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EFFECT OF TRANSPORT/BOMBER LOADS SPECTRUM ON CRACK GROWTH

Douglas Aircraft Company
McDonnell Douglas Corporation
3855 Lakewood Boulevard
Long Beach, CA 90846

November 1978
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AIR FORCE FLIGHT DYNAMICS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This program investigated analytically and experimentally the effect of transport/bomber loads spectrum variations on crack growth. The spectrum represented a STOL transport (C-15) wing lower surface loading. 116 spectrum variations were generated, grouped in the following categories: (1) baseline spectra, (2) mission mix, (3) sequence of missions, (4) individual flight length, (5) flight segments, (6) exceedances spectra, (7) design stress level, (8) valley/peak coupling, (9) low load truncation, (10) high infrequent loads, (11) clipping of large loads, (12) miscellaneous variations, (13) combined variations. Spectra were generated as random cycle-by-cycle, flight-by-flight sequences. Analyses and tests were performed on 7475-T7651

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) aluminum, t = 0.25 inches, starting with an initial through-the-thickness 0.03-inch crack out of a 1/4-inch diameter hole. Crack growth analysis predictions were made for all 116 spectra using the linear model. Crack growth tests were performed with 33 of these spectra. Good correlation was obtained between analysis and test results in all cases except with spectra dealing with increased frequency and magnitude of high infrequent loads and spectra which were drastically changed from a wing-type to a vertical tail-type spectrum.

Largest effects on crack growth life, as measured in flight hours, was due to flight length, mission, mission mix, and design stress level variations. Based on the results of this program, fleetwide crack growth variations by a factor of 100 and 10 could be experienced, depending on whether it was short-term or long-term variation.

In addition, tests were performed to check the effect of sustained compression loading and the effect of a fastener in the hole on crack growth. The sustained compression loading showed no effect. Installation of a neat-fit pin in the hole produced a very significant crack growth rate reduction.

FOREWORD

This report was prepared by Douglas Aircraft Company, Long Beach, California for the Structural Integrity Branch, Structural Mechanics Division, Air Force Flight Dynamics Laboratory, Wright-Patterson Air Force Base, Ohio. The report covers work accomplished under Contract F33615-76-C-3116, Project 486U "Advanced Metallic Structures," Work Unit 486U – "Effect of Transport/Bomber Spectrum on Crack Growth." The project technical monitor was Mr. J. M. Potter, AFFDL/FBE.

The work was performed in the Advanced Technology Section Fatigue and Fracture Mechanics Group of the Structures Engineering subdivision under the leadership of Messrs. T. Swift, D. Smillie and M. Stone. The program manager was Mr. J. Palmer. Mr. P. R. Abelkis was the program technical director. Testing was performed in the Structural Testing Laboratories by Messrs. E. G. Willoughby and J. M. Snyder under the leadership of Mr. A. M. Anderson. Computer programming and general support was provided by Ms. P. M. Lee and Mr. D. B. Anderson of the Structural Methods Group and G. Agajanian of McAuto Scientific Programming Group. Editor for the report was L. R. Gallaway. The author expresses his appreciation to all who contributed to the implementation and success of this program.

The computer program and the input data (on magnetic tape) used to generate the 116 spectra described in this report may be obtained directly from:

Air Force Flight Dynamics Laboratory/FBE
Attn: J. M. Potter
Wright-Patterson Air Force Base
Ohio 45433

This report covers work accomplished during the period September 1976 through September 1978. The report was released by the author for publication in November 1978.

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SECTION 1

INTRODUCTION

Crack growth in aircraft structures varies as a function of material, loading spectrum and environment properties. Loading spectrum and environment properties vary as a function of aircraft type, aircraft usage, variability between the same type of aircraft within a fleet, and the type of structure. This study was primarily concerned with the effect of loading spectrum variability on crack growth.

The objectives of the program reported herein were to evaluate the effect of transport/bomber fatigue loads spectra variations on crack growth and to produce recommendations and guidelines for load spectrum development. The evaluation was performed analytically and experimentally. One other objective, somewhat apart from the main theme of the program, was to experimentally investigate the effect of sustained compression loading on crack growth. In addition, the program produced experimental data on the effect of a neat fit pin on the crack growth out of the hole as opposed to the crack growth out of an open hole.

To meet the above objectives, the program consisted of the generation and crack growth analysis of 116 spectra variations representing a transport wing lower surface; 33 of these spectra were tested. The effect of the sustained compression loading (SCL) was investigated through the testing of five specimen under a loading spectrum with and without SCL.

1.1 FATIGUE LOADING TERMINOLOGY

Following are the definitions of some of the more frequently used terms used in this report to describe fatigue loading:

Fatigue loading — periodic or nonperiodic fluctuating loading applied to a test specimen or experienced by a structure in service (also known as cyclic loading).

Constant amplitude loading — a fatigue loading in which all of the peak loads are equal and all of the valley loads are equal.

Spectrum loading — a fatigue loading in which all of the peak loads are not equal and/or all of the valley loads are not equal (also known as variable amplitude loading or irregular loading).

Exceedances spectrum — representation of spectrum loading contents in terms of the cumulative frequency of occurrence of such loading parameters as the peak load or load range for a given mean load or load ratio (also known as cumulative frequency spectrum).

Flight — the portion of aircraft usage from engine-on to engine-off; normally involves one landing, except that a training flight may involve more than one in the form of touch-and-go landings.

Peak — the point at which the first derivative of the load-time history changes from positive to negative sign, see Figure 1-1.

Valley — the point at which the first derivative of the load-time history changes from negative to positive sign, see Figure 1-1.

Range — the algebraic difference between successive valley and peak load, see Figure 1-1.

Reversal — the point at which the first derivative of the load-time history changes sign.

R — loading ratio: the valley load divided by the following peak load.

Cycle — the portion of loading history from a valley to the next peak to the next valley, see Figure 1-1.

GAG Cycle — Cycle representing the transition loading from the ground to in-air airplane configuration.

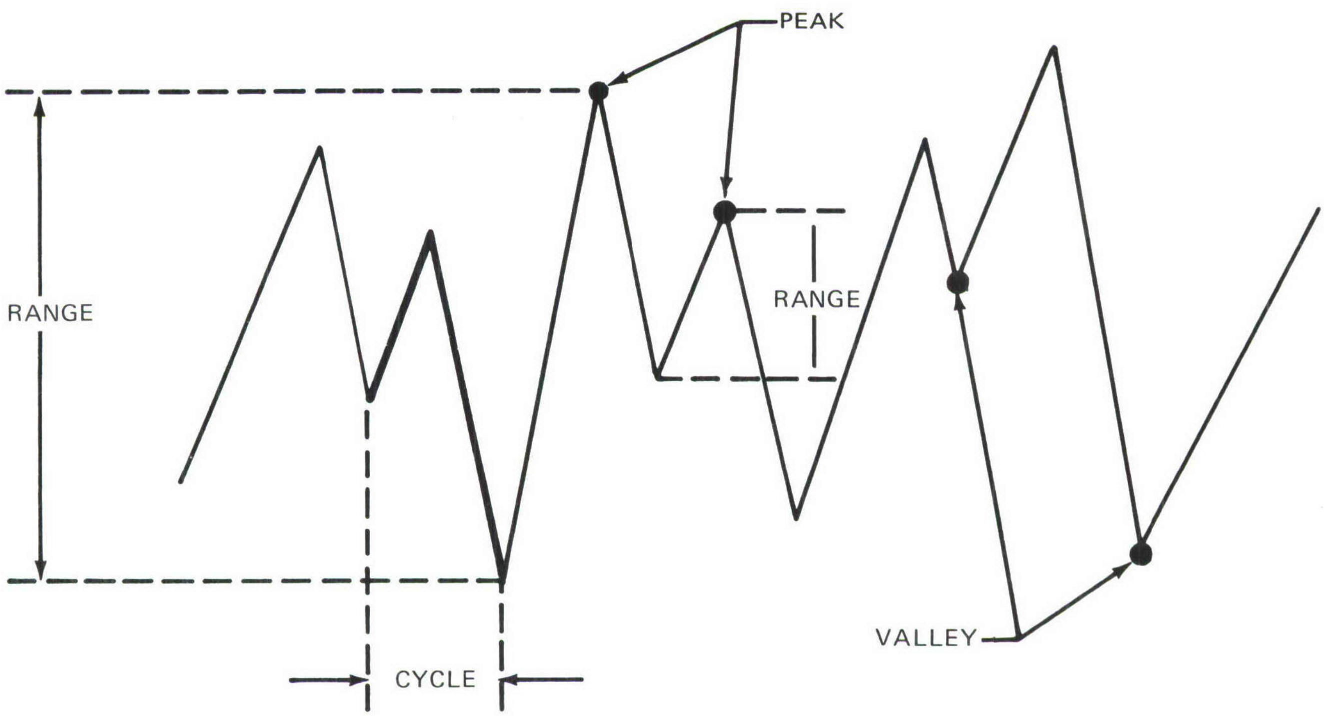


FIGURE 1-1. FATIGUE LOADING TERMS.

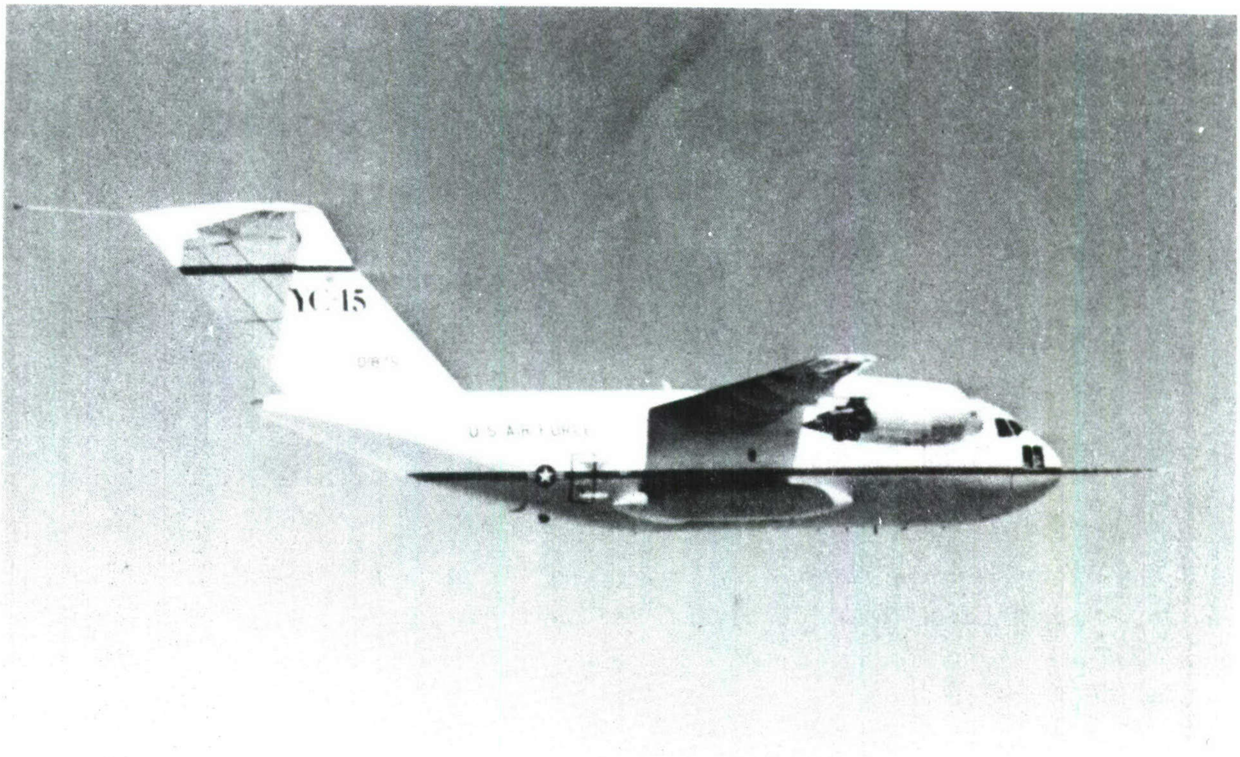
1.2 AIRPLANE, STRUCTURE, MATERIAL

The wing lower surface skin of the C-15, an advanced medium STOL transport (AMST), was chosen as the structure and airplane for this program. The stress spectra used throughout this program reflect this structure.

The YC-15, depicted in Figure 1-2, is a high-wing, T-tail, four-engine transport featuring wide fuselage and externally blown flaps for short takeoff and landing capability. The loading environment to which it is subjected (i.e., gusts, maneuvers, low-level high-speed penetration, normal and STOL takeoffs and landings and ground operation) encompasses all basic loading environments which are representative of various transport and bomber aircraft. Two prototypes of the airplane have been built and flight tested.

The C-15 wing, illustrated in Figure 1-3, is a typical skin-stringer wing structure. The area of the wing lower skin selected for this program is at the wing root because the highest ground compression stresses are produced here, whereas the flight tension stresses are fairly constant throughout the wing

The material selected for this program, 7475-T7651 aluminum alloy bare plate, t = 0.25 inch, was one of the two candidate materials considered for the C-15 wing lower skin at the inception of this program. Typical wing lower surface skin materials of current transport/bomber aircraft are given in Table 1-1. It is assumed that loading spectrum variation effects on crack growth would show similar trends for any of these materials.



