	25.7	0.0	12.6	.7	19.1	7.7	37.1
568	7.7	19.0	2.1	21.4	1.0	57.5	6.3	22.3	6.3	38.2
569	5.5	31.1	1.3	35.2	3.6	26.5	6.8	47.4	3.8	22.5
570	5.8	26.9	8.7	22.4	.6	28.3	9.7	44.8	[illegible]	39.7
571	-10.0	24.9	2.1	32.7	7.5	37.5	2.1	25.4	4.1	59.8
572	2.2	23.4	2.2	41.8	15.9	46.8	23.3	33.6	14.5	25.4
573	2.4	22.1	2.5	25.6	6.7	41.7	2.0	53.1	4.7	42.3
574	17.3	27.8	14.2	42.7	28.7	49.1	-3.4	26.8	-10.0	45.3
575	-1.0	42.8	-2.0	32.9	18.2	31.5	11.9	64.2	-.1	26.8
576	14.7	40.5	8.2	45.5	9.2	33.0	2.6	64.3	5.9	38.0
577	1.7	25.9	5.9	49.3	11.5	54.7	6.6	59.0	.1	29.2
578	9.5	22.0	7.1	45.1	9.1	22.7	-10.0	37.8	5.7	35.6
579	13.3	24.5	10.3	42.3	22.3	35.6	-1.2	26.6	11.2	27.1
580	6.7	33.6	23.2	41.0	22.9	40.5	.2	52.9	16.1	64.1
581	14.9	47.7	2.0	34.7	.4	24.5	11.4	31.0	4.5	51.1
582	17.7	32.0	4.8	20.7	-10.0	44.0	.7	41.0	8.4	41.6
583	2.1	37.4	8.3	51.2	27.8	78.1	2.8	51.2	9.5	55.2
584	11.4	28.8	6.8	31.7	1.1	36.9	6.4	20.7	.5	34.0
585	8.8	26.5	1.0	12.2	.2	50.9	5.0	45.0	6.7	35.3
586	1.6	51.4	-10.0	25.6	3.7	38.5	28.3	47.3	15.8	36.8
587	16.8	32.6	8.4	49.3	1.8	26.6	4.4	38.3	24.9	35.5
588	8.4	45.9	2.3	38.9	5.3	32.7	1.1	26.7	7.8	36.5
589	-.3	18.3	0.0	31.4	12.8	32.7	7.5	47.5	5.0	50.9
590	-10.0	45.9	-1.2	14.9	-6.4	51.0	15.1	29.0	14.0	49.3
591	1.4	28.9	1.4	32.4	2.7	43.8	17.3	35.5	21.4	52.4
592	-.6	19.1	5.2	63.9	.5	23.5	2.5	36.8	10.9	42.4
593	-.5	46.1	3.3	20.1	9.8	60.4	.2	38.6	-10.0	44.5
594	8.7	41.7	7.5	33.5	2.5	32.2	8.0	30.5	2.9	37.7
595	4.2	15.7	3.2	33.5	21.3	37.4	12.3	26.1	11.4	24.7
596	1.6	52.3	4.0	16.6	4.8	38.0	6.7	30.3	14.6	49.0
597	17.0	36.9	3.9	27.7	10.4	37.3	-10.0	38.3	0.0	27.7
598	.1	56.1	37.1	48.9	3.2	45.5	2.3	43.1	6.4	37.2
599	1.0	48.1	19.7	44.5	23.8	41.7	1.5	23.6	5.7	28.4
600	10.4	35.9	.1	22.6	7.9	49.8	16.9	27.0	-.1	36.4
601	12.0	45.2	20.7	55.9	-10.0	24.4	9.9	31.7	12.3	30.1
602	1.8	50.5	6.2	52.5	6.8	37.1	15.5	44.2	-2.7	20.7
603	8.8	31.1	10.6	[illegible]	16.9	49.5	7.3	[illegible]	6.1	38.4
604	11.2	58.2	8.0	47.9	7.7	62.6	32.4	55.4	12.6	31.8
605	6.1	43.0	-10.0	27.3	5.5	30.2	15.4	32.7	[illegible]	32.9
606	1.9	22.3	5.0	36.2	15.7	37.6	4.9	47.2	[illegible]	26.9
607	9.4	54.9	1.7	19.4	9.1	49.8	12.6	26.1	[illegible]	29.1
608	5.7	25.1	5.5	39.6	20.8	40.9	-.9	40.6	19.3	59.2
609	-10.0	37.3	1.2	38.3	3.5	26.6	3.5	22.8	6.6	41.1
610	1.1	28.8	4.4	42.2	9.6	34.8	-3.5	31.7	3.1	22.6
611	5.9	41.2	8.7	55.9	6.3	38.7	2.4	24.5	5.2	71.1
612	-.2	33.7	23.5	47.2	13.8	39.3	5.9	47.4	-10.0	35.7
613	23.0	48.5	0.0	37.4	2.0	23.3	4.7	25.9	8.0	52.0
614	.9	21.1	8.3	31.6	12.3	47.4	18.3	32.1	1.1	38.9
615	17.1	39.1	20.3	33.6	1.0	31.2	14.0	41.3	11.9	33.2
616	6.0	40.3	1.9	39.6	24.8	60.7	-10.0	17.0	3.8	53.5
617	17.5	47.1	3.9	15.5	4.7	35.0	14.2	52.5	18.3	28.8
618	3.7	64.5	1.2	22.3	9.2	48.5	8.9	37.0	6.4	23.4
619	3.3	34.4	6.8	47.3	5.6	28.4	11.5	27.1	[illegible]	32.0
620	12.3	26.2	2.8	51.3	-10.0	12.1	-.1	53.9	29.3	42.1