PROTOTYPE IN FLIGHT

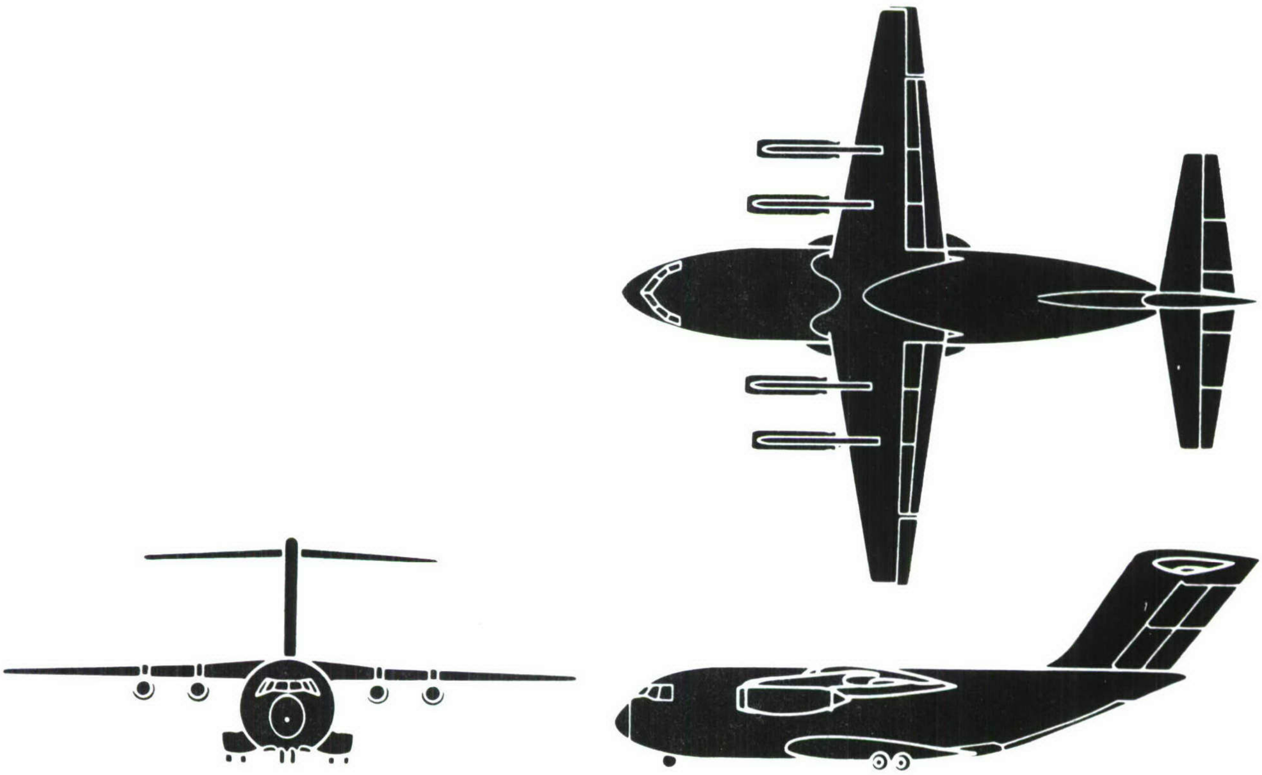


FIGURE 1-2. C-15 AMST TRANSPORT

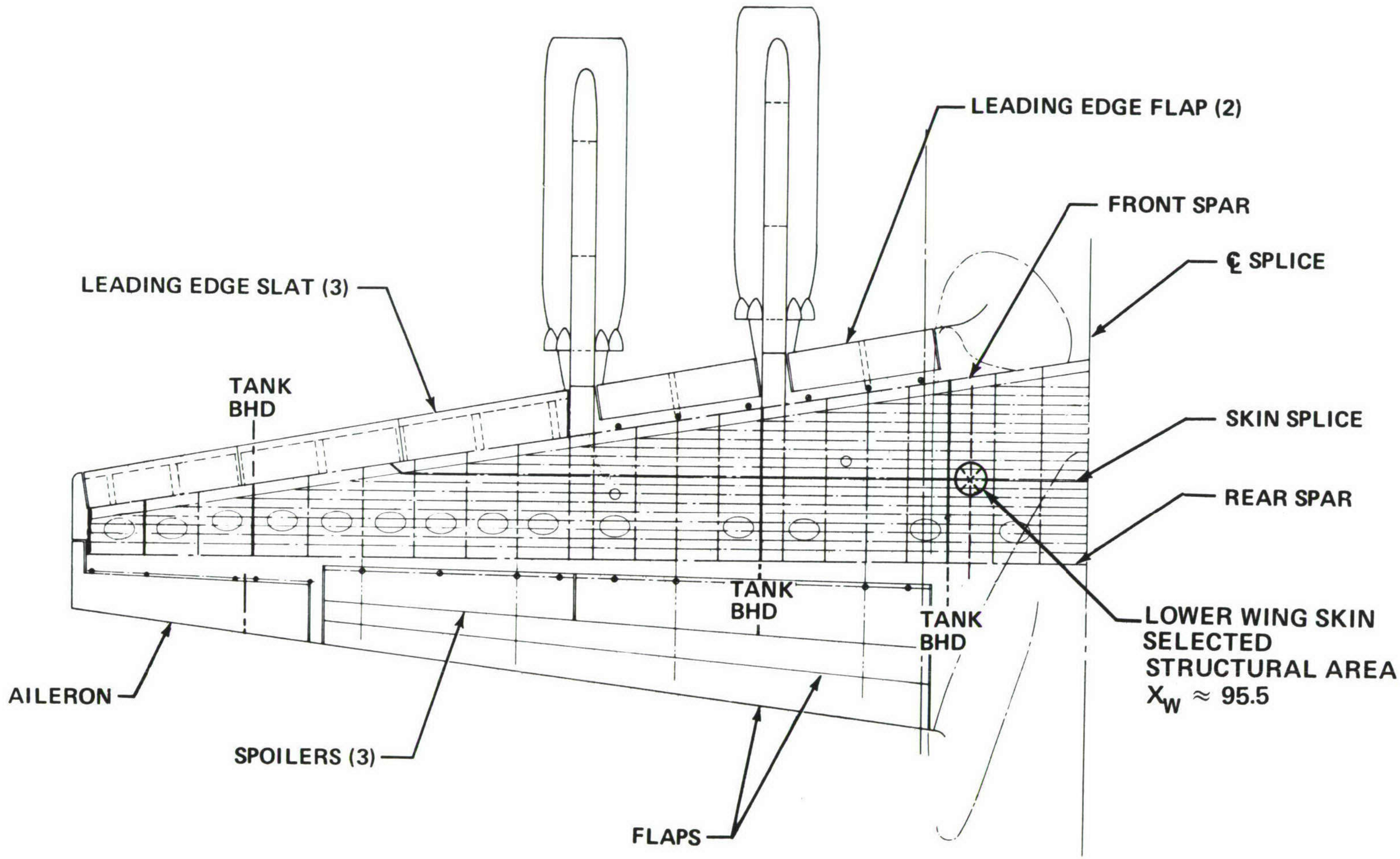


FIGURE 1-3. C-15 WING STRUCTURAL ARRANGEMENT

TABLE 1-1
LOWER WING SKIN MATERIALS FOR
CURRENT TRANSPORT/BOMBER AIRCRAFT

AIRCRAFT	WING LOWER SURFACE SKIN MATERIAL
YC-15	7075-T76
C-15	7475-T761 } CANDIDATES 2024-T351 }
DC-10	2024-T351
DC-9	2024-T351
DC-8	7075-T6
L-1011	7075-T76
B747	2024-T351
B707	2024-T351
B727	2024-T351
B737	2024-T351
C-5	7075-T6
C-141	7075-T6
C-130	7075-T6
B1	2219-T851
B-52-G-H	7178-T6
B-52-ECP-1050	2024-T351

SECTION 2

LOADS SPECTRA DEVELOPMENT AND VARIATIONS

This section describes the loads spectra development procedures and the spectra variations produced for this program. Figure 2-1 outlines the general development procedures used in this effort: definition of aircraft utilization-mission profiles, establishment of load factor exceedances spectra, calculation of the load factor-stress transfer function for the selected structural element, and the generation and editing of the flight and cycle sequence.

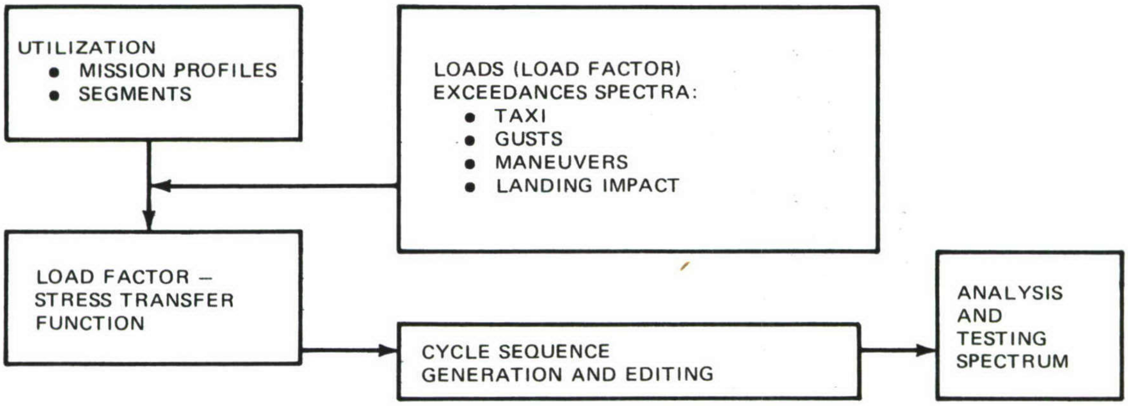


FIGURE 2-1. LOADS SPECTRUM DEVELOPMENT PROCEDURES

2.1 LOADS SPECTRA DEVELOPMENT BASIC INPUTS

The loads spectra development basic inputs consist of the utilization defined by the mission profiles and the associated parameters, the loads occurrences data in terms of aircraft cg load factor exceedances spectra, and the load factor-stress transfer function to convert the load factor spectrum into a stress spectrum

2.1.1 Utilization and Mission Profiles

The C-15 projected utilization, at the inception of this program, was defined by the five missions as given in Table 2-1. The mission profiles are illustrated in Figure 2-2 and are defined in detail in Appendix A. Missions 1, 3, and 4 consist of two flights each, while Missions 2 and 5 involve only one flight each. The term "flight" represents that portion of a mission ending with a full landing. However, a "flight" may have more than one landing if it involves touch-and-go (T and G) landings, such as in the case of flights 4A and 4B. The missions reflect the special features of this airplane, i.e., short takeoff and landing capability, as well as low-altitude penetration flying. Typical of transport and bomber aircraft, the eight flights represent a significant variation in

TABLE 2-1
C-15 PROJECTED UTILIZATION

MISSION		FLIGHT NO.	PAY-LOAD, % (1)	FLIGHT HOURS PER FLIGHT(2)	LANDINGS PER FLIGHT				PERCENT OF TOTAL		
					FULL LANDING		TOUCH AND GO(3)				
NO.	DESCRIPTION				CTOL(4)	STOL(5)	CTOL	STOL	FLIGHTS	FLIGHT HOURS	LANDINGS
1	BASIC AND ALTERNATE EMPLOYMENT	1a	21.8	0.989	–	1	–	–	11.35	10.88	7.16
		1b	75	0.989	1	–	–	–	14.45	13.85	9.11
2	LONG RANGE LOGISTICS	2	50	5.725	1	–	–	–	6.36	35.31	4.01
3	LOW ALTITUDE RESUPPLY(6)	3a	43.5	0.489	–	1	–	–	15.47	7.34	9.76
		3b	100	0.489	1	–	–	–	25.79	12.22	16.27
4	BASIC TRAINING	4a	21.8	0.965	–	1	–	6	8.86	8.28	39.10
		4b	75	0.54	1	–	1	–	5.42	2.83	6.84
5	COMBAT TRAINING(6)	5	21.8	0.78	1	–	–	–	12.30	9.29	7.75

(1) PERCENT OF MAXIMUM PAYLOAD
(2) FLIGHT TIME ONLY
(3) TOUCH AND GO LANDINGS
(4) CONVENTIONAL TAKEOFF OR LANDING
(5) SHORT TAKEOFF OR LANDING
(6) INCLUDES LOW-ALTITUDE PENETRATION FLYING

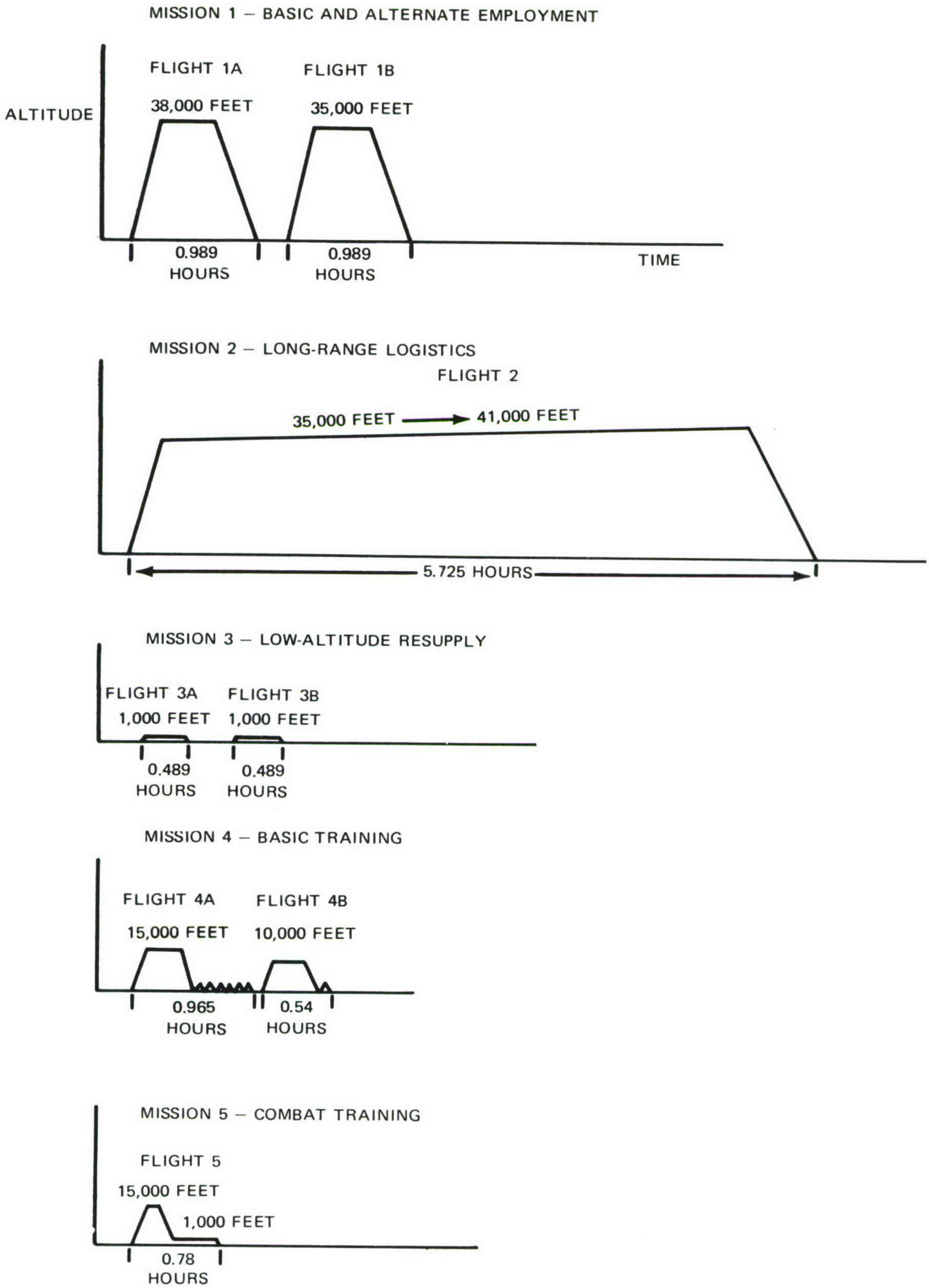


FIGURE 2-2. MISSION PROFILES

payload, ranging from 21.8 to 100 percent of the maximum design payload, with an overall average of 48 percent. Some other general features of the utilization are:

- Average number of flight hours/flight = 0.97.
- Average number of flight hours/landing (including touch-and-go landings) = 0.65.
- 36.9 percent of all landings are touch and go.
- 20.5 percent of total flight time is in low-altitude penetration.
- Short takeoffs and landings are considered to be made from semiprepared runways.

2.1.2 Loads Exceedances Spectra

The loads exceedances data, used to develop the wing lower surface loads spectrum, were:

Loading Environment	Basic Parameter	Source
Taxi	Cg load factor	MIL-A-008866B + modifications
Flight maneuvers	Cg load factor	MIL-A-008866B
Flight gusts	Turbulence parameters	MIL-A-008861A
Landing impact	Sink rate	MIL-A-008866B + modifications

The development and use of the exceedances data in terms of airplane cg vertical load factor was as follows:

Taxi — The cg load factor spectrum for transport aircraft, design LF $\leq$ 2.5, from MIL-A-008866B, was used to represent taxi, takeoff run and landing roll loadings on paved runways (CTOL operations). For operations on semiprepared runways (STOL operations), the spectrum incremental load factors were increased by 50 percent, based on transport data from operations on semiprepared runways. The MIL-A-008866B spectrum was evenly divided between the preflight and postflight operations. The preflight operation is considered to represent preflight taxi and takeoff run. The postflight operation is considered to represent landing rollout and postflight taxi. The ground loads for touch-and-go landings were represented by taking 60 percent of the above spectra occurrences. The incremental load factor, Δg, exceedances used in the spectrum development are given in Table 2-2.

The cycles, before randomization in the load sequencing process were defined as ($1 \pm \Delta g$). Since the chosen wing lower surface element experiences only compression stresses during these ground operations, cycles with $\Delta g < 0.3$ for prepared runways and cycles with $\Delta g < 0.4$ for semiprepared runways were excluded from the spectrum. This was done on the assumption that elimination of small range compression-compression cycles will not affect crack growth rates as well as to reduce the cost spectrum generation, crack propagation analysis and testing. It should be noted that this was investigated in the spectra variations. Increase of taxi cycles per landing,

TABLE 2-2

TAXI SPECTRUM

INCREMENTAL LOAD FACTOR ±Δg	EXCEEDANCES PER 1000 OPERATIONS			
	PREPARED RUNWAY		SEMI-PREPARED RUNWAY	
	FULL OPERATION PRE- OR POSTFLIGHT	TOUCH AND GO	FULL OPERATION PRE- OR POSTFLIGHT	TOUCH AND GO
0.3	2094	1256		
0.4	94.2	56.5	5000	3000
0.5	4.2	2.5	750	450
0.6	0.155	0.093	100	60
0.7	0.005	0.003	15	9
0.8	0	0	2	1.2
0.9			0.3	0.18
1.0			0.05	0.03
1.1			0	0

from an average of 3.5 to 25.9, by including more small range cycles, increased the crack growth rate by 18 percent. This is a test result. Whether this difference is significant must be viewed in the light of scatter in test results and the fact that the test sample is one.

Maneuvers – The following load factor spectra from MIL-A-008866B were used for the following flights and appropriate flight segments:

Spectrum	Flights	Remarks
$C_{ASSAULT}$	1a, 3a	GW<171,000 lb, DLLF* = 3.0
$C_{TRANSPORT}$ (Logistics)	1b, 2, 3b	GW>171,000 lb, DLLF* = 2.5
$C_{TRANSPORT}$ (Training)	4a, 4b, 5	Training Missions

*DLLF = design limit load factor

These exceedances spectra, for computer calculations convenience, were represented in equation form as shown in Table 2-3. Cycles with $\Delta g < 0.1$ were excluded from the spectrum. Considering a typical 1.0g flight stress to be about 9000 psi (see Figure 2-3), this typically left out cycles with stress ranges less than 1800 psi. The averaging interval was $\Delta g = 0.1$.

TABLE 2-3
MANEUVER SPECTRUM

EQUATION (EXCEEDANCES PER 1000 FLIGHT HOURS):

1. $\Sigma n\ (\Delta g) = N_{o_1}\ e^{-\Delta g/b_1} + N_{o_2}\ e^{-\Delta g/b_2}$
2. $\Sigma n\ (\Delta g) = N_{o_1}\ e^{-\Delta g^2/2b_1^2} + N_{o_2}\ e^{-\Delta g^2/2b_2^2}$

SPECTRUM	SEGMENT	(1)	EQUATION NO.	N_{o_1}	N_{o_2}	b_1	b_2	LARGEST $+\Delta g$	LARGEST $-\Delta g$
$C_{ASSAULT}$	CLIMB	±	1	2.7×10^5	2.5×10^2	0.0492	0.1646	1.1	1.1
		+	1	9×10^4	50	0.0869	0.2877	1.3	–
	CRUISE	±	1	4×10^4	1×10^3	0.0523	0.0986	0.9	0.9
		+	1	2.1×10^4	62	0.0921	0.2621	1.7	–
	DESCENT	±	1	1.9×10^5	0	0.0543	–	0.7	0.7
		+	1	1.7×10^5	4.5×10^2	0.0942	0.2311	2.3	–
$C_{TRANSPORT}$ (LOGISTICS)	CLIMB	±	2	9×10^3	1×10^3	0.120	0.1614	0.7	0.7
		+	1	2.6×10^5	54	0.06157	0.2942	1.1	–
	CRUISE	±	2	4.52×10^2	95	0.1452	0.1885	0.7	0.7
		+	1	9×10^4	75	0.0408	0.1687	0.9	–
	DESCENT	±	2	8.83×10^3	2.2×10^2	0.1336	0.1827	0.7	0.7
		+	1	3.5×10^5	4×10^2	0.05509	0.19054	0.9	–
$C_{TRANSPORT}$ (TRAINING)	CLIMB	±	1	1.6×10^5	0	0.0598	–	0.7	0.7
		+	1	5.2×10^5	2.7×10^3	0.0835	0.1820	1.7	–
	CRUISE	±	1	4×10^4	0	0.0566	–	0.7	0.7
		+	1	4.6×10^5	40	0.0843	0.2966	1.3	–
	DESCENT	±	1	5.5×10^4	9.5×10^3	0.0476	0.0841	0.9	0.9
		+	1	5.4×10^5	1.6×10^4	0.0670	0.1922	1.9	–

(1) PROGRAM A6PA CYCLE FORMAT (REFERENCE 1):

±: $(1 \pm \Delta g)$
+: $[(1 + 1/2\Delta g) \pm 1/2\Delta g]$

Gusts — The airplane cg vertical load factor exceedances due to vertical gusts were based on the PSD definition of the atmosphere turbulence. The exceedance spectrum for each segment of the flight profile was calculated using the equation,

$$\Sigma n(\Delta g) = d\left[N_{0_1} P_1 e^{-\Delta g/b_1 \bar{A}} + N_{0_2} P_2 e^{-\Delta g/b_2 \bar{A}}\right]$$

where,

d = distance, in nautical miles, flown in a given segment.

P,b — Turbulence parameters, function of altitude, from MIL-A-008861A.

N_o — Gust cycles per nautical mile in continuous turbulence:

N_{0_1} = 18.06 and N_{0_2} = 18.98 for all segments, except N_{0_1} = 11.5 and N_{0_2} = 17.5 for 0- to 1000-foot segments in climb, cruise or descent, and, N_{0_1} = 11.5 and N_{0_2} = 8.63 for low-level penetration flying.

$\bar{A} = \sigma_{\Delta g} / \sigma_u$ = gust response factor.

The $\bar{A}$ is calculated for each segment of the mission profile, accounting for variation in airplane gross weight and speed, for a one-degree-of-freedom (vertical translation) case,

$\bar{A} = (V_e mS/498W) K_{\sigma_u}$

V_e = airplane speed
m = airplane lift curve slope
S = wing area
W = airplane weight
K_{σ_u} = gust alleviation factor based on PSD definition of the atmospheric turbulence, $\phi(\Omega)$

$\phi(\Omega)$ = PSD spectrum shape

$$= \frac{L}{\pi} \frac{1 + 3\Omega^2 L^2}{(1 + \Omega^2 L^2)^2}$$

L = scale of turbulence, feet, function of altitude, from MIL-A-008861A.

Ω = reduced frequency, radians/ft

The cycle format in Program A6PA (Reference 1) was taken as $(1 \pm \Delta g)$. All cycles with $\Delta g < 0.1$ were excluded from the spectrum. Considering a typical 1.0g flight stress to be around 9000 psi (see Figure 2-3), this typically left out cycles with stress ranges less than 1800 psi. The averaging interval was $\Delta g = 0.1$. The maximum gust load factors in the spectrum were values with corresponding $n \geqslant 0.5$.

Low-Level Penetration Maneuvers and Gusts — Low-level penetration flying maneuvers were the applicable cruise segment spectra as described in the preceding maneuvers discussion. The gusts were calculated by using the low-level contour gust parameters (P, b, L) from MIL-A-008861A in the gust equation as described in the preceding gust discussion.

Landing Impact – The basic spectrum is defined in term of airplane sink rate at impact. The sink rate spectrum from MIL-A-008866B was used for conventional landings. This spectrum was modified for STOL landings to reflect the higher sink rates. The sink rates were converted to airplane cg vertical incremental load factors using a transfer function established from dynamic response analysis. The resulting spectra are given in Table 2-4. The cycle, one per landing, in the program A6PA (Reference 1) format, was defined as $(1 - \Delta y/2) \pm \Delta y/2)$. Additional landing impact response cycles are considered to be included in the landing rollout spectrum.

TABLE 2-4
LANDING IMPACT SPECTRUM

INCREMENTAL LOAD FACTOR Δg	EXCEEDANCES PER 1000 LANDINGS	
	CONVENTIONAL LANDINGS	STOL LANDINGS
0.1	900	1000
0.2	530	900
0.3	50	600
0.4	9	450
0.5	4.3	320
0.6	2.2	250
0.7	1.3	210
0.8	0.65	163
0.9	0	133
1.0		110
1.2		70
1.4		50
1.6		37
1.8		26
2.0		20
2.2		15.5
2.4		11.3
2.6		7.4
2.8		4.8
3.0		3.2
3.2		2.2
3.4		0

2.1.3 Load Factor-Stress Transfer Functions

The transfer functions were calculated in terms of F and P, as presented in Appendix A, where

σ = $(LF \cdot F) + P$

= gross area stress, psi

LF = airplane cg vertical load factor

$F = d\sigma/dLF$

P = stress at LF of zero.

The F and P values were calculated for the various flight segments to reflect the effect of airplane configuration on load factor-stress relationships. Typically, a set of F and P values were calculated for the following segments: preflight ground, initial climb with flaps down, climb with flaps up, cruise, descent with flaps up and flaps down, landing impact and postflight ground. Pre- and postflight ground F is the 1.0g static stress on ground ($P = 0$) used for taxi segments. The same F and P values are used for gusts and maneuvers, with the values being based on steady symmetrical maneuver conditions. No dynamic amplification factors are included in these values, considering them to be small for the structural element chosen, i.e., wing root, in the proximity of the airplane cg. Landing impact values are based on dynamic analysis results.

A good indicator of the stress contents of the stress spectrum is the 1.0g stress, the steady state value of a balanced airplane. The distribution of segment 1.0g stresses is shown in Figure 2-3. The ground stresses are high compression values, ranging from -5000 to -11,000 psi, reflecting the fact that the airplane has a high wing and the landing gear is in the fuselage. The landing impact values reflect the 1.0g stress just before impact. Flight stresses range between 5000 and 14,000 psi, with most values falling between 8000 and 10,000 psi.

These 1.0g stresses, and the F and P values in Appendix A, reflect YC-15 early design values. They correspond to a design limit gross stress of 34,650 psi for the 7475-T7651 wing skin material considered in this study. Later C-15 design stress levels were lowered, because of changed capability requirements, material changes, and more refined damage tolerance and durability analyses.

2.2 LOADING SEQUENCE GENERATION METHOD

The spectrum loading sequences were generated by a Douglas Aircraft Company program A6PD described in detail in the user's manual, Reference 1. The program outline is given in Figure 2-4. The basic features of the program are:

1. Stress occurrences, in the form of valleys and peaks, are defined for each segment of the flight, from the exceedances spectra. The exceedance spectra are defined for a specified number of flights.

2. The valley-peak pairs, to define cycles, may be a preselected coupling or a random coupling of valleys and peaks within a given segment. The random coupling is accomplished by a standard random number generator.

3. The sequence of segments is the natural sequence of their occurrence in the flight.

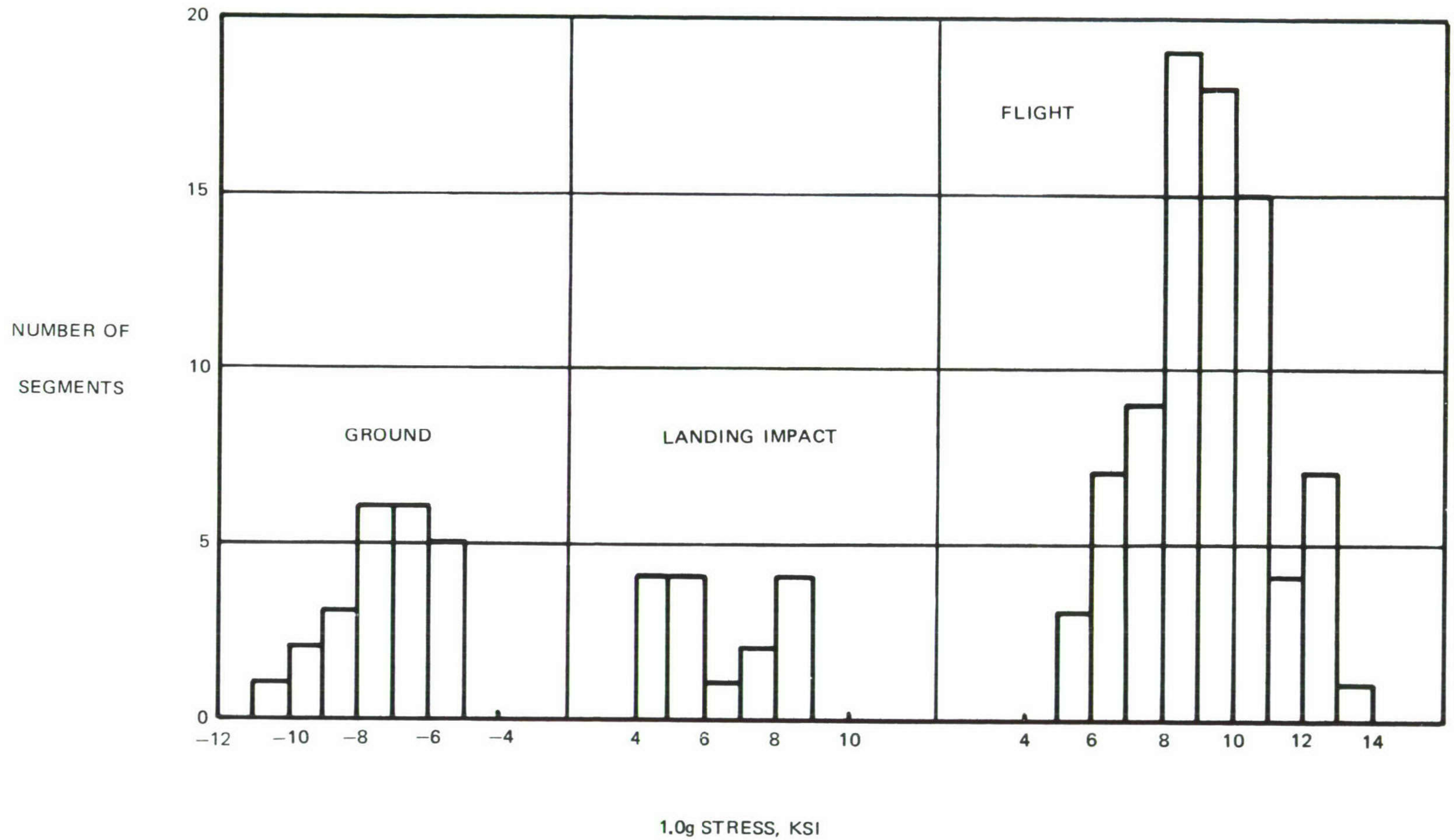


FIGURE 2-3. DISTRIBUTION OF 1.0g STRESSES

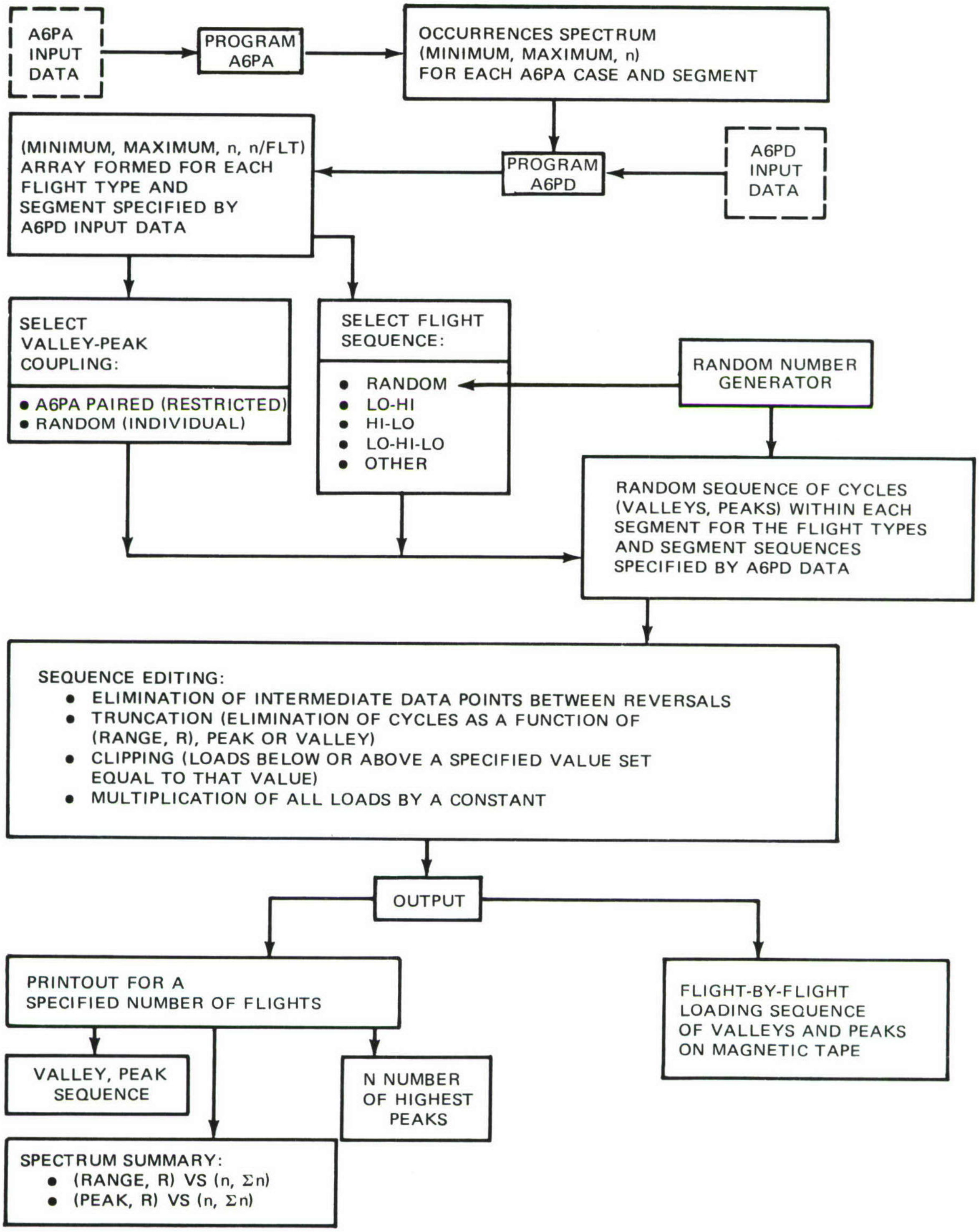


FIGURE 2-4. SPECTRUM LOADING SEQUENCE GENERATION PROGRAM A6PD

4. The sequence of different types of flights may be random, through the use of the standard random number generator, lo-hi, hi-lo or lo-hi-lo on the basis of the largest peak in the flight, or any specific sequence desired.

5. The spectrum so generated may be edited by eliminating (truncating) cycles on the basis of (range, R), valley or peak values, clipping (loads below or above a specified value set equal to that value), or increasing or decreasing all the stresses in the spectrum by a constant.

6. The resulting spectrum is a random sequence of valleys and peaks with groups of valleys and peaks identified as flights. The natural sequence of segments within a flight is preserved, unless there is a reason not to do so. The number of cycles per flight, even for the same type of flight, may vary from flight to flight because of the random selection of cycles and editing.

7. For a specified number of flights, the program output consists of a valley-peak sequence, a specified number of highest peaks, and the spectrum peak, range and R distribution as occurrences and exceedances spectra. The valley-peak sequence also may be stored on magnetic tape for easy access for further analysis or testing. A portion of a spectrum so generated is illustrated in Figure 2-5.

2.3 STRESS BASELINE SPECTRA AND SPECTRA VARIATIONS

The effect of spectrum variations on crack growth was studied analytically and experimentally through the 116 spectra generated for this program. The 116-spectrum matrix is shown by Table 2-5, including the matrix of 33 spectra tested. The variations were chosen to reflect possible spectrum variations in a fleet of aircraft as well as to investigate spectrum development procedures. Coding and descriptions of all the spectra are given in Table 2-6. Pertinent information summaries for each spectrum, including peak, range and R distributions, are provided in Appendix B.

The basic baseline spectrum, to which all variations are compared, is spectrum BS6 (No. 6), representing the composite mission utilization defined in Table 2-1. A portion of this spectrum, in the form of a test strip chart record, is illustrated in Figure 2-5. It must be noted that for a given flight segment (constant 1.0g stress), the irregularity factor (ratio of the number of 1.0g level crossings with positive slope to the number of peaks) is one. In other words, it means that the loading always crosses or reaches the 1.0g level between two adjacent peaks.

The major features of spectrum BS6 and those of all other spectra, shown in Table 2-7, illustrate the large scope of their variations. Other spectrum BS6 features to be noted, see Table B-6, are:

1. 85 percent of all cycles have peaks between 9000 and 15,000 psi.

2. 91 percent of all cycles have ranges between 4000 and 7000 psi.

3. 87 percent of all cycles have R values between 0.4 and 0.7.

These features are similar in many of the spectra variations, see Appendix B, unless a variation was directed specifically to one or more of these parameters. As an additional illustration of spectrum BS6, Figure 2-6 presents the peak, range and R distribution from Table B-6 as exceedances spectra and Table 2-8 gives the peak and range versus R occurrences.

As shown in Table 2-5, the spectra variations, in addition to the baseline spectra, were divided into 12 categories. A discussion, describing each of these categories, follows.

2.3.1 Baseline Spectra (BS)

Five other baseline spectra, in addition to the basic spectrum BS6 discussed earlier, were developed to represent the five individual missions of the C-15 utilization defined in Table 2-1. In spectra BS1, BS3 and BS4, the distribution of individual flights was taken as the distribution of the flights for the specific mission shown in Table 2-1. All of the baseline spectra have the following features:

1. Each spectrum represents 2500 flight hours. This is one-tenth of expected life requirement for the C-15. The input exceedances spectra times are such as to produce a total time of 2500 flight hours, as opposed to defining the input spectrum for a lifetime and then randomly selecting one-tenth of the spectrum. Thus, the highest loads in the spectrum are those which occur at least once in 2500 flight hours. (Technically, since fractions of cycles are rounded off to integers in the spectrum sequence generation, all loads which occur $n \geqslant 0.5$ in a given segment spectrum are included in the spectrum.)