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

621	13.5	34.5	12.0	29.9	6.1	37.7	3.1	32.0	4.8	39.6
622	10.2	22.5	-.4	32.4	.7	47.0	14.1	34.9	3.2	36.8
623	1.0	21.9	2.8	26.0	8.4	50.2	2.5	27.0	.4	46.7
624	36.3	55.1	-10.0	31.6	-3.4	56.8	18.3	36.3	17.3	42.9
625	1.8	24.7	.3	70.3	11.4	32.2	10.5	33.4	.4	39.1
626	18.7	36.4	14.3	40.1	14.0	34.7	-1.1	64.7	13.8	31.3
627	2.6	25.6	5.8	33.0	2.0	41.0	3.6	30.9	16.5	33.0
628	-10.0	19.0	1.6	43.4	21.4	53.9	0.0	74.1	1.6	45.3
629	5.1	31.7	8.3	64.5	18.3	43.0	29.6	44.5	1.3	43.9
630	28.5	53.7	9.0	42.3	14.6	31.9	20.6	34.6	2.8	33.4
631	10.4	47.9	1.3	12.7	1.1	37.0	11.6	46.5	-10.0	34.9
632	4.4	37.6	8.5	38.4	7.8	39.0	14.7	59.5	5.4	62.3
633	.8	56.9	.4	27.1	4.8	45.9	3.4	13.5	3.9	45.7
634	.3	32.8	2.5	38.2	17.9	28.1	5.5	26.8	8.1	44.6
635	17.1	53.4	3.1	23.9	4.5	46.0	-10.0	53.1	1.8	57.3
636	3.6	15.1	4.3	17.3	-.8	14.4	4.2	21.7	-.5	20.6
637	2.4	43.7	-.6	34.1	9.1	31.3	6.4	28.4	-.6	28.9
638	15.5	48.1	8.6	20.4	5.1	45.8	.2	42.4	2.0	59.7
639	2.7	28.3	3.1	21.6	-10.0	43.5	6.8	33.5	18.1	38.4
640	25.7	42.4	13.2	37.9	9.2	22.6	1.4	46.8	19.8	34.5
641	.4	38.3	24.6	65.1	2.7	24.4	7.0	32.3	16.0	30.9
642	13.3	59.8	4.0	25.0	6.8	29.1	6.0	17.9	2.7	37.1
643	16.5	40.4	-10.0	28.3	3.9	30.2	1.3	56.1	3.8	27.6
644	.8	35.8	4.3	63.3	4.3	40.7	24.6	45.4	25.2	41.5
645	-.6	77.0	13.2	48.3	-7.1	33.3	23.0	47.0	3.2	26.1
646	11.3	36.5	26.4	37.1	19.5	36.6	13.8	33.1	1.3	46.4
647	-10.0	64.3	12.7	34.4	13.8	38.9	11.8	44.7	9.1	28.6
648	8.1	33.3	14.2	35.6	16.9	65.3	14.5	67.5	12.2	56.5
649	8.7	68.0	14.3	47.5	7.9	19.9	2.2	32.2	3.6	61.4
650	12.9	46.7	1.4	24.1	8.4	52.6	.4	26.3	-10.0	25.1
651	14.0	70.3	4.2	17.6	.5	35.6	15.3	31.5	.1	11.1
652	.4	54.8	1.7	32.0	7.6	44.1	10.6	52.4	1.0	25.3
653	.3	62.3	12.4	45.3	29.9	40.2	3.1	26.0	3.8	23.8
654	7.7	33.2	13.3	54.5	7.0	50.2	-10.0	39.5	10.3	20.7
655	4.1	31.6	20.7	55.2	3.0	35.8	19.8	44.5	21.9	46.5
656	6.4	39.8	6.3	43.2	12.9	42.0	4.2	41.2	6.3	40.7
657	4.3	46.3	11.3	29.6	12.4	32.3	11.5	30.2	5.0	46.7
658	2.5	53.2	10.2	21.9	-10.0	23.9	13.9	27.7	14.2	32.7
659	9.5	29.5	18.7	48.6	26.4	47.2	18.2	51.0	.9	30.6
660	19.3	58.5	11.1	34.4	17.0	39.2	12.6	31.4	3.1	60.9
661	43.7	54.5	29.4	40.7	8.4	38.3	15.6	40.0	13.0	28.3
662	10.6	31.2	-10.0	47.2	25.7	50.9	37.1	48.6	16.0	26.4
663	4.4	37.1	8.8	26.3	16.0	49.1	17.1	52.1	7.6	25.1
664	6.9	47.6	10.9	58.6	1.6	39.8	15.5	64.3	7.4	32.4
665	19.7	33.2	22.9	33.3	21.9	38.8	9.3	25.7	3.8	43.8
666	-10.0	50.1	-.2	25.5	7.9	20.6	7.0	31.3	8.9	22.3
667	-1.1	59.3	7.0	34.8	6.1	36.3	12.5	30.1	9.7	47.1
668	11.9	31.9	-1.0	41.1	33.6	34.1	15.5	50.0	-1.2	56.3
669	31.4	49.1	10.3	30.9	12.2	49.3	-1.7	24.7	-10.0	29.9
670	2.3	40.7	9.3	21.3	9.6	33.1	.8	20.7	2.7	31.0
671	11.7	47.2	-1.6	18.3	2.2	23.1	2.6	62.6	1.7	43.7
672	3.2	68.9	17.5	29.9	10.2	26.3	14.2	29.4	.5	55.9
673	0.0	34.9	10.8	29.1	4.8	41.9	-10.0	53.9	11.0	52.2
674	16.7	67.8	11.0	43.4	20.9	42.1	22.7	46.1	-4.3	51.8
675	10.8	35.7	12.5	72.6	5.6	44.5	4.4	34.2	.1	27.1
676	10.7	57.0	22.3	39.3	11.4	52.0	9.7	41.9	22.8	39.5
677	11.2	35.0	3.3	36.7	-10.0	40.9	2.3	34.3	5.4	29.2
678	4.7	32.8	18.2	31.2	2.6	35.8	1.2	21.0	3.2	17.8
679	4.7	35.4	-.3	34.2	10.3	36.6	14.9	36.3	5.5	19.9
680	9.0	66.6	14.3	39.9	4.2	41.2	18.3	35.8	6.7	33.3
681	20.1	31.1	-10.0	23.1	2.8	43.3	14.2	30.9	8.9	27.5
682	6.6	56.9	35.9	54.6	11.2	46.7	.6	33.2	7.1	47.6