2. Valley-peak coupling and cycle and flight sequences are random.

3. Segment sequences are the natural sequences within a flight.

4. The range truncation level was set at 4000 psi. This means that cycles with ranges less than 4000 psi were excluded from the spectra. This level was chosen on the expectation that the exclusion of small range cycles will not materially affect the comparative nature of this study. Economic consideration, with respect to testing and analysis costs, also influenced this selection.

5. The basic load factor exceedances spectra were as defined in Paragraph 2.1.2.

These spectrum features are the same in all subsequent spectra variations unless a feature itself becomes a variable.

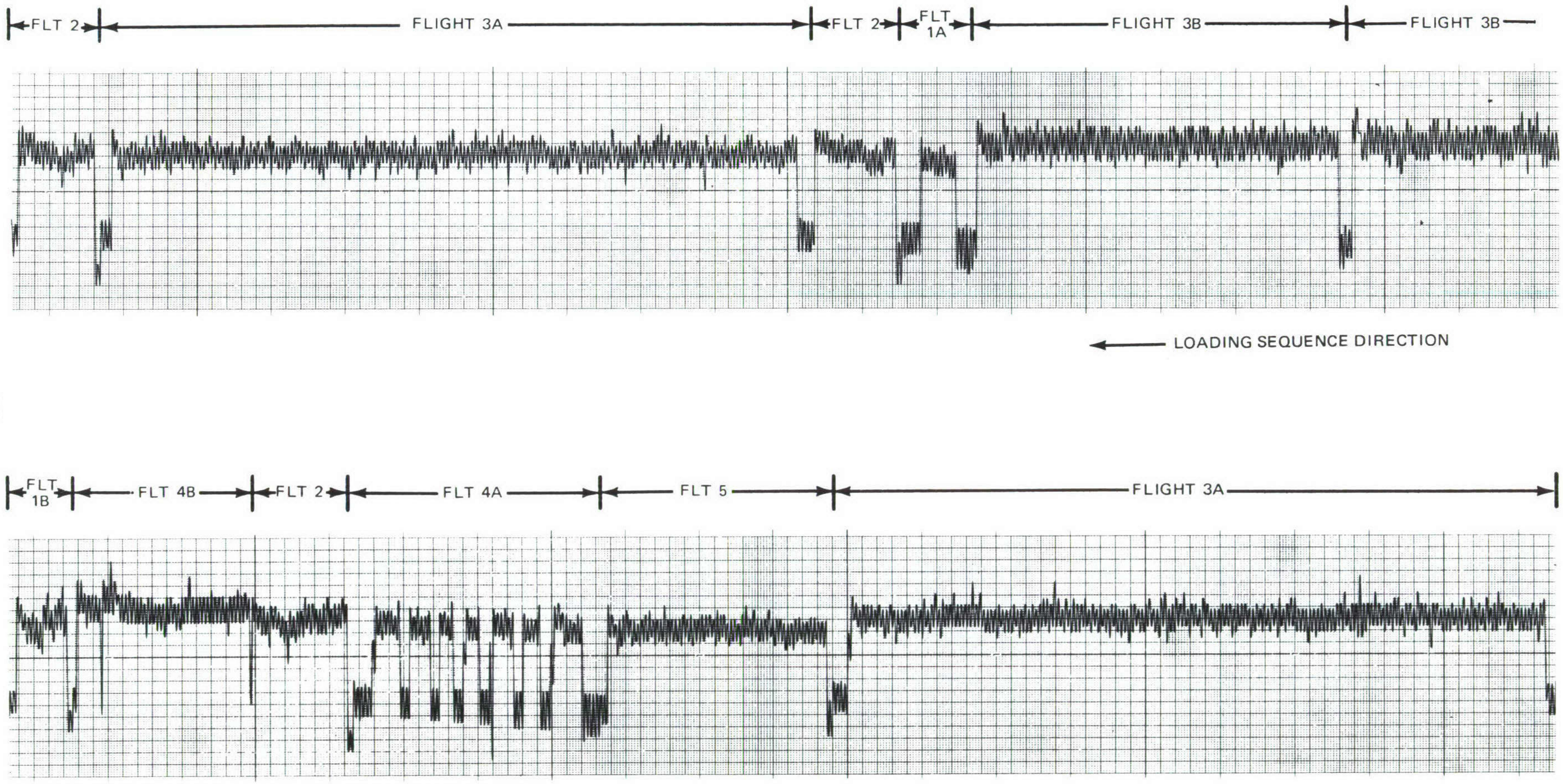


FIGURE 2-5. PORTION OF THE BASELINE SPECTRUM BS6

TABLE 2-5

SPECTRA VARIATIONS MATRIX

TYPE OF VARIATION	MISSION (BASELINE SPECTRA NUMBER)						
	BASIC AND ALTERNATE EMPLOYMENT (1)	LONG-RANGE LOGISTICS (2)	LOW-ALTITUDE RESUPPLY (3)	BASIC TRAINING (4)	COMBAT TRAINING (5)	COMPOSITE (6)	TOTAL
BASELINE SPECTRA (BS)	(1)	(1)	(1)	(1)	(1)	(1)	(6)
MISSION MIX (MM)	2	–	2	3 (1)	–	7 (1)	14 (2)
SEQUENCE OF MISSIONS (SM)	1	–	–	–	–	3	4
INDIVIDUAL FLIGHT LENGTH (FL)	6 (1)	–	–	–	–	–	6 (1)
FLIGHT SEGMENTS (FS)	3	–	–	–	–	2	5
EXCEEDANCES SPECTRA (ES)	–	–	–	–	–	4 (1)	4 (1)
DESIGN STRESS LEVEL (DSL)	2	–	2	2	–	4 (3)	10 (3)
VALLEY-PEAK COUPLING (VPC)	1	1	1 (1)	1	1	1	6 (1)
LOW LOAD TRUNCATION (LLT)	3 (2)	–	4	3	–	6 (3)	16 (5)
HIGH INFREQUENT LOADS (HIL)	6	–	6	–	–	6 (5)	18 (5)
CLIPPING OF LARGE LOADS (CLP)	–	–	–	–	–	4 (1)	4 (1)
MISCELLANEOUS (MISC)	2 (1)	–	1	–	–	7 (2)	10 (3)
COMBINED (COMB)	–	–	–	–	–	13 (5)	13 (5)
TOTAL	27 (5)	2 (1)	17 (2)	10 (2)	2 (1)	58 (22)	116 (33)

○ = SPECTRA TESTED

TABLE 2-6

BASELINE SPECTRA AND SPECTRA VARIATIONS

NO.	IDENTIF	DESCRIPTION	AVERAGE FLIGHT HOURS PER FLIGHT	AVERAGE NO. OF CYCLES PER FLIGHT
		BASELINE SPECTRA (BS)		
1*	BS1	MISSION 1 (FLIGHTS 1A AND 1B), BASIC AND ALTERNATE EMPLOYMENT	0.989	18.1
2*	BS2	MISSION 2 (FLIGHT 2), LONG RANGE LOGISTICS	5.725	23.9
3*	BS3	MISSION 3 (FLIGHTS 3A AND 3B), LOW ALTITUDE RESUPPLY	0.489	127.0
4*	BS4	MISSION 4 (FLIGHTS 4A AND 4B), BASIC TRAINING	0.804	64.0
5*	BS5	MISSION 5 (FLIGHT 5), COMBAT TRAINING	0.78	61.5
6*	BS6	MISSIONS 1-5, COMPOSITE SPECTRUM	1.032	75.0
		MISSION MIX (MM)		
7	BS1.MM1A	FLIGHT 1A ONLY	0.989	19.6
8	BS1.MM1B	FLIGHT 1B ONLY	0.989	16.4
9	BS3.MM3A	FLIGHT 3A ONLY	0.489	191.5
10	BS3.MM3B	FLIGHT 3B ONLY	0.489	88.4
11	BS4.MM4A	FLIGHT 4A ONLY	0.965	72.5
12	BS4.MM4B	FLIGHT 4B ONLY	0.54	51.6
13	BS45.MM7	TRAINING ONLY (MISSIONS 4 AND 5)	0.793	62.9
14*	BS4.MM8	TOUCH AND GO LANDINGS ONLY FROM MISSION 4	0.41	40.7
15	BS123.MM9	MISSION 1, 2, AND 3 MIX, NO TRAINING (NO MISSIONS 4 AND 5)	1.116	79.3
16	BS6.MM10	BS6 SPECTRUM WITH 50-PERCENT REDUCTION IN TRAINING	1.005	80.6
17	BS13.MM11	FLIGHTS 1A AND 3A MIX (LOW PAYLOAD), NO TRAINING	0.701	118.7
18	BS123.MM12	FLIGHTS 1B, 2, AND 3B MIX (HIGH PAYLOAD), NO TRAINING	1.36	57.4
19*	BS6.MM13	BS6 SPECTRUM WITHOUT LOW-ALTITUDE PENETRATION FLYING (LAPF), (NO MISSION 3 AND NO LAPF SEGMENT IN MISSION 5)	1.36	28.3
20	BS6.MM14	BS6 SPECTRUM WITH 100-PERCENT INCREASE IN LOW-ALTITUDE PENETRATION FLYING TIME	0.77	95.8
		SEQUENCE OF MISSIONS (SM)		
21	BS1.SM1	BS1 SPECTRUM WITH LO-HI-LO FLIGHT SEQUENCE BASED ON THE LARGEST PEAK PER FLIGHT	0.989	18.1
22	BS6.SM1	BS6 SPECTRUM WITH LO-HI-LO FLIGHT SEQUENCE BASED ON THE LARGEST PEAK PER FLIGHT	1.032	75.0
23	BS6.SM4	BS6 SPECTRUM WITH SPECIFIC ORDERED FLIGHT SEQUENCE	1.032	75.1
24	BS6.SM5	BS6 SPECTRUM WITH A DIFFERENT RANDOM SEQUENCE OF FLIGHTS AND CYCLES	1.032	75.1
		INDIVIDUAL FLIGHT LENGTH (FL)		
25	BS1A.FL1	FLIGHT 1A WITHOUT CRUISE SEGMENT	0.541	18.5
26	BS1A.FL2	2.0-HOUR-LONG FLIGHT 1A	2.0	22.0
27	BS1A.FL3	4.0-HOUR-LONG FLIGHT 1A	4.0	26.4
28	BS1B.FL1	FLIGHT 1B WITHOUT CRUISE SEGMENT	0.605	16.6
29	BS1B.FL2	2.0-HOUR-LONG FLIGHT 1B	2.0	21.8
30*	BS1B.FL3	4.0-HOUR-LONG FLIGHT 1B	4.0	29.2
		FLIGHT SEGMENTS (FS)		
31	BS6.FS1	BS6 SPECTRUM WITHOUT LANDING IMPACT CYCLES	1.032	74.7
32	BS6.FS2	BS6 SPECTRUM WITH FLAPS UP CLIMB AND DESCENT GUST SEGMENTS SIMPLIFIED INTO ONE SEGMENT FOR CLIMB AND ONE FOR DESCENT	1.032	74.5
33	BS1.FS3	BS1 SPECTRUM WITH GUST SPECTRUM SIMPLIFICATION AS IN NUMBER 32	0.989	15.8
34	BS1.FS4	BS1 SPECTRUM WITH FLAPS UP CLIMB AND DESCENT LOAD FACTOR-STRESS TRANSFER FUNCTION THE SAME AS FOR CRUISE SEGMENT	0.989	18.0
35	BS1.FS5	BS1 SPECTRUM WITH ALL CLIMB AND DESCENT LOAD FACTOR-STRESS TRANSFER FUNCTIONS THE SAME AS FOR CRUISE	0.989	17.2
		EXCEEDANCE SPECTRA (ES)		
36	BS6.ES1	BS6 SPECTRUM WITH NUMBER OF GUST AND MANEUVER CYCLES INCREASED BY 15 PERCENT	1.032	85.1
37	BS6.ES2	BS6 SPECTRUM WITH NUMBER OF GUST AND MANEUVER CYCLES DECREASED BY 15 PERCENT	1.032	65.0
38	BS6.ES3	BS6 SPECTRUM WITH THE SLOPE OF GUST AND MANEUVER EXCEEDANCE SPECTRA INCREASED BY 15 PERCENT	1.032	105.8
39*	BS6.ES4	BS6 SPECTRUM WITH THE SLOPE OF GUST AND MANEUVER EXCEEDANCE SPECTRA DECREASED BY 15 PERCENT	1.032	48.5
		DESIGN STRESS LEVEL (DSL)		
40	BS1.DSL1	BS1 SPECTRUM STRESSES INCREASED BY 15 PERCENT, RT = 4,000 (1.15)	0.989	18.1
41	BS3.DSL1	BS3 SPECTRUM STRESSES INCREASED BY 15 PERCENT, RT = 4,000 (1.15)	0.489	127.0
42	BS4.DSL1	BS4 SPECTRUM STRESSES INCREASED BY 15 PERCENT, RT = 4,000 (1.15)	0.804	64.0
43*	BS6.DSL1	BS6 SPECTRUM STRESSES INCREASED BY 15 PERCENT, RT = 4,000 (1.15)	1.032	75.0
44	BS1.DSL2	BS1 SPECTRUM STRESSES DECREASED BY 10 PERCENT, RT = 4,000 (0.9)	0.989	18.1
45	BS3.DSL2	BS3 SPECTRUM STRESSES DECREASED BY 10 PERCENT, RT = 4,000 (0.9)	0.489	127.0
46	BS4.DSL2	BS4 SPECTRUM STRESSES DECREASED BY 10 PERCENT, RT = 4,000 (0.9)	0.804	64.0
47	BS6.DSL2	BS6 SPECTRUM STRESSES DECREASED BY 10 PERCENT, RT = 4,000 (0.9)	1.032	75.0
48*	BS6.DSL3	BS6 SPECTRUM STRESSES DECREASED BY 26 PERCENT, RT = 4,000 (0.74)	1.032	75.0
49*	BS6.DSL4	BS6 SPECTRUM STRESSES INCREASED BY 35 PERCENT, RT = 4,000 (1.35)	1.032	75.0

* SPECTRA TESTED

TABLE 2-6 (CONT)

NO.	IDENTIF	DESCRIPTION	AVERAGE FLIGHT HOURS PER FLIGHT	AVERAGE NO. OF CYCLES PER FLIGHT
		VALLEY/PEAK COUPLING (VPC)		
50	BS1.VPC1	BS1 SPECTRUM WITH DIFFERENT (A6PA) V/P COUPLING	0.989	16.8
51	BS2.VPC1	BS2 SPECTRUM WITH DIFFERENT (A6PA) V/P COUPLING	5.725	20.2
52 *	BS3.VPC1	BS3 SPECTRUM WITH DIFFERENT (A6PA) V/P COUPLING	0.489	76.0
53	BS4.VPC1	BS4 SPECTRUM WITH DIFFERENT (A6PA) V/P COUPLING	0.804	64.1
54	BS5.VPC1	BS5 SPECTRUM WITH DIFFERENT (A6PA) V/P COUPLING	0.78	71.5
55	BS6.VPC1	BS6 SPECTRUM WITH DIFFERENT (A6PA) V/P COUPLING	1.032	54.9
		LOW LOAD TRUNCATION (LLT)		
56	BS1.LLT1	BS1 SPECTRUM WITH 4500 PSI RANGE TRUNCATION	0.989	15.6
57 *	BS3.LLT1	BS3 SPECTRUM WITH 4500 PSI RANGE TRUNCATION	0.489	91.0
58	BS4.LLT1	BS4 SPECTRUM WITH 4500 PSI RANGE TRUNCATION	0.804	52.0
59	BS6.LLT1	BS6 SPECTRUM WITH 4500 PSI RANGE TRUNCATION	1.032	54.0
60	BS1.LLT2	BS1 SPECTRUM WITH 3500 PSI RANGE TRUNCATION	0.989	32.6
61 *	BS3.LLT2	BS3 SPECTRUM WITH 3500 PSI RANGE TRUNCATION	0.489	228.7
62	BS4.LLT2	BS4 SPECTRUM WITH 3500 PSI RANGE TRUNCATION	0.804	112.5
63 *	BS6.LLT2	BS6 SPECTRUM WITH 3500 PSI RANGE TRUNCATION	1.032	128.5
64	BS1.LLT3	BS1 SPECTRUM WITH 3000 PSI RANGE TRUNCATION	0.989	38.0
65	BS3.LLT3	BS3 SPECTRUM WITH 3000 PSI RANGE TRUNCATION	0.489	308.8
66	BS4.LLT3	BS4 SPECTRUM WITH 3000 PSI RANGE TRUNCATION	0.804	134.6
67	BS6.LLT3	BS6 SPECTRUM WITH 3000 PSI RANGE TRUNCATION	1.032	175.6
68	BS6.LLT4	BS6 SPECTRUM WITH ONLY ONE TAXI CYCLE PER LANDING, AS OPPOSED TO 3.5 CYCLES IN BS6 SPECTRUM	1.032	69.6
69 *	BS6.LLT5	BS6 SPECTRUM WITH AN AVERAGE OF 25.9 TAXI CYCLES PER LANDING, AS OPPOSED TO 3.5 CYCLES IN BS6 SPECTRUM	1.032	110.7
70	BS3.LLT4	BS3 SPECTRUM WITH 5000 PSI RANGE TRUNCATION	0.489	90.9
71 *	BS6.LLT6	BS6 SPECTRUM WITH 5000 PSI RANGE TRUNCATION	1.032	48.5
		HIGH INFREQUENT LOADS (HIL)		
72	BS1.HIL1	BS1 SPECTRUM WITH THE NUMBER OF TEN HIGHEST PEAKS INCREASED TO 100	0.989	18.2
73	BS1.HIL2	BS1 SPECTRUM WITH THE NUMBER OF TEN HIGHEST PEAKS INCREASED TO 200	0.989	18.2
74	BS1.HIL3	BS1 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 33,056 PSI	0.989	18.1
75	BS1.HIL4	BS1 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 27,750 PSI	0.989	18.1
76	BS3.HIL1	BS3 SPECTRUM WITH THE NUMBER OF TEN HIGHEST PEAKS INCREASED TO 100	0.489	127.1
77	BS3.HIL2	BS3 SPECTRUM WITH THE NUMBER OF TEN HIGHEST PEAKS INCREASED TO 200	0.489	127.1
78	BS3.HIL3	BS3 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 33,056 PSI	0.489	127.0
79	BS3.HIL4	BS3 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 27,750 PSI	0.489	127.0
80 *	BS6.HIL1	BS6 SPECTRUM WITH THE NUMBER OF TEN HIGHEST PEAKS INCREASED TO 100	1.032	75.0
81 *	BS6.HIL2	BS6 SPECTRUM WITH THE NUMBER OF TEN HIGHEST PEAKS INCREASED TO 200	1.032	75.1
82 *	BS6.HIL3	BS6 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 33,056 PSI	1.032	75.0
83 *	BS6.HIL4	BS6 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 27,750 PSI	1.032	75.0
84	BS1.HIL5	BS1 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 33,056 PSI AND THEIR NUMBER INCREASED TO 200	0.989	18.2
85	BS1.HIL6	BS1 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 27,750 PSI AND THEIR NUMBER INCREASED TO 200	0.989	18.2
86	BS3.HIL5	BS3 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 33,056 PSI AND THEIR NUMBER INCREASED TO 200	0.489	127.1
87	BS3.HIL6	BS3 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 27,750 PSI AND THEIR NUMBER INCREASED TO 200	0.489	127.0
88 *	BS6.HIL5	BS6 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 33,056 PSI AND THEIR NUMBER INCREASED TO 200	1.032	75.0
89	BS6.HIL6	BS6 SPECTRUM WITH THE TEN HIGHEST PEAKS SET EQUAL TO 27,750 PSI AND THEIR NUMBER INCREASED TO 200	1.032	75.0