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

683	19.9	37.0	6.5	29.1	.2	33.3	1.0	46.2	15.8	33.3
684	18.5	46.8	24.5	45.6	20.6	59.0	-.4	36.1	2.3	76.4
685	-10.0	51.6	14.9	31.1	10.2	39.0	11.8	24.9	6.0	52.3
686	39.4	60.6	11.3	31.6	2.4	20.0	9.2	55.0	19.4	37.0
687	10.5	29.2	-2.3	71.2	2.7	33.4	.8	26.9	19.5	48.5
688	3.7	18.8	1.9	30.5	18.9	56.2	4.9	34.3	-10.0	74.7
689	15.9	38.8	21.1	73.0	-.7	44.6	2.4	33.4	10.1	51.2
690	3.6	26.7	6.7	37.1	8.6	49.4	5.5	44.4	6.9	24.7
691	3.4	47.0	12.0	37.2	15.1	41.3	3.6	35.5	13.6	27.1
692	8.5	21.2	2.3	79.3	35.4	46.0	-10.0	25.9	9.9	37.6
693	22.7	39.5	8.1	56.8	19.9	44.7	9.2	30.7	13.1	42.8
694	23.1	38.8	13.0	23.2	6.6	55.8	.3	42.2	15.6	49.7
695	7.1	24.8	3.9	31.0	4.2	61.6	.5	19.0	5.0	56.2
696	13.3	57.0	1.4	45.6	-10.0	62.2	3.5	47.1	19.0	52.1
697	19.1	42.4	18.4	44.0	6.2	30.4	9.5	43.9	6.1	21.7
698	.5	26.2	15.0	27.5	1.3	24.1	4.9	26.2	13.3	34.3
699	1.8	39.5	9.1	41.7	6.7	20.0	.6	35.0	1.8	49.0
700	3.3	17.3	-10.0	21.2	9.3	41.4	10.9	33.3	1.1	33.9
701	4.2	31.7	.4	31.1	3.6	39.2	14.3	29.4	7.9	25.2
702	3.4	28.7	3.5	52.2	2.1	39.5	10.4	39.1	6.1	39.7
703	1.4	49.1	1.0	45.7	11.2	33.2	1.4	43.6	4.4	29.9
704	-10.0	39.9	9.6	26.0	2.4	36.1	6.5	24.7	10.5	38.1
705	6.8	52.4	6.6	32.6	3.0	32.2	11.0	21.9	4.0	49.8
706	3.5	26.6	7.1	24.7	9.7	73.9	17.7	33.8	2.0	38.7
707	14.7	34.4	6.3	23.0	12.5	46.4	5.1	20.2	-10.0	38.1
708	8.3	50.4	18.5	35.7	10.0	29.0	13.4	36.2	1.9	41.0
709	18.3	40.9	20.0	64.0	26.3	57.7	17.1	27.3	3.6	30.7
710	9.0	37.9	11.7	29.7	.5	47.9	-3.6	57.0	32.3	49.4
711	5.6	28.5	11.6	33.2	12.2	37.7	-10.0	46.[illegible]	1.9	31.2
712	2.5	42.0	17.4	45.6	8.0	41.6	7.6	47.5	10.1	40.6
713	1.1	53.3	4.8	73.0	12.4	28.7	.2	20.6	6.8	59.3
714	2.1	36.6	4.1	36.1	6.8	19.1	2.4	36.7	25.8	38.2
715	0.0	42.0	5.7	32.3	-10.0	25.8	3.2	33.2	12.4	69.7
716	4.7	27.8	.3	45.4	1.9	36.2	-1.5	38.0	15.9	38.1
717	-.1	31.3	12.3	37.8	12.8	50.9	0.0	53.6	8.3	26.4
718	4.5	44.7	8.2	49.3	6.4	38.0	1.1	25.0	6.6	34.3
719	3.1	31.7	-10.0	33.7	16.3	36.6	17.9	47.6	1.7	40.0
720	25.8	43.2	13.3	32.2	11.1	26.1	5.5	70.1	8.5	31.0
721	18.5	41.4	6.7	62.0	-.1	22.8	-1.7	40.9	19.0	49.4
722	5.7	47.9	-.1	41.4	7.6	30.4	14.7	31.8	15.8	30.2
723	-10.0	38.2	4.1	40.1	0.0	40.9	17.0	27.1	1.3	60.2
724	2.2	34.9	11.4	27.3	0.0	28.5	17.4	55.9	22.0	38.5
725	8.2	42.2	12.4	58.0	7.8	36.4	24.8	39.4	2.9	46.2
726	2.5	46.2	17.5	40.6	24.6	45.5	7.9	32.6	-10.0	53.2
727	14.0	29.4	14.0	24.1	13.8	24.4	11.1	41.9	3.5	43.6
728	6.5	30.5	14.4	45.5	26.5	49.2	6.7	66.6	17.4	70.0
729	7.3	43.2	8.3	28.7	16.9	43.8	14.2	46.5	19.7	45.1
730	29.0	39.6	6.0	25.0	1.8	60.7	-10.0	43.1	2.4	34.4
731	.3	30.1	4.6	38.4	3.5	36.5	1.8	67.4	13.7	31.4
732	19.4	46.6	7.4	32.2	21.0	39.1	16.1	29.8	16.3	28.5
733	9.2	54.7	9.6	65.1	36.3	51.7	.8	14.0	3.3	52.2
734	6.4	46.5	22.4	46.3	-10.0	24.0	6.5	24.6	6.7	34.7
735	1.5	32.1	17.9	52.8	13.9	34.0	15.2	33.2	7.7	36.3
736	6.8	53.3	1.5	67.3	15.7	33.4	7.5	35.5	19.2	41.4
737	14.5	38.7	28.6	67.0	1.3	30.2	3.6	37.8	21.7	34.8
738	16.3	37.6	-10.0	37.1	9.2	26.8	9.6	26.0	6.3	32.1
739	23.8	34.9	1.1	43.3	6.6	43.8	-12.1	32.3	20.8	37.0
740	23.2	38.0	-.1	53.0	17.6	41.6	1.6	42.5	.7	29.9
741	14.7	32.9	7.3	33.6	20.2	48.3	8.7	31.9	2.5	52.9
742	-10.0	40.4	5.5	17.6	-.1	24.7	10.7	36.7	22.3	35.7
743	12.9	44.0	10.7	33.5	0.0	50.5	4.8	35.1	9.3	37.1
744	.7	33.5	8.8	51.5	27.4	47.5	11.9	49.0	12.4	40.0