*SPECTRA TESTED

TABLE 2-6 (CONT)

NO.	IDENTIF	DESCRIPTION	AVERAGE FLIGHT HOURS PER FLIGHT	AVERAGE NO. OF CYCLES PER FLIGHT
		CLIPPING OF LARGE LOADS (CLP)		
90	BS6.CLP1	BS6 SPECTRUM WITH STRESSES ABOVE 21,531 PSI SET EQUAL TO 21,531 PSI	1.032	75.0
91	BS6.CLP2	BS6 SPECTRUM WITH STRESSES ABOVE 17,942 PSI SET EQUAL TO 17,942 PSI	1.032	75.0
92 *	BS6.CLP3	BS6 SPECTRUM WITH STRESSES BELOW ZERO PSI SET EQUAL TO ZERO	1.032	69.5
93	BS6.CLP4	BS6 SPECTRUM WITH STRESSES BELOW −5000 PSI SET EQUAL TO −5000 PSI	1.032	73.5
		MISCELLANEOUS (MISC)		
94	BS6.MISC1	BS6 SPECTRUM WITH FLIGHT INCREMENTAL LOADS AVERAGING INTERVAL Δg = 0.05, AS OPPOSED TO 0.10 IN BS6	1.032	74.7
95 *	BS6.MISC2	BS6 SPECTRUM WITH FLIGHT INCREMENTAL LOADS AVERAGING INTERVAL Δg = 0.20, AS OPPOSED TO 0.10 IN BS6	1.032	155.2
96	BS6.MISC3	250 FLIGHT HOURS BS6 SPECTRUM SEQUENCE	1.032	74.9
97	BS6.MISC4	500 FLIGHT HOURS BS6 SPECTRUM SEQUENCE	1.032	75.0
98	BS6.MISC5	1250 FLIGHT HOURS BS6 SPECTRUM SEQUENCE	1.032	75.0
99 *	BS6.MISC6	SIMPLIFIED BS6 SPECTRUM	1.032	73.0
100	BS1.MISC7	EFFECT OF LOAD ALLEVIATION SYSTEM ON BS1 SPECTRUM (FLIGHT 1.0g STRESSES INCREASED AND INCREMENTAL STRESSES DECREASED)	0.989	16.7
101	BS3.MISC8	600 FLIGHT BS3 SPECTRUM SEQUENCE	0.489	124.8
102 *	BS1.MISC9	BS1 SPECTRUM WITH DIFFERENT SEQUENCE OF CYCLES WITHIN FLIGHT (NORMAL IN-AIR SEGMENT SEQUENCE IGNORED)	0.989	22.4
103	BS6.MISC10	BS6 SPECTRUM WIHTOUT TAXI, LANDING IMPACT OR GAG CYCLES	1.032	67.8
		COMBINED (COMB)		
104	BS6.COMB1	BS6 SPECTRUM WITH DIFFERENT (A6PA) VPC AND RANGE TRUNCATION = 3500 PSI	1.032	117.8
105	BS6.COMB2	BS6 SPECTRUM WITH DIFFERENT (A6PA) VPC AND RANGE TRUNCATION = 3000 PSI	1.032	168.4
106 *	BS6.COMB3	BS6 SPECTRUM WITH 15 PERCENT HIGHER STRESSES AND RANGE TRUNCATION = 3500 (1.15) PSI	1.032	128.5
107	BS6.COMB4	BS6 SPECTRUM WITH 15 PERCENT HIGHER STRESSES AND RANGE TRUNCATION = 3000 (1.15) PSI	1.032	175.6
108	BS6.COMB5	BS6 SPECTRUM WITH 10 PERCENT LOWER STRESSES AND RANGE TRUNCATION = 4500 (0.9) PSI	1.032	54.0
109 *	BS6.COMB6	BS6 SPECTRUM WITH 10 PERCENT LOWER STRESSES AND RANGE TRUNCATION = 3500 (0.9) PSI	1.032	128.5
110	BS6.COMB7	BS6 SPECTRUM WITH THE TEN HIGHEST PEAKS = 33,056 PSI AND THEIR NUMBER INCREASED TO 200, AND RANGE TRUNCATION = 3500 PSI	1.032	128.6
111	BS6.COMB8	BS6 SPECTRUM WITH THE TEN HIGHEST PEAKS = 27,750 PSI AND THEIR NUMBER INCREASED TO 200, AND RANGE TRUNCATION = 3500 PSI	1.032	75.1
112	BS6.COMB9	BS6 SPECTRUM WITH 15 PERCENT HIGHER STRESSES (RT = 4000 x 1.15) AND THE TEN HIGHEST PEAKS = 27,750 PSI, AND THEIR NUMBER INCREASED TO 200	1.032	75.1
113	BS6.COMB10	BS6 SPECTRUM WITH 26 PERCENT LOWER STRESSES (RT = 4000 x 0.74) AND THE TEN HIGHEST PEAKS = 27,750 PSI, AND THEIR NUMBER INCREASED TO 200	1.032	75.1
114 *	BS6.COMB11	BS6 SPECTRUM WITHOUT TAXI, LANDING IMPACT OR GAG CYCLES, FLIGHT 1.0g STRESSES = 0, AND THEN STRESSES MULTIPLIED BY 2.0	1.032	66.8
115 *	BS6.COMB12	BS6 SPECTRUM WITH THE NUMBER OF THE TEN HIGHEST PEAKS INCREASED TO 100 AND RANGE TRUNCATION = 3500 PSI	1.032	128.6
116 *	BS6.COMB13	SPECTRUM BS6.COMB11 WITH 35 PERCENT HIGHER STRESSES	1.032	66.8

* SPECTRA TESTED

TABLE 2-7

MAJOR FEATURES OF BASELINE SPECTRUM BS6 AND VARIATIONS

	SPECTRUM BS6	VARIATIONS LOW	VARIATIONS HIGH
PER SPECTRUM:			
FLIGHT HOURS	2,500	249	2,500
FLIGHTS	2,422	243	6,095
LANDINGS	3,843	388	25,000
TOTAL CYCLES	181,644	8,842	1,578,809
LARGEST PEAK, PSI (PERCENT LIMIT)	23,923 (69 PERCENT)	16,675 (48 PERCENT)	33,167 (96 PERCENT)
SMALLEST VALLEY, PSI	−24,298	−32,802	0
AVERAGE NUMBER OF:			
FLIGHT HOURS/FLIGHT	1.032	0.41	5.725
TOTAL CYCLES/FLIGHT	75.0	15.6	308.8
TAXI CYCLES/LANDING	3.5	1.0	25.9
MANEUVER AND GUST CYCLES/FLIGHT	71.5	10.9	303.4
RANGE TRUNCATION, PSI	4,000	3,000	5,000
VALLEY/PEAK COUPLING	RANDOM	RESTRICTED	RESTRICTED

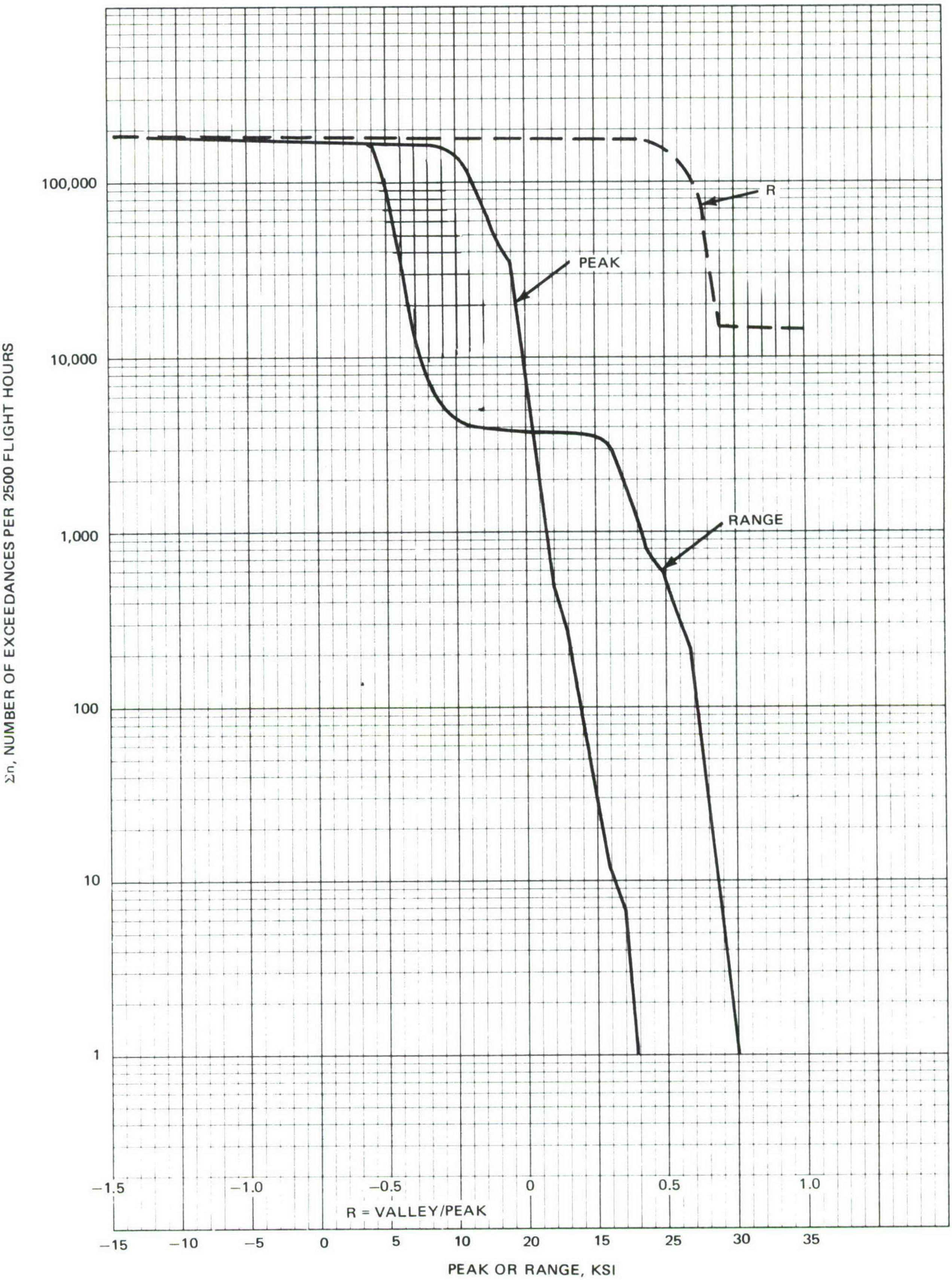


FIGURE 2-6. SPECTRUM BS6 PEAK, RANGE AND R EXCEEDANCES

TABLE 2-8

SPECTRUM BS6 PEAK AND RANGE VERSUS R OCCURRENCES FOR 2500 FLIGHT HOURS

PEAK, KSI	R = −1.4	−1.2	−1.0	−0.8	−0.6	−0.4	−0.2	0	0.2	0.4	0.6	0.8	1.0		TOTAL
−12 TO −11														47	47
−11 TO −10															0
−10 TO −9														9	9
−9 TO −8															0
−8 TO −7														201	201
−7 TO −6														914	914
−6 TO −5														1,373	1,373
−5 TO −4														3,084	3,084
−4 TO −3														7,026	7,026
−3 TO −2														736	736
−2 TO −1														54	54
−1 TO 0														2	2
0 TO 1															0
1 TO 2															0
2 TO 3															0
3 TO 4															0
4 TO 5	65	9	28	17	31	25	52	73	84						384
5 TO 6	41	13	4	24	29	24	45	40	74	64					358
6 TO 7	6	2		2	4	5	7	15	20	34					95
7 TO 8	56	23							4	58	105				246
8 TO 9	147	1	27					4	49	734	3,235				4,197
9 TO 10	46	300	17	1				4	48	760	16,044				17,220
10 TO 11	3	160	238	457	5	6		4	38	671	12,069	20,693			34,344
11 TO 12		3	206	252	68			1	10	695	8,973	21,625			31,833
12 TO 13		100	2	167	399	93		1	19	406	13,372	21,502			36,061
13 TO 14			33	367	321	55			4	207	2,993	5,036			9,016
14 TO 15			4	72	113	60			8	201	5,824	20,096			26,378
15 TO 16					15	17	1		4	50	4,895	1,046			6,028
16 TO 17					1	2	2			43	1,051	466			1,565
17 TO 18										5	98	83			186
18 TO 19					1	2				11	176	7			197
19 TO 20										5	47	11			63
20 TO 21										2	9	5			16
21 TO 22											4				4
22 TO 23										2	4				6
23 TO 24											1				1
TOTAL	364	611	559	1359	987	289	107	142	362	3948	68,900	90,570	0	13,446	181,644

(Continued on next page.)

TABLE 2-8 (Cont'd)

SPECTRUM BS6 PEAK AND RANGE VERSUS R OCCURRENCES FOR 2500 FLIGHT HOURS (CONT)

RANGE, KSI	R = –1.4	–1.2	–1.0	–0.8	–0.6	–0.4	–0.2	0	0.2	0.4	0.6	0.8	1.0		TOTAL
4 TO 5								28	149	526	22,156	51,177		922	74,958
5 TO 6							15	75	20	746	21,265	39,177		4,844	66,142
6 TO 7						9	76	10	45	527	19,918	209		4,136	24,930
7 TO 8					20	35	6	15	47	1035	4,636	7		2,063	7,864
8 TO 9					31	5	7	3	17	550	371			1,350	2,346
9 TO 10			10	25	9			4	40	382	476			102	1,048
10 TO 11	9	9	18	4		5		1	12	130	60			25	273
11 TO 12		10	4		4			2	20	36	12			4	92
12 TO 13	19	3		2				3	9	12	5				53
13 TO 14	12							1	2	4	1				20
14 TO 15	11	2							1						14
15 TO 16	10														10
16 TO 17	11														11
17 TO 18	2	23				6									31
18 TO 19	8		35	1	5	36									85
19 TO 20	3		8	2	1	103									117
20 TO 21	58	4	1	349		23									435
21 TO 22	148		206	314	429	15	1								1,113
22 TO 23	12	312	149	120	344	33	1								971
23 TO 24	42	122	55	79	121	7	1								427
24 TO 25	12	26	34	23	16	6									117
25 TO 26	4		2	356	1	4									367
26 TO 27	2		17	1		2									22
27 TO 28		96	1	70											167
28 TO 29		4	15	1	4										24
29 TO 30	1		4		1										6
30 TO 31					1										1
TOTAL	364	611	559	1359	987	289	107	142	362	3948	68,900	90,570	0	13,446	181,644

2.3.2 Mission Mix (MM)

Fourteen spectra were generated to represent individual flights as well as mission mixes different from the baseline, with emphasis on training, touch-and-go landings, payloads and time in low-level penetration flying. Together with the baseline spectra, they represent a cross section and possible extremes of the C-15 utilization.

2.3.3 Sequence of Missions (SM)

The question raised here is whether the sequence of missions has an effect on crack growth. The four spectra generated in this category considered ordered sequences on the basis of the largest peak per flight, a different random sequence from that of the baseline and a specific sequence with emphasis on grouping training missions.

2.3.4 Individual Flight Length (FL)

The flight lengths of flights 1A and 1B were varied between flights with no cruise to flights 4.0 hours long. In varying the flight lengths, fuel was also changed to reflect different amounts of fuel burned.

2.3.5 Flight Segments (FS)

The five spectra were generated to study the effect of leaving out landing impact cycles, simplifying the gust spectrum (all climb and all descent flaps up segments equivalenced to one climb and one descent segment by considering average speed and turbulence parameters), or reducing the number of stress transfer functions by using the cruise segment transfer function for climb and descent segments.

2.3.6 Exceedances Spectra (ES)

The number of occurrences or the slope of the maneuver and gust load factor spectra were increased or decreased 15 percent in order to reflect possible variations between individual fleet aircraft.