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

745	-.7	28.1	7.4	36.7	25.6	45.2	4.1	32.8	-10.0	33.9
746	10.4	41.9	5.8	52.8	1.8	28.8	1.1	32.6	21.1	45.5
747	.7	11.8	1.2	46.5	27.2	50.5	2.1	50.3	-.4	24.8
748	5.4	28.3	13.6	25.6	.6	42.4	9.4	45.8	6.8	29.6
749	13.0	63.5	7.3	39.2	19.0	34.3	-10.0	34.6	5.2	31.5
750	17.5	49.0	21.2	43.2	2.7	45.7	1.9	43.4	2.3	24.1
751	5.3	19.3	-3.9	29.5	14.8	39.6	24.6	53.6	24.8	38.7
752	.2	65.8	2.2	36.7	5.1	34.0	12.6	36.5	1.6	65.6
753	11.9	24.4	12.8	40.7	-10.0	43.8	13.4	32.8	5.1	43.5
754	4.8	33.8	7.7	18.5	5.4	68.7	9.0	52.6	9.8	57.0
755	25.9	59.2	3.4	23.2	13.1	66.3	38.1	51.8	30.0	54.6
756	16.0	29.3	5.2	43.4	20.9	70.4	14.5	41.1	24.1	55.7
757	5.0	30.3	-10.0	35.5	13.4	32.2	1.5	51.1	13.6	45.3
758	8.4	35.0	11.5	34.6	12.3	66.3	-.2	53.1	27.1	38.3
759	6.6	56.6	24.1	63.3	9.6	33.5	1.4	45.7	12.5	40.2
760	15.0	38.7	5.4	41.8	3.0	29.1	2.4	45.1	.3	37.7
761	-10.0	24.8	3.6	30.6	2.2	20.3	9.0	47.5	3.7	38.3
762	20.4	38.3	.3	49.1	21.2	51.7	2.5	52.4	33.1	65.9
763	8.2	42.2	7.2	44.8	10.7	40.1	4.2	45.8	3.6	33.4
764	.4	32.6	5.0	44.1	1.4	15.7	-4.4	40.9	-10.0	34.3
765	4.9	23.9	5.6	42.1	4.5	22.1	11.5	35.1	3.1	37.9
766	13.5	26.8	13.7	31.3	11.0	29.7	4.9	40.2	7.4	32.6
767	11.6	37.2	-.1	26.4	8.6	62.7	1.0	33.6	5.2	58.4
768	13.6	44.0	21.7	37.5	6.3	59.8	-10.0	38.4	19.8	43.0
769	2.4	19.2	7.9	33.0	5.9	23.5	11.5	37.8	2.2	32.1
770	4.3	42.9	.2	45.1	4.8	38.3	20.3	31.1	10.1	42.0
771	13.9	40.4	1.4	37.3	1.1	25.1	6.3	35.4	6.0	28.2
772	11.6	21.8	6.5	42.7	-10.0	55.4	3.6	18.6	1.6	61.4
773	10.5	31.0	14.9	33.4	.5	20.3	8.0	40.7	14.0	29.0
774	7.3	29.7	7.0	30.7	.9	36.6	11.5	23.3	5.0	20.8
775	1.7	17.3	4.1	20.5	8.3	36.0	2.0	36.1	20.5	43.3
776	.1	18.8	-10.0	21.1	4.0	34.4	0.0	11.8	0.0	17.6
777	2.0	34.4	4.0	24.6	9.3	61.3	13.9	53.1	0.0	50.6
778	25.6	38.4	12.1	36.8	.1	51.2	4.2	37.5	12.1	55.1
779	24.2	34.8	8.1	24.1	.9	46.8	31.7	49.2	9.7	23.3
780	-10.0	39.2	2.7	38.9	9.7	31.2	.6	34.0	22.5	48.5
781	-.1	42.9	2.9	20.0	-.5	36.4	1.5	39.1	7.4	29.2
782	12.9	33.5	9.9	22.7	-.2	18.6	3.0	31.8	1.2	36.8
783	-1.3	20.7	2.8	16.7	.2	23.8	4.2	56.2	-10.0	39.6
784	11.0	44.5	2.1	35.8	10.8	44.3	3.3	21.8	1.6	22.0
785	3.8	29.7	7.7	22.5	10.1	26.3	6.4	32.5	1.6	26.0
786	7.8	17.8	1.1	35.0	-1.2	41.3	9.2	22.4	-.2	22.8
787	3.6	28.2	7.8	34.8	1.1	76.2	-10.0	48.5	3.4	35.5
788	6.3	35.0	1.7	24.9	14.4	25.3	11.1	61.6	6.6	21.2
789	5.3	49.8	1.7	21.6	.1	12.0	2.0	45.1	17.5	48.3
790	4.2	56.2	1.6	21.4	4.1	41.5	.5	18.1	5.5	49.3
791	.9	16.4	1.1	27.5	-10.0	37.3	3.5	28.6	8.5	39.2
792	.3	32.7	9.7	23.3	3.6	18.4	3.4	34.3	1.7	51.1
793	4.6	45.0	7.1	32.9	7.1	19.7	2.7	58.8	16.0	43.6
794	21.7	49.3	.5	13.8	2.7	18.3	5.4	46.3	11.1	26.6
795	9.7	35.2	-10.0	33.5	12.7	34.7	13.9	28.2	15.4	27.4
796	5.8	22.2	.6	59.8	-.1	40.4	11.3	30.9	2.3	63.4
797	41.3	73.4	23.7	39.3	8.2	23.3	9.9	45.7	25.9	51.2
798	-2.8	42.5	12.0	32.6	10.7	31.6	3.3	70.0	29.2	47.4
799	-10.0	43.6	8.2	22.5	9.8	31.6	.5	25.7	.2	30.9
800	20.3	51.9	4.3	19.1	8.7	19.3	1.8	38.1	11.4	32.5
801	13.8	52.5	2.8	18.3	4.3	42.5	4.1	41.7	.3	26.3
802	0.0	54.3	1.4	31.1	12.0	47.5	11.4	31.7	-10.0	38.0
803	-3.4	26.4	5.4	42.1	10.3	50.8	2.7	65.4	17.6	57.5
804	14.7	38.6	12.0	35.8	16.5	46.0	9.3	26.6	10.8	29.8
805	15.9	29.0	4.8	37.4	28.6	31.6	5.9	38.6	2.6	44.7
806	2.8	32.0	0.3	66.9	31.4	43.4	-10.0	23.1	6.1	34.4

*% OF DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

807	17.8	43.7	3.5	19.1	3.7	38.4	3.2	45.0	26.3	45.1
808	2.7	25.1	3.2	51.6	13.4	26.1	2.7	25.4	12.2	[illegible]
809	16.8	35.4	20.8	43.5	2.0	51.5	25.2	43.8	16.2	32.9
810	8.5	18.7	7.3	29.1	-10.0	40.3	2.9	29.6	17.3	57.6
811	[illegible]	33.3	7.3	43.9	11.8	30.7	9.3	33.6	[illegible]	58.6
812	7.1	23.5	1.2	33.5	1.7	18.4	7.3	18.7	2.6	28.2
813	14.2	49.8	0.0	25.1	6.7	49.3	-.6	33.7	6.3	35.6
814	1.3	43.0	-10.0	33.6	2.6	13.6	1.7	57.3	36.1	59.2
815	4.2	44.4	13.1	39.1	1.7	48.1	23.6	37.5	[illegible]	48.2
816	13.3	34.9	7.3	28.2	8.7	36.0	14.7	42.3	17.8	61.5
817	11.8	26.0	8.5	38.7	9.8	38.0	4.3	25.7	.1	16.2
818	-10.0	29.3	5.8	55.0	0.0	24.6	4.6	78.0	14.3	37.1
819	.4	33.9	22.7	49.3	13.7	32.5	9.8	58.7	3.8	29.7
820	3.0	35.4	22.5	53.6	2.8	34.4	.4	25.5	4.2	60.8
821	2.6	48.6	7.4	26.7	9.5	26.9	9.7	35.7	-10.0	23.2
822	1.0	21.5	7.3	55.5	9.5	41.9	8.6	42.3	3.4	30.0
823	14.5	33.5	6.3	42.1	20.2	31.3	4.5	35.8	5.5	20.8
824	1.9	40.8	25.0	43.5	13.6	39.0	1.9	38.0	8.2	36.6
825	18.8	53.3	10.0	22.6	3.2	49.7	-10.0	27.9	5.4	16.1
826	1.5	34.1	5.7	27.6	1.9	32.0	18.9	55.9	12.2	25.8
827	4.5	33.7	[illegible]	48.7	20.5	44.9	23.6	43.7	11.3	23.1
828	5.5	38.2	3.2	49.2	5.4	19.7	.7	13.5	-.2	29.2
829	9.4	63.2	43.6	59.1	-10.0	27.9	0.0	44.9	12.6	32.4
830	6.8	29.9	3.9	20.6	1.5	33.0	-1.7	37.4	12.8	37.3
831	-4.6	31.4	18.3	28.7	26.6	40.2	10.5	45.5	4.3	36.8
832	4.4	32.3	18.3	45.5	11.0	52.6	1.9	44.9	1.9	34.4
833	16.8	29.4	-10.0	53.3	3.4	56.8	5.6	20.6	.1	55.2
834	15.0	29.4	.3	25.3	4.5	36.1	11.7	52.3	2.2	37.2
835	2.3	41.1	1.3	29.5	2.9	63.2	6.6	25.8	-.5	38.3
836	21.3	45.3	10.3	47.5	.6	37.6	13.0	56.3	14.3	33.4
837	-10.0	15.7	4.9	49.5	13.5	37.7	4.9	51.2	6.7	22.3
838	11.5	22.2	9.7	53.3	10.5	37.8	.3	70.0	8.0	28.0
839	5.3	16.2	.5	43.3	14.2	27.6	6.6	39.2	6.2	38.8
840	5.0	28.0	11.7	70.7	-.5	36.7	25.3	52.2	-10.0	24.5
841	9.3	36.0	4.5	43.4	23.5	37.9	9.6	37.5	0.0	43.3
842	29.0	48.6	1.6	52.4	.1	20.9	.8	24.0	11.9	42.9
843	4.9	24.4	2.4	62.3	1.0	23.2	.1	32.4	9.1	25.7
844	.6	24.2	-.3	34.6	6.2	68.4	-10.0	41.2	16.9	37.2
845	13.2	62.5	29.0	53.4	3.1	36.1	7.0	77.3	11.4	40.7
846	8.7	29.1	13.7	40.5	19.7	34.9	8.3	34.1	13.9	31.9
847	3.8	37.8	[illegible]	31.2	.2	62.5	2.8	36.5	1.3	33.1
848	15.0	29.2	17.5	39.2	-10.0	41.4	19.1	56.5	14.1	38.1
849	.8	26.3	10.5	23.6	4.7	26.9	12.7	39.6	20.5	35.5
850	6.2	30.0	11.5	40.1	14.0	44.1	12.3	26.0	13.0	48.1
851	34.7	48.0	12.1	38.3	26.9	40.7	.3	41.6	24.7	43.4
852	11.2	35.1	-10.0	18.9	2.2	21.9	7.6	29.1	9.1	33.2
853	2.3	29.1	.4	32.0	20.4	40.7	14.2	33.1	22.6	43.5
854	13.3	30.3	18.5	33.0	3.6	42.0	.7	29.5	2.1	23.0
855	5.5	38.9	2.2	28.4	2.9	[illegible]	15.1	31.0	14.3	38.6
856	-10.0	27.0	2.4	49.8	23.2	54.4	.4	26.7	2.1	54.7
857	.9	25.2	9.7	32.9	8.0	26.5	9.7	63.7	7.6	18.0
858	.3	36.6	20.2	34.6	18.1	43.6	2.2	23.7	-1.3	42.0
859	19.4	78.5	32.0	[illegible]	.2	48.2	11.4	40.8	-10.0	33.7
860	4.1	50.1	21.3	45.7	3.3	33.9	8.6	36.8	19.5	57.4
861	26.1	38.4	.2	41.1	21.4	55.0	12.6	66.3	7.7	49.9
862	6.3	27.7	1.4	37.9	1.1	47.6	9.5	30.5	4.8	49.3
863	5.3	24.2	6.2	21.4	3.2	39.6	-10.0	18.5	.5	9.9
864	4.3	65.7	15.0	45.8	19.3	56.4	3.8	38.3	1.3	32.8
865	2.9	36.4	25.7	55.1	6.6	28.4	2.0	19.4	-.6	43.8
866	6.6	22.3	4.5	39.3	2.7	27.5	15.3	43.7	1.0	42.3
867	14.9	25.2	7.1	29.5	-10.0	47.7	6.5	24.4	4.6	[illegible]
868	16.9	39.4	13.2	34.9	1.9	39.0	17.9	31.6	11.3	42.3