2.3.7 Design Stress Level (DSL)

All stresses in a given baseline spectrum were increased or decreased by multiplying them by a constant. This variation is viewed as representing design stress changes or reflecting a change in usage severity. It should be noted here that in the loading sequence generation program multiplication of all stresses by a constant is done after the range truncation. Because of this and because the baseline spectrum input range truncation level was retained, the variation spectra truncation levels are different from the baseline spectra by the multiplication constant.

2.3.8 Valley-Peak Coupling (VPC)

All six baseline spectra were regenerated using the alternative (program A6PA) valley-peak coupling method. This method restricts the coupling to cycles with equal incremental load factors above and below 1.0g ($1 \pm \Delta$ g) or to making the 1.0g load the peak or valley of the cycle.

2.3.9 Low Load Truncation (LLT)

Practical cost and time consideration in analysis and testing require elimination of cycles which do not contribute (or contribute very marginally) to crack growth. In this study, elimination of such cycles was investigated as a function of the cycle range, regardless of the R value. Spectra were generated with range truncation (RT) levels of 3000, 3500, 4000 (baseline spectra), 4500 and 5000 psi. In addition, two spectra were generated to investigate the effect of compression-compression (R >1.0) cycles, which in this case were the taxi cycles.

2.3.10 High Infrequent Loads (HIL)

High infrequent tension stresses in a spectrum loading are known to slow down (retard) the crack growth rate at subsequent lower loads. The frequency of occurrence and the magnitude of such loads may significantly vary from aircraft to aircraft or from one time interval to another in the same aircraft. The 10 highest peaks (19,500 to 24,600 psi) in the baseline spectra were chosen as the variables to investigate this effect. The frequency of occurrence and/or the magnitude of these 10 highest peaks were increased as follows: frequency of occurrence to 100 or 200, magnitude to 27,750 psi (80 percent limit) or 33,056 psi (95 percent limit).

2.3.11 Clipping of Large Loads (CLP)

This category of variations is similar to the HIL, except that the magnitude of high infrequent loads was reduced. In the case of tension high infrequent loads, all peaks above 21,531 psi (value of approximately tenth highest load in baseline spectrum) and above 17,942 psi (value of approximately 300th highest load in baseline spectrum) were set to equal these values. To investigate the effect of compression loadings, the baseline spectrum was clipped at zero (no compression loads in the spectrum) and at -5000 psi.

2.3.12 Miscellaneous (MISC)

A number of miscellaneous parameters were investigated in this category: (1) The averaging interval of the maneuver and gust spectra: $\Delta g = 0.05$ and 0.20 versus 0.10 in the baseline spectrum; (2) Spectrum length: shorter spectra than the baseline; (3) Increase of flight 1.0g stresses (14 percent) and decrease of the stress amplitude (10 percent) to simulate the effect of a loads alleviation system; (4) Ignoring of the normal flight segment sequence to study effect of cycles within a flight; (5) Removal of taxi, landing impact and GAG cycles to show the effect of

GAG cycles; and (6) Simplification of a baseline spectrum. This requires more explanation. Sometimes, for practical reasons, it is desired to have a simpler spectrum in place of random cycle-by-cycle spectrum. For this reason, a simplified spectrum (BS6.MISC6) was derived using the following procedures:

1. Use the (peak, R) distribution of the random spectrum.

2. Retain the peak magnitudes of the 25 highest peaks.

3. Average the maneuver and gust lower peak loadings to reduce the number of cycle types to a manageable number. Retain the same number of cycles.

4. Calculate one average ground-to-air cycle.

5. Calculate an average taxi cycle. Retain the same number of cycles.

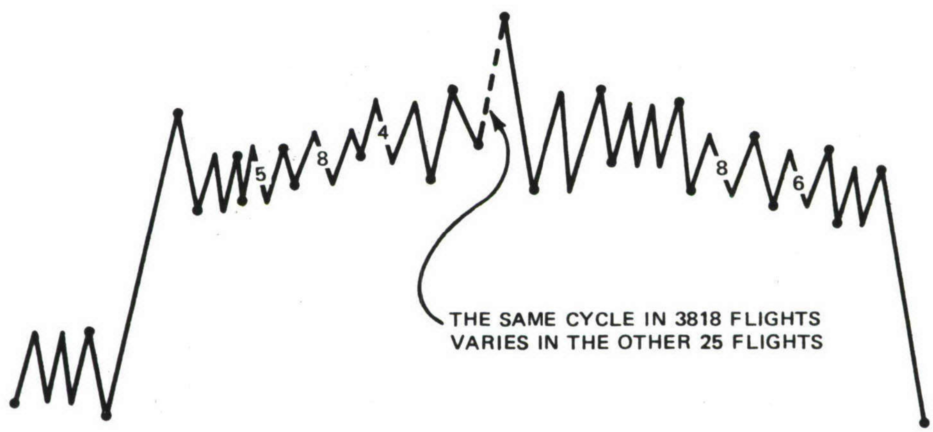
6. Eliminate landing impact cycles.

7. Put the same number of cycles in each "flight," with a "flight" for each landing.

8. Order maneuver and gust cycles within a "flight" in a lo-hi-lo sequence according to cycle peak.

9. General rules that were followed retain most of the cycles, reduce the number of different loading cycles by averaging, and retain the high infrequent loads without averaging.

The resulting 46-cycle simplified "flight" (3843 such "flights" in the 2500-flight-hour spectrum) was reduced to this form:



A total of 12 types of loading cycles define the spectrum.

2.3.13 Combined (COMB)

Thirteen spectra were generated to study the effect of the following combined variables: valley-peak coupling and range truncation, range truncation and design stress level, high infrequent loads and range truncation, high infrequent loads and design stress level. One other type of spectrum was generated in this category that is distinctly different from all other spectra. These are spectra BS6.COMB11 and BS6.COMB13 which, in a broad sense, have a mean of zero, most cycles have a negative R and can be considered, in its format, to be representative of a vertical tail spectrum.

As a summary of some of the spectra variations, Figure 2-7 schematically shows the different ways that these variations affect the peak load exceedances spectra.

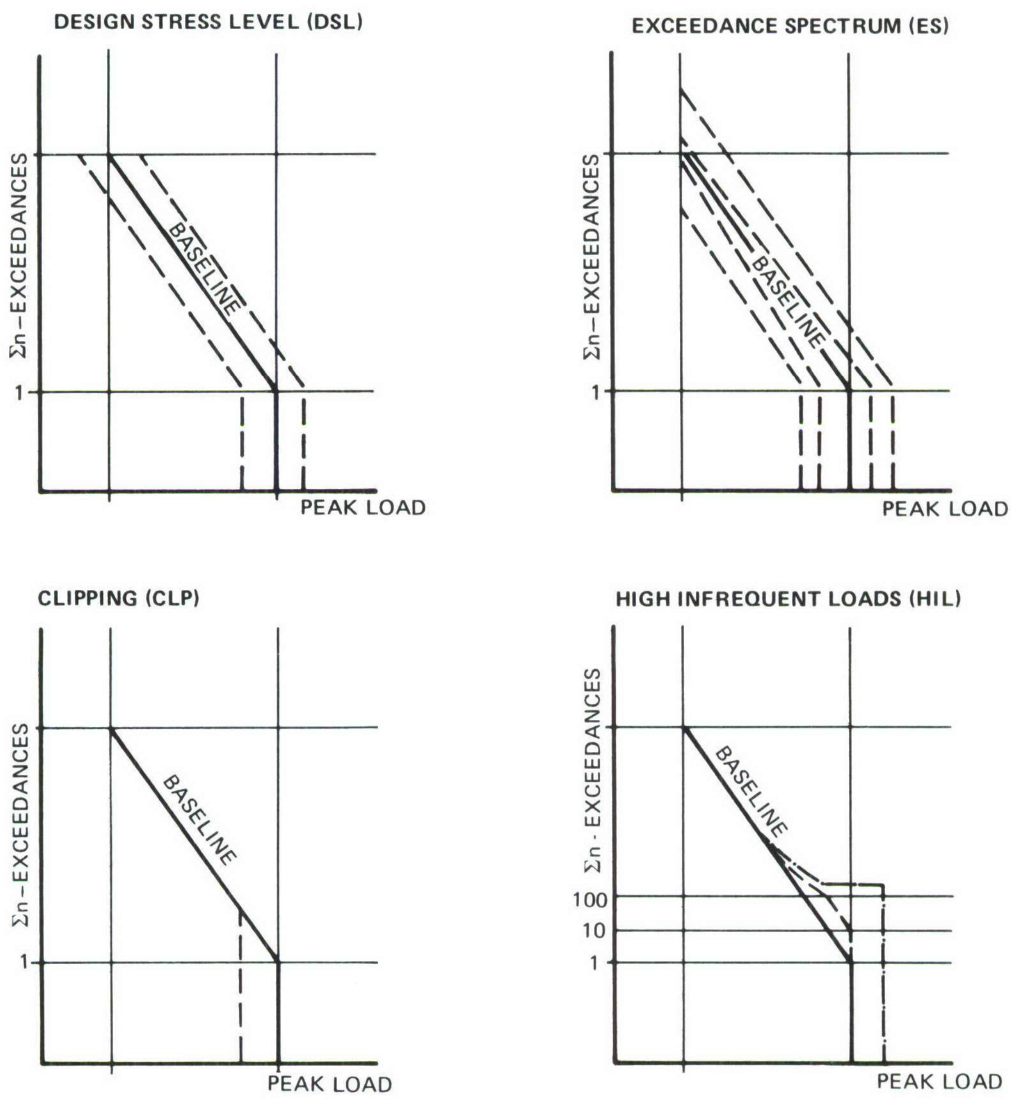


FIGURE 2-7. SCHEMATIC EXAMPLES OF SPECTRA VARIATIONS EFFECT ON PEAK LOADS EXCEEDANCES.

SECTION 3

CRACK GROWTH ANALYSIS

Crack growth analyses were performed on all 116 spectra described in Section 2. The objectives were to establish the effect of spectra variations on crack growth and to produce information to help in the selection of spectra for testing. All analyses were performed to propagate a through-the-thickness 0.03-inch crack, out of one side of a 0.25-inch-diameter open hole in a 9.0-inch-wide panel for 1.0 inch. The spectra, as described in Appendix B, were repeated cycle-by-cycle until 1.0 inch of cracking was attained.

3.1 ANALYSIS METHOD SELECTION

The program plan called for the selection of the analysis method on the basis of a baseline spectrum test results. This selection was to be made before any additional tests were run.

Tests were run on two specimens (A1 and A2) with the composite baseline spectrum BS6. The test results are given in Table C-4. Each specimen had a crack out of an open hole and out of a hole filled with a fastener. Only the crack data out of an open hole were used in the analysis-test correlation to select the analysis method.

Analytical prediction of crack growth rates under spectrum loadings require:

1. Knowledge of the spectrum loading sequence.

2. Basic crack growth rates under constant amplitude loading for the material in question, in the form of da/dN versus ΔK for various R values.

3. Stress intensity factor, K, solution for the crack-specimen geometry in question. K, psi$\sqrt{\text{in.}}$, is a function of crack length-specimen geometry and stress.

4. Method, model or technique to integrate the above three items and to account for loads interaction effects on crack growth behavior.

Item 1 was developed in this program. Item 2, see Section 3.2, was partly generated in this program, partly obtained from another program. Item 3, the stress intensity factor solution is readily available for the specimen geometry in question, through-crack out of one side of hole in a finite width plate:

$$K = \sigma\sqrt{\pi a \sec\left(\frac{\pi a}{W}\right)} \cdot \beta$$

where

σ = gross area stress, psi

a = crack length, from the edge of hole, in.

W = panel width, in.

β = Bowie hole correction factor, Reference 2

The relationships between K, σ and a, for the specimen of this program is given in Figure 3-1. The analyses methods under Item 4 can be divided into two groups: the method which does not account for loads interaction effects, hereafter to be referred to as the 'linear' model, and all the other methods, which, by considering yield zone sizes, residual stress fields or crack closure phenomena attempt to account for the loads sequence and interaction effects. These latter methods are summarized in Reference 3. All of these methods primarily concentrate on the so called 'retardation' effect, i.e., slowdown of the crack growth rate at lower loads after the application of a higher load.

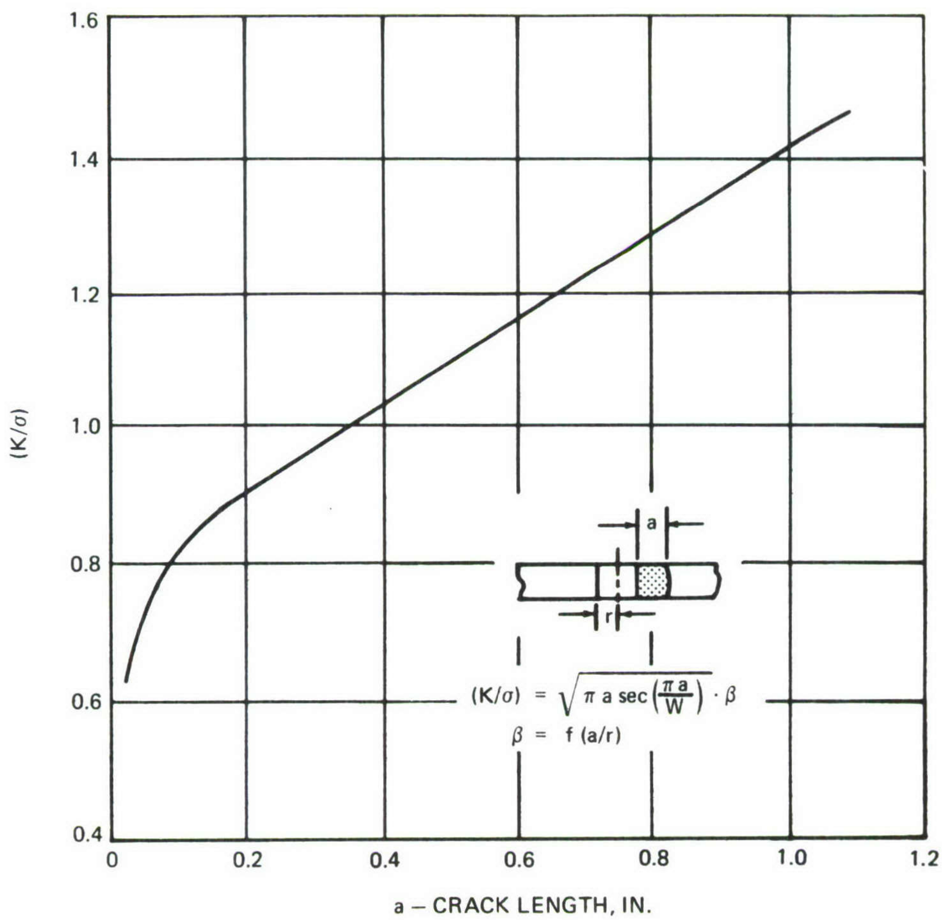


FIGURE 3-1. STRESS INTENSITY FACTOR FOR CRACK OUT OF ONE SIDE OF 1/4-INCH-DIAMETER HOLE, PLATE WIDTH W ≥ 9.0 IN.

As an initial attempt in correlating analysis and spectrum BS6 test results, the linear and generalized Willenborg (References 4 and 5) models were used. Compression stresses were considered in the calculation of ΔK and R in both analyses. In the crack growth computer program, da/dN data were input in a tabular form, see Paragraph 3.2, for a family of R values. The generalized Willenborg model in the computer program was handled as,

$$\Delta\sigma_{EFF} = \Delta\sigma$$

$$R_{EFF} = (\sigma_{MIN} - \sigma_{RED})/(\sigma_{MAX} - \sigma_{RED})$$

$$\sigma_{RED} = \phi\,(\sigma_{a_p} - \sigma_{MAX})$$

$$\phi = [1 - K_o/K_{MAX})]\ (1/1.3)$$

$$\sigma_{a_p} = \frac{\sigma_y}{\beta}\sqrt{\left(\frac{a_p - a}{a}\right) c_z}$$

where

$\Delta\sigma$ = stress range

σ_{MIN} = minimum stress

σ_{MAX} = maximum stress

K_o = da/dN threshold value at $R = 0$

K_{MAX} = maximum stress intensity factor

σ_y = yield stress

β = correction factor for specimen geometry effect in K calculation

a_p = distance to the end of the preceding higher load plastic zone

a = crack length

c_z = constant in the calculation of the plastic zone size, $R_y = \frac{1}{c_z \pi}\left(\frac{K_{MAX}}{\sigma_y}\right)^2$

The following values were used in the analysis:

$K_o = 3\ \text{ksi}\sqrt{\text{in.}}$

σ_y = 66.574 ksi for 7475-T7651

c_z = $4\sqrt{2}$, plain strain condition.