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

869	2.5	30.6	14.0	38.2	13.5	39.8	2.5	53.4	.4	38.2
870	10.0	44.0	9.0	36.0	5.1	37.2	13.4	27.0	2.6	37.2
871	2.9	55.6	-10.0	31.5	.6	20.7	5.9	34.6	14.2	56.2
872	1.3	36.0	7.6	77.7	15.8	36.4	19.5	67.9	9.1	38.3
873	15.0	35.5	12.3	41.2	24.1	38.7	7.3	21.5	7.5	58.5
874	15.0	56.4	3.2	18.9	7.8	46.7	7.0	49.0	6.3	16.8
875	-10.0	53.2	-.2	29.7	13.6	43.0	13.9	41.1	2.7	18.9
876	2.2	24.9	13.6	25.2	10.7	37.1	1.6	32.5	3.7	49.5
877	22.4	49.2	-1.2	23.2	13.1	36.9	13.6	46.3	27.6	45.9
878	3.2	32.8	14.6	37.0	14.9	40.9	4.0	50.0	-10.0	37.9
879	5.1	20.3	8.1	42.9	31.5	46.4	-.8	35.8	.2	58.1
880	3.7	33.4	2.5	47.8	-.7	30.7	7.2	22.0	5.1	37.3
881	8.9	26.7	3.9	58.5	10.0	24.7	14.6	54.2	14.7	41.7
882	.1	24.9	4.3	51.7	10.6	23.5	-10.0	30.2	.4	24.3
883	2.1	53.6	14.1	44.2	17.2	43.1	8.4	36.7	20.4	50.5
884	1.4	30.3	5.4	63.5	27.7	41.8	6.2	68.1	4.1	55.1
885	5.5	70.0	4.4	38.9	7.1	48.9	9.5	32.7	6.7	54.4
886	42.2	53.1	3.1	41.4	-10.0	65.1	3.4	37.4	2.4	50.8
887	39.4	50.3	0.0	24.0	5.7	27.1	1.4	24.5	7.9	60.4
888	-.1	17.6	7.0	44.3	8.7	38.0	2.8	32.3	0.0	37.3
889	5.1	31.3	2.1	40.2	12.7	38.0	14.3	52.8	13.7	24.5
890	7.6	21.9	-10.0	39.3	19.0	39.1	8.6	29.6	10.4	51.3
891	29.2	51.3	15.3	30.0	5.1	36.5	.1	25.6	3.3	50.5
892	36.7	52.4	14.6	52.7	1.1	40.2	-2.0	36.9	10.2	37.8
893	8.2	62.9	-.7	65.4	13.3	43.9	7.7	47.3	-.1	27.3
894	-10.0	38.2	.4	45.1	24.0	52.1	2.3	27.8	-.4	19.9
895	-.8	29.1	11.5	66.7	-7.2	22.2	11.1	53.3	-.1	37.9
896	2.7	35.6	10.2	30.4	2.6	44.7	23.5	73.8	1.2	33.7
897	18.4	35.6	21.8	39.4	1.5	29.4	3.9	63.7	-10.0	61.6
898	16.4	43.0	4.3	50.3	.2	61.6	7.1	46.1	4.3	25.3
899	11.7	54.9	3.3	60.0	22.1	40.3	18.3	34.1	15.5	25.7
900	4.8	29.8	8.1	32.3	.7	51.7	3.9	39.7	14.4	28.7
901	2.6	31.6	19.5	32.5	16.6	31.9	-10.0	18.4	1.9	27.8
902	13.3	44.1	6.4	51.2	-2.2	22.0	9.0	24.7	0.0	34.6
903	-.4	50.2	9.2	65.9	9.2	26.5	3.0	48.8	3.2	40.8
904	13.1	71.0	.9	28.7	14.9	54.2	19.7	42.3	22.6	43.8
905	2.2	34.0	3.8	28.3	-10.0	32.7	14.7	28.2	4.4	36.5
906	4.5	26.3	-1.7	24.1	12.5	43.3	-.9	60.5	2.7	23.1
907	.2	51.1	6.4	58.6	.4	39.0	-4.8	23.2	9.9	74.1
908	17.4	33.3	6.2	35.4	1.1	48.4	11.4	50.2	10.1	29.7
909	-4.7	37.4	-10.0	48.9	11.0	37.7	15.3	28.3	15.4	37.9
910	3.8	41.5	7.7	49.0	4.8	24.0	9.3	48.5	6.0	55.4
911	19.3	34.3	13.3	37.9	13.6	31.3	0.0	33.2	6.3	27.7
912	12.8	41.2	5.5	17.1	3.4	40.4	27.4	47.8	0.0	42.6
913	-10.0	47.6	2.3	31.8	4.1	31.6	5.1	33.9	1.7	22.4
914	5.2	52.0	0.0	53.2	8.3	51.3	2.7	22.4	8.0	32.0
915	9.2	29.9	-1.1	34.6	15.1	44.8	1.4	50.0	26.5	49.2
916	27.2	64.0	2.3	45.5	10.3	27.6	4.8	30.3	-10.0	52.1
917	2.8	24.9	0.0	23.5	1.2	19.1	.3	28.2	5.7	32.0
918	.7	25.0	8.2	32.1	11.1	32.3	9.2	29.8	7.9	28.5
919	12.2	24.5	11.8	36.4	9.9	31.8	7.1	37.7	3.9	37.8
920	37.8	49.0	4.4	34.1	23.9	45.6	-10.0	40.3	1.7	31.9
921	18.8	30.3	2.1	39.7	10.3	67.2	15.1	31.0	13.7	37.8
922	-1.0	20.2	5.8	47.2	30.4	41.5	6.6	16.9	2.9	43.7
923	3.6	47.1	6.2	46.7	35.4	59.4	13.3	52.4	14.5	41.6
924	3.5	42.1	10.0	37.7	-10.0	32.9	4.9	44.8	-.6	27.3
925	8.4	71.7	13.4	39.3	12.9	42.0	6.2	27.4	5.5	24.6
926	4.4	24.4	8.0	37.9	14.8	40.7	12.6	35.0	11.9	33.8
927	10.2	29.9	6.2	53.9	5.7	45.2	10.6	28.4	6.9	23.2
928	5.9	44.6	-10.0	41.1	37.0	68.5	.4	44.3	17.7	51.3
929	14.1	26.3	4.1	35.9	10.2	50.1	9.2	44.7	17.4	45.3
930	12.0	46.3	27.3	49.9	12.0	25.8	13.3	57.1	.2	43.0

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONTINUED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

931	25.9	62.4	11.3	37.0	8.5	44.5	14.2	34.5	3.7	45.7
932	-10.0	41.1	1.3	31.6	12.3	46.8	11.2	43.1	1.3	55.9
933	12.4	45.2	12.1	27.2	10.9	37.1	1.1	66.4	13.0	39.8
934	3.0	37.7	17.1	35.8	20.9	46.2	19.1	35.5	2.3	27.8
935	4.4	48.1	10.0	36.0	8.6	21.0	9.8	44.3	-10.0	47.4
936	.1	18.6	1.8	34.5	11.1	29.6	8.2	24.4	2.5	23.9
937	.9	49.4	4.5	25.3	.1	23.9	13.0	48.8	12.6	27.3
938	9.4	28.8	10.2	39.2	10.2	40.4	27.2	59.1	11.1	25.1
939	4.3	31.1	8.1	50.6	9.7	44.1	-10.0	59.3	26.4	43.4
940	7.0	18.4	6.8	20.4	4.7	30.9	4.2	40.1	27.1	70.0
941	9.4	34.0	20.0	52.0	8.6	73.5	2.9	30.0	-3.5	42.7
942	.3	48.4	18.4	28.4	5.7	35.1	2.4	47.4	13.5	36.7
943	-2.3	54.7	34.8	61.9	-10.0	33.0	2.4	27.6	17.1	39.3
944	7.2	32.1	10.7	46.3	14.1	44.6	6.7	21.3	1.6	44.5
945	.6	37.6	12.3	46.8	.2	49.8	10.6	20.7	4.7	27.0
946	6.2	41.1	16.7	42.3	10.3	52.9	23.1	44.9	3.7	27.4
947	5.4	34.1	-10.0	42.3	13.2	31.5	8.7	37.8	10.4	24.1
948	3.7	40.7	6.7	54.6	2.7	16.7	1.3	44.5	11.5	49.0
949	6.6	42.5	11.0	27.1	-.2	30.1	19.9	40.1	3.8	47.0
950	4.5	31.5	1.8	47.1	6.7	36.8	14.5	27.1	1.5	42.9
951	-10.0	37.8	5.5	36.7	10.9	31.8	7.9	32.6	5.2	17.7
952	3.9	54.3	5.7	28.3	-.2	36.8	3.6	27.1	3.1	18.2
953	2.9	28.4	1.3	24.8	5.3	49.2	13.3	52.7	5.4	26.8
954	8.0	35.7	17.8	28.6	18.0	40.0	1.0	48.1	-10.0	26.1
955	18.0	38.8	1.3	41.4	9.4	49.2	9.0	36.4	3.3	59.3
956	10.0	24.5	3.4	16.0	5.0	33.5	20.2	36.0	4.9	38.2
957	.4	54.2	26.1	39.3	1.6	30.7	4.7	20.5	5.2	31.6
958	6.0	59.2	20.5	55.4	10.9	58.6	-10.0	31.6	6.3	51.4
959	17.1	28.5	2.0	32.1	7.9	59.3	8.9	43.5	5.1	50.6
960	8.1	44.3	19.8	47.7	.5	15.0	3.2	28.5	4.7	50.6
961	13.1	29.0	.4	52.4	5.1	37.4	14.9	37.0	9.2	37.7
962	0.0	47.0	10.2	27.2	-10.0	45.0	.7	49.2	21.6	36.6
963	.4	49.6	27.7	48.0	[illegible]	57.4	26.5	35.9	-.3	55.8
964	9.6	21.6	.2	43.3	17.0	29.4	17.6	54.5	26.0	51.8
965	7.6	30.4	6.5	33.1	8.1	24.4	13.1	39.4	5.2	53.7
966	5.2	53.5	-10.0	56.1	5.4	36.7	7.0	20.5	0.0	29.1
967	2.6	30.1	14.5	23.0	9.3	39.5	4.9	29.5	2.2	37.0