The analyses and test results are compared in Figure 3-2. In general, test results agree well with the linear model analysis, but the generalized Willenborg model predicts much slower crack growth. Note that the analysis represents cracking only on one side of the hole, whereas test results at longer crack length include cracking on the other side. For this reason, and because most of the life is spent in the short crack range, a direct comparison between test and analysis results is made over the first half inch of cracking, a = 0.03 to 0.53 inch:

	Flight Hours	Test/Analyses
Test (average of two tests)	4,118	–
Analysis – Linear	4,212	0.98
Analysis – Generalized Willenborg	6,600	1.57

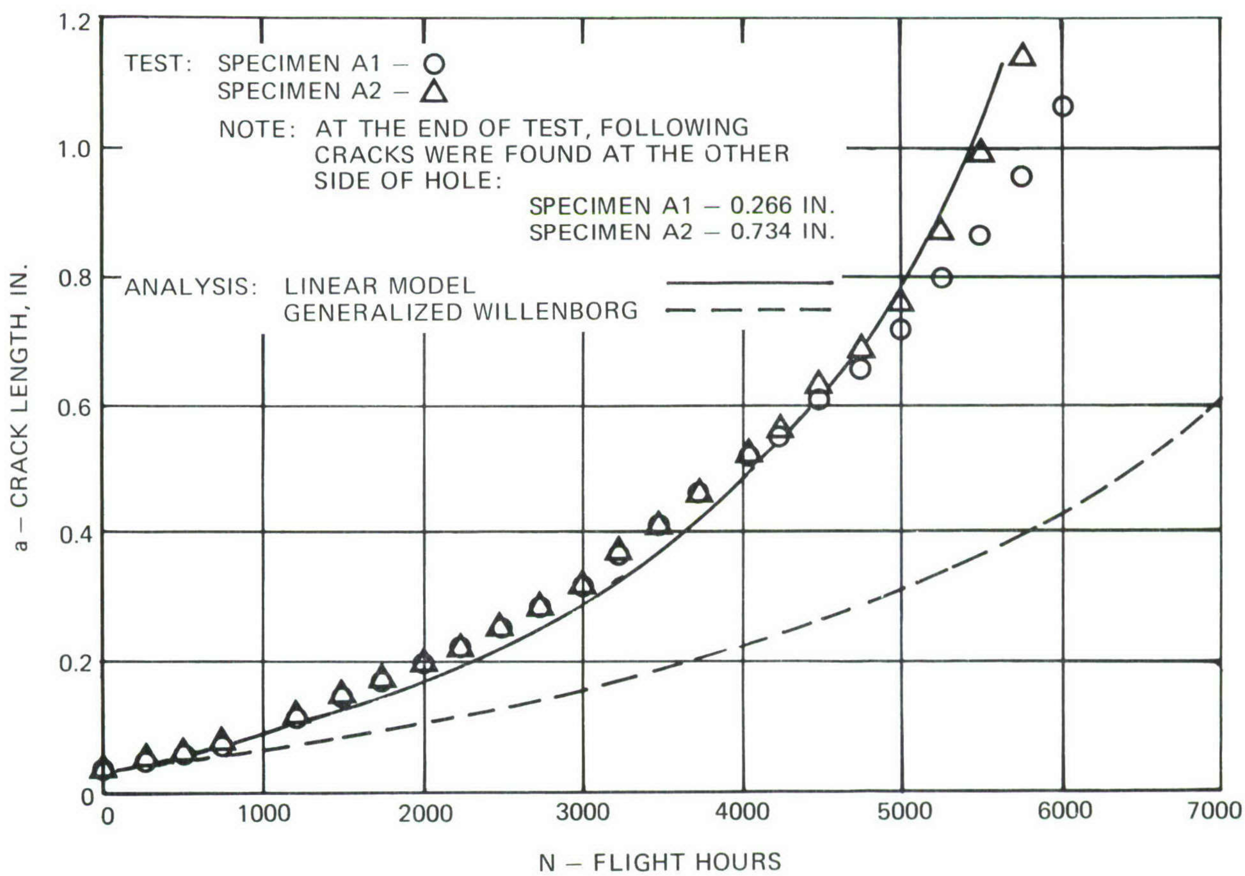


FIGURE 3-2. TEST VERSUS ANALYSIS CRACK GROWTH COMPARISON, OPEN HOLE, SPECTRUM BS6

Any adjustments in the generalized Willenborg model, for the purpose of correlating better with test results, could be accomplished only by removing its retardation features until the model became equivalent to the linear model. As a consequence of this, the linear model was chosen to perform the crack growth analysis of the spectra variations. The reason that the linear model correlates well with the test result is believed to be in the nature of the loading spectrum and the use of good representative da/dN data. The features of the loading spectrum are such that its retardation and acceleration contributions tend to balance each other and produce good correlation with the linear model.

3.2 CRACK GROWTH da/dN DATA

The major portion of the constant amplitude da/dN crack growth data was obtained from Reference 6. These data were obtained on center cracked panels (width = 4 and 12 inches) with a starting total crack length of 0.5 inch. Additional data were generated in this program on specimens with through-the-thickness cracks out of 1/4- or 3/16-inch-diameter open or fastener filled hole. The data were generated to provide a comparison between results from two different types of specimens as well as to obtain data in areas of the spectrum loading not covered by Reference 6. These data are given in Appendix C, Tables C-2 and C-3. The data in Reference 6 and in this program were obtained from specimens made from the same lot and heat of material used to make all other specimens in this program. All of the Reference 6 and open hole data from this program are shown in Figure 3-3. The data from fastener filled holes were not used. The data, as used in a tabular format, in the crack growth computer program are given in Table 3-1.

3.3 CRACK GROWTH ANALYSIS RESULTS

Linear model cycle-by-cycle crack growth analysis results for the 116 spectra are given in Table 3-2. The results are given in terms of life (cycles and flight hours) to propagate the crack from 0.03 to 0.53 and to 1.03 inches. Sample crack growth curves for baseline spectra are shown in Figure 3-4. Evaluation of these results in the light of spectra variations and test results is given in Section 5. However, at this point it is worthwhile to make the following observations about these analysis results:

1. The crack growth life has been presented in terms of cycles and flight hours, because the former is a typical counting parameter in spectra generation and crack growth analysis and the latter is the most common service time parameter kept for each aircraft. Two other parameters could be used to designate the life: flights and landings. A flight is usually associated with one landing, except when a number of touch-and-go landings are performed during training flights. To illustrate the significance of the life parameter when comparing spectra, Figure 3-5 shows the crack growth life in terms of cycles, landings, flights and flight hours for the six baseline spectra. The shortest life is due to spectrum BS3 in three of the four parameters, but if one chose the longest life, four different spectra would be

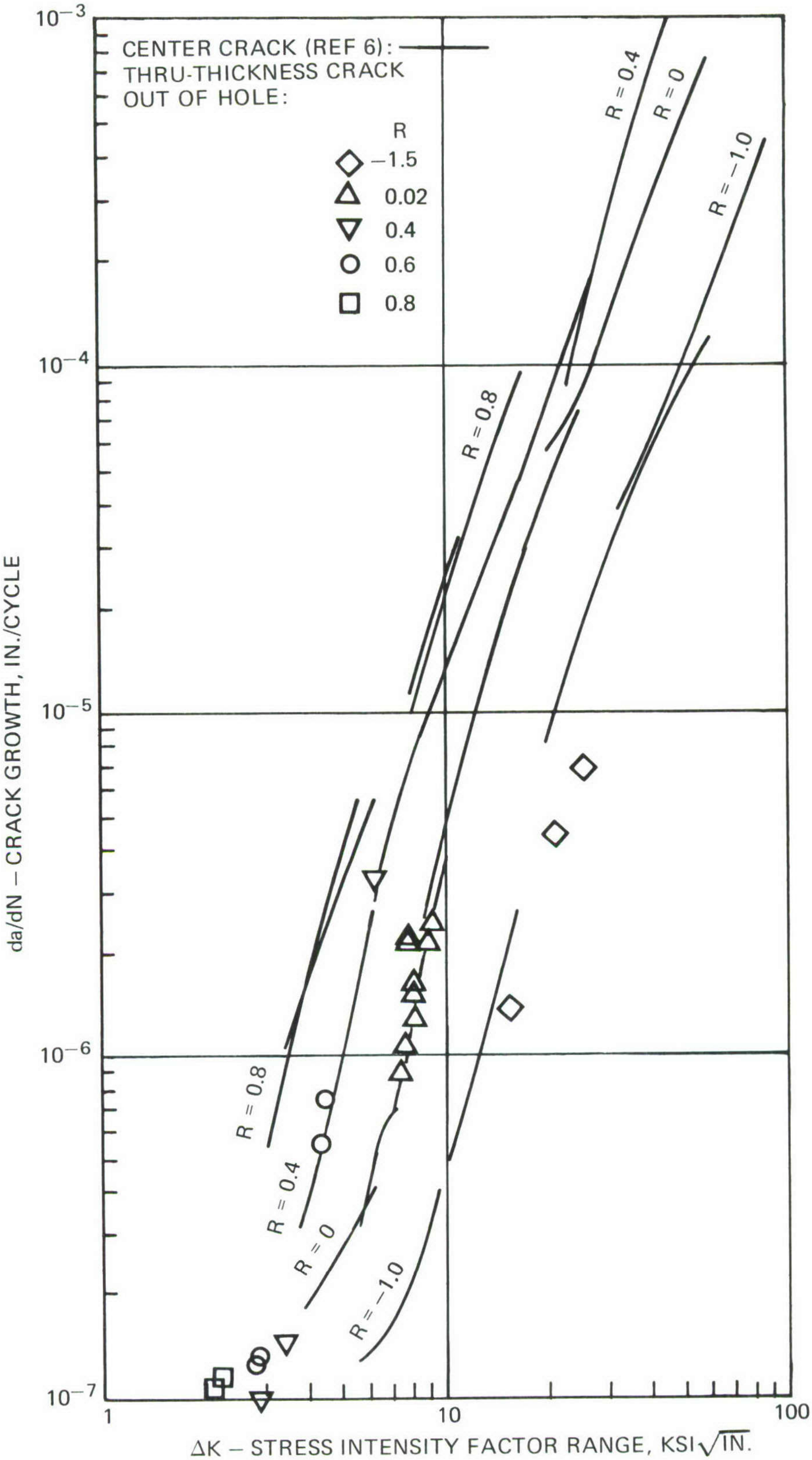


FIGURE 3-3. 7475-T7651 BARE PLATE, t = 0.25 IN., da/dN DATA (L-T), ROOM TEMPERATURE AND AIR

TABLE 3-1

CRACK GROWTH da/dN DATA (L-T) USED IN CRACK GROWTH ANALYSIS 7475-T7651 BARE PLATE, t = 0.25 INCH ROOM TEMPERATURE AND AIR

R = – 1.5		–1.0		0		0.4		0.8	
ΔK	da/dN	ΔK	da/dN	ΔK	da/dN	ΔK	da/dN	ΔK	da/dN
1.2*	1×10^{-10}	1.1*	1×10^{-10}	1*	1×10^{-10}	1.0*	4×10^{-10}	1*	5×10^{-9}
7.15*	1×10^{-7}	6*	1×10^{-7}	4.2*	1×10^{-7}	3.1	1×10^{-7}	2.05	1×10^{-7}
7.5*	1.2×10^{-7}	7	1.65×10^{-7}	5.0*	2.2×10^{-7}	3.4	1.7×10^{-7}	2.2	1.2×10^{-7}
8*	1.5×10^{-7}	8	2.35×10^{-7}	5.4	3.0×10^{-7}	3.6	2.2×10^{-7}	2.5	2.25×10^{-7}
9*	2.1×10^{-7}	9	3.4×10^{-7}	5.8	3.8×10^{-7}	3.8	3.0×10^{-7}	2.75	3.3×10^{-7}
10*	3.1×10^{-7}	10	4.6×10^{-7}	6	4.5×10^{-7}	3.9	3.4×10^{-7}	3.0	5.0×10^{-7}
12*	5.3×10^{-7}	12	8.5×10^{-7}	7	7.2×10^{-7}	4.0	4.0×10^{-7}	3.5	9.5×10^{-7}
15	1.2×10^{-6}	14	1.7×10^{-6}	8	1.45×10^{-6}	4.5	5.8×10^{-7}	4.0	1.7×10^{-6}
18	2.5×10^{-6}	17	4.3×10^{-6}	9	2.9×10^{-6}	5.0	1.1×10^{-6}	4.5	2.7×10^{-6}
20	3.6×10^{-6}	20	8.7×10^{-6}	10	4.6×10^{-6}	6.0	2.45×10^{-6}	5.0	4.0×10^{-6}
25	6.6×10^{-6}	25	1.65×10^{-5}	12	9.2×10^{-6}	7.0	4.9×10^{-6}	6.0	7×10^{-6}
30*	1.1×10^{-5}	30	2.65×10^{-5}	14	1.55×10^{-5}	8.0	7.7×10^{-6}	7.0	1.05×10^{-5}
35*	1.6×10^{-5}	40	5.6×10^{-5}	17	2.8×10^{-5}	9.0	1.02×10^{-5}	8.0	1.48×10^{-5}
40*	2.3×10^{-5}	50	9.7×10^{-5}	20	4.3×10^{-5}	10.0	1.3×10^{-5}	9.0	1.95×10^{-5}
50*	4.0×10^{-5}	60	1.62×10^{-4}	25	7.7×10^{-5}	12.0	2.1×10^{-5}	10.0	2.55×10^{-5}
60*	6.5×10^{-5}	70	2.45×10^{-4}	30	1.25×10^{-4}	14.0	3.0×10^{-5}	12.0	4.0×10^{-5}
70*	9.5×10^{-5}	80	3.5×10^{-4}	40	2.8×10^{-4}	17.0	4.9×10^{-5}	14.0	5.7×10^{-5}
80*	1.4×10^{-4}	90	4.7×10^{-4}	50	5.0×10^{-4}	20.0	7.5×10^{-5}	17.0	1.3×10^{-4}
100*	2.4×10^{-4}	100	6.2×10^{-4}	60	7.7×10^{-4}	25.0	1.45×10^{-4}	20	2.9×10^{-4}
400*	1×10^{-2}	300*	1×10^{-2}	150*	1×10^{-2}	100*	1×10^{-2}	44*	1×10^{-2}

R = STRESS RATIO = $\sigma_{MIN}/\sigma_{MAX}$
ΔK = STRESS INTENSITY FACTOR, KSI$\sqrt{IN.}$
da/dN = CRACK GROWTH UNDER CONSTANT AMPLITUDE LOADING, IN./CYCLE
*EXTRAPOLATED FOR ANALYSIS INTERPOLATION.

TABLE 3-2

LINEAR CRACK GROWTH ANALYSIS RESULTS

SPECTRUM		LIFE TO PROPAGATE THE CRACK			
		a = 0.03 → 0.53 IN.		a = 0.03 → 1.03 IN.	
NO.	IDENTIFICATION	CYCLES	FLIGHT HOURS	CYCLES	FLIGHT HOURS
1	BS1	297,818	16,255	394,089	21,510
2	BS2	326,737	78,347	427,922	102,724
3	BS3	292,031	1,124	380,441	1,465
4	BS4	279,968	3,518	371,009	4,662
5	BS5	640,722	8,124	803,133	10,183
6	BS6	306,065	4,212	400,112	5,506
7	BS1.MM1A	668,178	33,719	868,471	43,827
8	BS1.MM1B	193,365	11,670	257,307	15,529
9	BS3.MM3A	429,535	1,097	550,754	1,406
10	BS3.MM3B	205,707	1,138	270,095	1,505
11	BS4.MM4A	361,558	4,812	475,963	6,335
12	BS4.MM4B	190,352	1,992	253,304	2,651
13	BS45.MM7	376,834	4,751	489,614	6,173
14	BS4.MM8	298,901	3,011	393,976	3,969
15	BS123.MM9	290,952	4,095	380,640	5,357
16	BS6.MM10	318,706	3,711	418,382	4,872
17	BS13.MM11	440,852	2,604	563,232	3,326
18	BS123.MM12	209,223	4,957	276,094	6,542
19	BS6.MM13	300,616	14,457	396,231	19,055
20	BS6.MM14	311,607	2,504	406,660	3,268
21	BS1.SM1	297,691	16,266	392,661	21,456
22	BS6.SM1	294,375	4,051	415,950	5,723
23	BS6.SM4	308,886	4,245	402,912	5,537
24	BS6.SM5	307,535	4,226	399,983	5,496
25	BS1A.FL1	602,934	17,632	785,714	22,977
26	BS1A.FL2	682,528	62,048	881,738	80,158
27	BS1A.FL3	595,874	90,284	770,933	116,808
28	BS1B.FL1	192,211	7,005	255,906	9,327
29	BS1B.FL2	216,932	19,902	287,738	26,398
30	BS1B.FL3	201,480	27,600	270,538	37,060
31	BS6.FS1	305,102	4,217	399,186	5,517
32	BS6.FS2	307,768	4,262	401,439	5,559
33	BS1.FS3	294,397	18,475	390,974	24,535
34	BS1.FS4	290,934	16,021	384,667	21,182
35	BS1.FS5	319,041	17,569	420,623	23,163
36	BS6.ES1	307,381	3,728	402,778	4,884
37	BS6.ES2	305,045	4,843	397,995	6,319
38	BS6.ES3	282,909	2,760	368,501	3,594
39	BS6.ES4	329,267	7,006	430,729	9,165

TABLE 3-2 (Continued)

LINEAR CRACK GROWTH ANALYSIS RESULTS

SPECTRUM		LIFE TO PROPAGATE THE CRACK			
		a = 0.03 → 0.53 IN.		a = 0.03 → 1.03 IN.	
NO.	IDENTIFICATION	CYCLES	FLIGHT HOURS	CYCLES	FLIGHT HOURS
40	BS1.DSL1	177,217	9,683	240,169	13,123
41	BS3.	169,672	653	228,092	878
42	BS4.	166,848	2,096	227,072	2,853
43	BS6.	178,800	2,460	239,100	3,290
44	BS1.DSL2	454,563	24,838	589,318	32,201
45	BS3.	450,977	1,736	577,850	2,225
46	BS4.	428,096	5,378	555,584	6,980
47	BS6.	473,550	6,516	607,425	8,358
48	BS6.DSL3	1,120,050	15,412	1,396,125	19,211
49	BS6.DSL4	99,750	1,373	139,350	1,917
50	BS1.VPC1	263,306	15,501	351,691	20,704
51	BS2.	257,368	72,942	341,279	96,724
52	BS3.	159,144	1,024	214,472	1,380
53	BS4.	268,066	3,362	356,332	4,469
54	BS5.	580,223	6,330	730,802	7,972
55	BS6.	204,448	3,843	274,775	5,165
56	BS1.LLT1	259,459	16,449	345,088	21,878
57	BS3.	223,041	1,199	293,020	1,575
58	BS4.	232,024	3,587	309,920	4,792
59	BS6.	233,226	4,457	308,178	5,890
60	BS1.LLT2	461,746	14,008	601,600	18,251
61	BS3.	403,884	864	520,521	1,113
62	BS4.	429,638	3,070	561,150	4,010
63	BS6.	418,268	3,359	539,700	4,334
64	BS1.LLT3	559,930	14,573	725,724	18,888
65	BS3.	511,373	810	656,818	1,040
66	BS4.	519,960	3,106	675,692	4,036
67	BS6.	538,038	3,162	695,025	4,085
68	BS6.LLT4	284,455	4,218	371,942	5,515
69	BS6.LLT5	451,673	4,213	589,986	5,503
70	BS3.LLT4	222,663	1,198	292,581	1,574
71	BS6.LLT6	215,724	4,589	285,966	6,084
72	BS1.HIL1	291,983	15,867	386,877	21,023
73	.HIL2	284,539	15,462	377,450	20,511
74	.HIL3	294,722	16,104	390,037	21,312
75	.HIL4	296,188	16,184	392,155	21,428
76	BS3.HIL1	291,313	1,121	379,648	1,461
77	BS3.HIL2	290,424	1,117	378,631	1,457