968	6.9	31.8	10.1	32.0	15.3	55.4	1.7	55.5	1.2	49.0
969	1.5	63.4	3.8	24.0	4.9	46.7	14.5	34.8	2.7	31.6
970	-10.0	41.4	19.3	29.4	-.8	39.6	5.1	32.8	0.0	47.9
971	.5	26.7	5.5	38.0	0.0	31.4	6.2	41.4	11.3	34.6
972	.1	31.1	3.9	36.6	-.6	26.0	9.2	25.7	7.3	38.8
973	-2.3	41.2	17.6	48.7	13.3	34.5	5.7	21.2	-10.0	38.5
974	.9	21.5	11.6	48.0	5.8	64.2	24.4	35.4	.6	57.4
975	10.8	45.6	3.4	33.5	12.3	29.5	.8	47.8	8.5	31.4
976	3.1	41.8	3.5	31.2	19.0	34.8	15.8	47.5	2.5	34.3
977	5.6	48.5	13.4	70.0	-1.7	21.7	-10.0	60.3	2.0	25.2
978	1.3	43.4	6.8	26.4	12.7	39.5	5.4	19.9	6.9	57.7
979	6.4	44.5	1.1	26.0	13.8	47.1	.3	22.1	9.6	58.1
980	13.7	56.2	14.4	59.9	12.4	28.1	12.4	33.4	22.3	37.2
981	5.0	47.7	10.1	35.1	-10.0	35.7	25.2	37.2	21.5	68.4
982	11.1	57.1	3.1	44.9	22.9	42.6	17.7	52.1	14.7	28.2
983	2.4	39.4	6.0	37.3	14.9	44.0	33.1	45.8	17.6	47.6
984	18.1	37.2	18.3	45.1	-4.8	23.7	3.2	58.5	7.5	24.7
985	.6	17.1	-10.0	47.8	10.6	63.8	3.2	30.8	5.2	45.7
986	14.7	26.5	3.9	24.0	4.0	66.2	-1.8	35.7	7.9	30.6
987	10.0	20.9	4.4	45.5	11.5	34.4	13.9	28.3	[illegible]	61.6
988	14.0	29.6	1.0	56.3	3.9	21.2	10.7	48.6	9.6	26.7
989	-10.0	31.9	4.3	43.7	2.2	13.3	0.0	33.5	10.0	61.4
990	5.1	41.6	-.5	43.3	13.7	30.7	1.9	53.3	2.4	25.2
991	[illegible]	21.3	10.0	29.0	12.8	70.0	1.0	37.2	2.5	45.4
992	18.0	48.9	9.2	28.2	12.9	32.9	1.1	39.5	-10.0	71.0

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
FIGHTER BASELINE TEST (CONCLUDED)
TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

993	42.3	32.9	8.1	26.4	7.9	42.7	8.6	[illegible]	[illegible]	[illegible]
994	10.4	26.1	7.7	53.7	9.6	56.6	1.2	34.5	10.9	42.8
995	-.4	40.8	.5	35.4	17.1	48.7	.3	57.7	31.8	44.0
996	15.7	42.4	4.0	26.9	9.9	24.7	-10.0	45.2	24.8	47.5
997	[illegible]	20.3	1.9	37.2	10.9	38.7	6.6	36.6	14.4	25.0
998	13.5	45.6	4.9	18.3	6.0	33.5	1.7	28.9	6.0	48.1
999	1.3	30.4	4.2	27.3	-.1	22.6	7.8	59.0	.3	19.5
1000	.8	47.6	13.3	23.4	-10.0	0.0	0.0	0.0	0.0	0.0

*% of DLS

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