TABLE 3-2 (Continued)

LINEAR CRACK GROWTH ANALYSIS RESULTS

SPECTRUM		LIFE TO PROPAGATE THE CRACK			
		a = 0.03 → 0.53 IN.		a = 0.03 → 1.03 IN.	
NO.	IDENTIFICATION	CYCLES	FLIGHT HOURS	CYCLES	FLIGHT HOURS
78	BS3.HIL3	291,846	1,124	380,111	1,464
79	BS3.HIL4	291,973	1,124	380,238	1,464
80	BS6.HIL1	304,500	4,190	397,725	5,473
81	.HIL2	302,578	4,158	395,702	5,438
82	.HIL3	305,700	4,206	399,300	5,494
83	.HIL4	305,925	4,210	399,900	5,503
84	BS1.HIL5	242,269	13,238	323,664	17,685
85	BS1.HIL6	263,409	14,393	350,887	19,173
86	BS3.HIL5	286,176	1,102	373,439	1,438
87	BS3.HIL6	291,765	1,123	380,044	1,463
88	BS6.HIL5	290,971	4,000	382,632	5,260
89	BS6.HIL6	304,500	4,190	389,700	5,362
90	BS6.CLP1	306,075	4,212	400,125	5,506
91	.CLP2	306,450	4,217	400,875	5,516
92	.CLP3	299,754	4,451	390,590	5,800
93	.CLP4	306,422	4,302	397,929	5,587
94	BS6.MISC1	306,121	4,229	399,794	5,523
95	2	327,627	2,179	427,886	2,845
96	3	310,386	4,239	404,909	5,530
97	4	308,100	4,248	402,075	5,543
98	5	307,125	4,222	401,250	5,516
99	6	355,672	5,029	461,150	6,520
100	BS1.MISC7	260,230	15,393	348,679	20,625
101	BS3.MISC8	287,562	1,127	375,803	1,472
102	BS1.MISC9	288,495	12,721	380,480	16,776
103	BS6.MISC10	318,556	4,848	411,607	6,264
104	BS6.COMB1	341,267	2,990	447,640	3,922
105	2	461,753	2,830	598,999	3,671
106	3	236,587	1,900	318,062	2,554
107	4	305,702	1,797	404,911	2,380
108	5	359,428	6,874	463,085	8,857
109	6	655,015	5,260	830,689	6,671
110	7	400,823	3,219	520,980	4,184
111	8	409,176	3,286	528,305	4,248
112	9	175,950	2,421	234,900	3,232
113	10	987,225	13,584	1,242,600	17,098
114	11	620,465	9,584	813,612	12,568
115	12	416,502	3,344	537,082	4,312
116	13	206,376	3,188	273,052	4,218

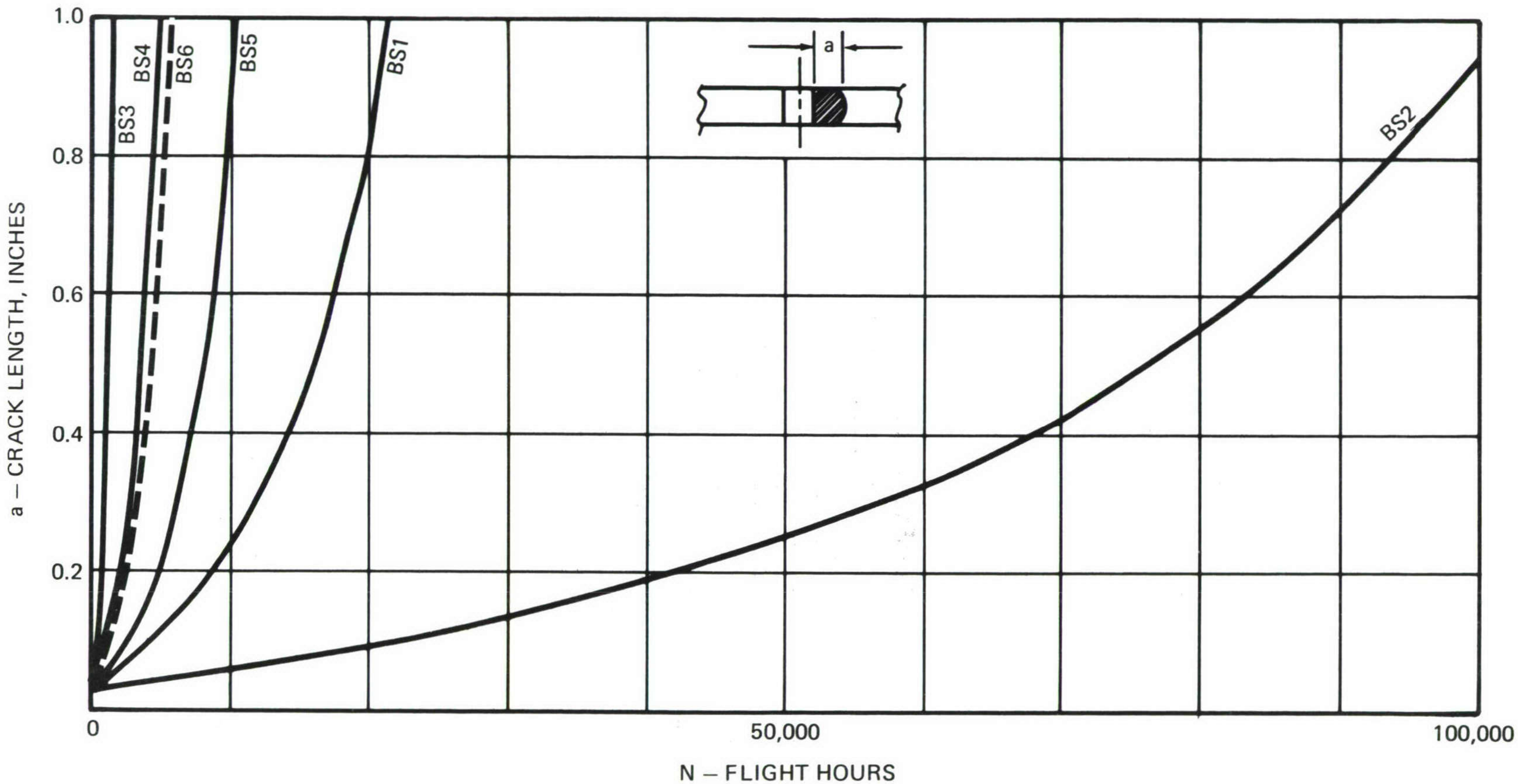


FIGURE 3-4. LINEAR ANALYSIS CRACK GROWTH CURVES FOR BASELINE SPECTRA

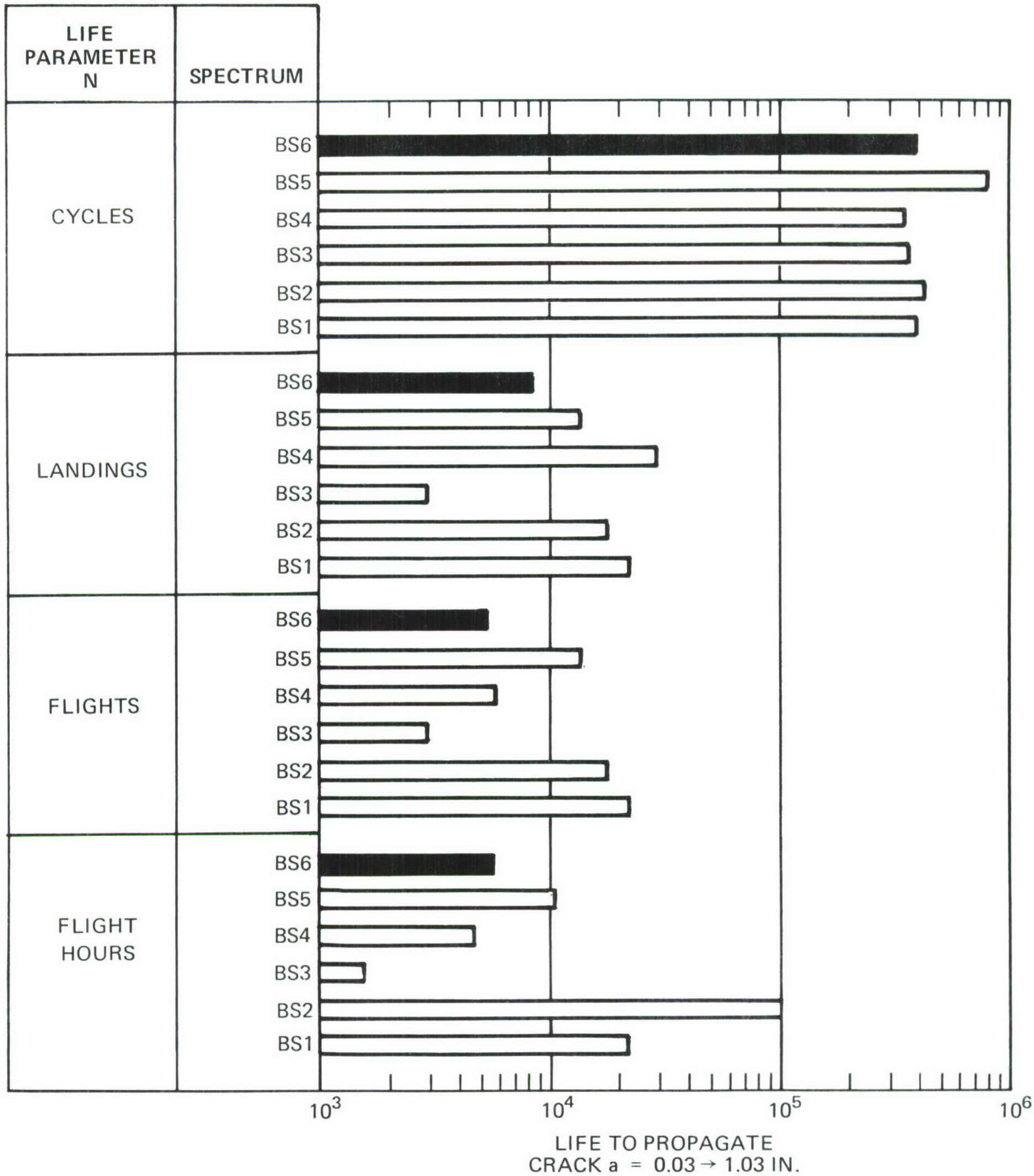


FIGURE 3-5. LINEAR ANALYSIS CRACK GROWTH LIFE FOR BASELINE SPECTRA IN TERMS OF DIFFERENT LIFE PARAMETERS

chosen, depending on the life parameter: BS5-cycles, BS4-landings, BS1-flights, BS2-flight hours. Throughout the report, flight hours are used as the primary life parameter. Conversion to any other parameter can be performed using information given for each spectrum in Appendix B.

2. The crack growth curves, a versus N, see Figures 3-2 and 3-4, are smooth curves for all spectra. Because of this, the ratio of life to propagate the crack 1/2 inch to the life to propagate the crack 1 inch is fairly constant for all spectra. The ratio varies between 0.74 and 0.78 for 93 percent of the spectra, with the smallest value being 0.71 and the largest 0.80. Such consistency implies that different spectra crack growth comparison will show the same trends whether the comparison is made after 1/2 or 1 inch of cracking.

3. The crack growth per flight varies with flight type and crack length. As an example, crack growth rates per flight, for the eight difference flight types, at a = 0.03 inch, are:

Flight	Cycles/Flight	da/dF
1a	15	3.45×10^{-6}
1b	13	1.15×10^{-5}
2	24	1.25×10^{-5}
3a	84	6.10×10^{-5}
3b	88	6.76×10^{-5}
4a	63	2.62×10^{-5}
4b	54	4.14×10^{-5}
5	58	1.50×10^{-5}

The crack growth rate per flight also varies even for the same flight type, because the number of cycles per flight and their magnitude vary from flight to flight. For example, for flight type 2, starting at a = 0.03 inch, the variation for 10 flights is as follows:

Cycles/Flight	da/dF
25	1.25×10^{-5}
30	1.20×10^{-5}
19	8.51×10^{-6}
31	1.24×10^{-5}
27	1.07×10^{-5}
19	9.29×10^{-6}
25	1.28×10^{-5}
17	7.74×10^{-6}
19	1.08×10^{-5}
20	1.12×10^{-5}

4. The wing spectrum has significant cycle once per flight, the ground-air-ground (GAG) cycle associated with each takeoff and landing. The contribution of this cycle to the total crack growth per flight varies with flight type and crack length. For example, at a = 0.03 inch, one GAG cycle contributes anywhere from 5 to 50 percent of the total crack growth per flight for the eight different flights. This percentage decreases with crack growth, i.e., at longer cracks the contribution of the other cycles becomes more significant.

SECTION 4

EXPERIMENTAL PROGRAM

The experimental program consisted of tests on 7475-T7651 aluminum alloy bare plate, 0.25 inch thick, taken from the same lot and heat. The tests can be divided into three parts:

1. Material characterization tests: static strength, material chemical analysis, fracture toughness and constant amplitude loading crack growth da/dN. Fracture toughness and some of the da/dN data were obtained from another program, Reference 6.

2. Baseline spectra and spectra variation crack growth tests. Thirty-five specimens.

3. Tests to study the effect of sustained compression loading on crack growth under spectrum loading. Five specimens.

All experimental data, except those obtained from Reference 6, are presented in Appendix C.

4.1 MATERIAL CHARACTERIZATION

Chemical analysis and tensile static strength results are given in Table C-1. The chemical analysis results met all specification values for the material. Material tensile static strength properties (L), average of three specimens, are:

Yield = 66,574 psi
Ultimate = 75,776 psi
Elongation = 14.13 percent.

Fracture toughness, K_C values, for two different panel widths (W = 4 and 12 inches) were calculated from test results of center cracked panels, where

$$K_c = \sigma\sqrt{\pi a \sec\left(\frac{\pi a}{W}\right)}$$

The total crack lengths at fast fracture, averages of four tests each, and the K_C values were

W = 4.0 in.	2a = 1.52 in.	K_c = 70.55 KSI$\sqrt{\text{in.}}$
W = 12.0 in.	2a = 2.09 in.	K_c = 113.92 KSI$\sqrt{\text{in.}}$

The constant amplitude loading da/dN data are reported in Tables C-2 and C-3 of Appendix C. Data were obtained from eight specimens, although only one specimen was entirely devoted to generate da/dN data. Other data were either generated on specimens with previous spectrum loading or the data were taken directly from precracking results. The specimens were from 9 to 11.5 inches wide. The crack was a thru-the-thickness crack out of one side of a 1/4- or 3/16-inch-diameter open or a fastener-filled hole. Further discussion of the use of these data in the crack growth analysis is to be found in Section 3.2.

4.2 BASELINE SPECTRA AND SPECTRA VARIATIONS CRACK GROWTH TESTS

Thirty-five specimens were tested under 33 different loading spectra. The results are given in Appendix C, Tables C-4 through C-35 and are summarized in Table 5-1.

4.2.1 Specimen

The specimen used in this series of tests is defined in Figure 4-1: 9.0 inches wide with two 1/4-inch diameter holes with a 0.03-inch through-the-thickness crack on one side of each hole. The initial crack length of 0.03 inch was chosen, through preliminary analysis, to produce approximately 1.0 inch of cracking in 5000 flight hours of baseline spectrum BS6 (two applications of the 2500- flight-hour spectrum). As can be seen from test results, Figure 3-2, the estimate was fairly accurate. It took approximately 5700 flight hours, over two repetitions of the spectrum, to propagate the crack 1.0 inch. The objective of two repetitions of the spectrum was to produce loads interaction effects of the loads at the end of the spectrum on the loads at the beginning of the spectrum. This objective, i.e., repetition of the spectrum more than twice, was attained in most tests (see Appendix C), the major exception being spectrum BS3 and its variations requiring less than a complete spectrum to propagate the crack 1.0 inch.

The 0.03-inch crack was developed as follows. A 0.014-inch notch was produced by a special broach on one side of a 3/16-inch pilot hole. A fatigue crack was initiated in this notch and was propagated to a 0.04725-inch length under constant amplitude loading of $S_{max} = 12{,}000$ psi and $R = 0.02$. The peak value of this loading was chosen to be a magnitude which was typically encountered in the first few flights of any given spectrum so as to minimize the effect of this loading on the subsequent crack growth under spectrum loading. Between 30,000 and 40,000 cycles were needed to attain this precrack, the small scatter indicating that the broach-produced notch is highly identically reproducible. This is also reflected in the fact that when the required precrack length was reached in one hole, in most specimens, the crack length in the other hole was not far behind. All specimens were polished and scribed on one side in the area of expected crack growth in order to facilitate crack length measurement. Scribe marks were 0.1 inch apart, the field of vision of the optical measurement instrument.

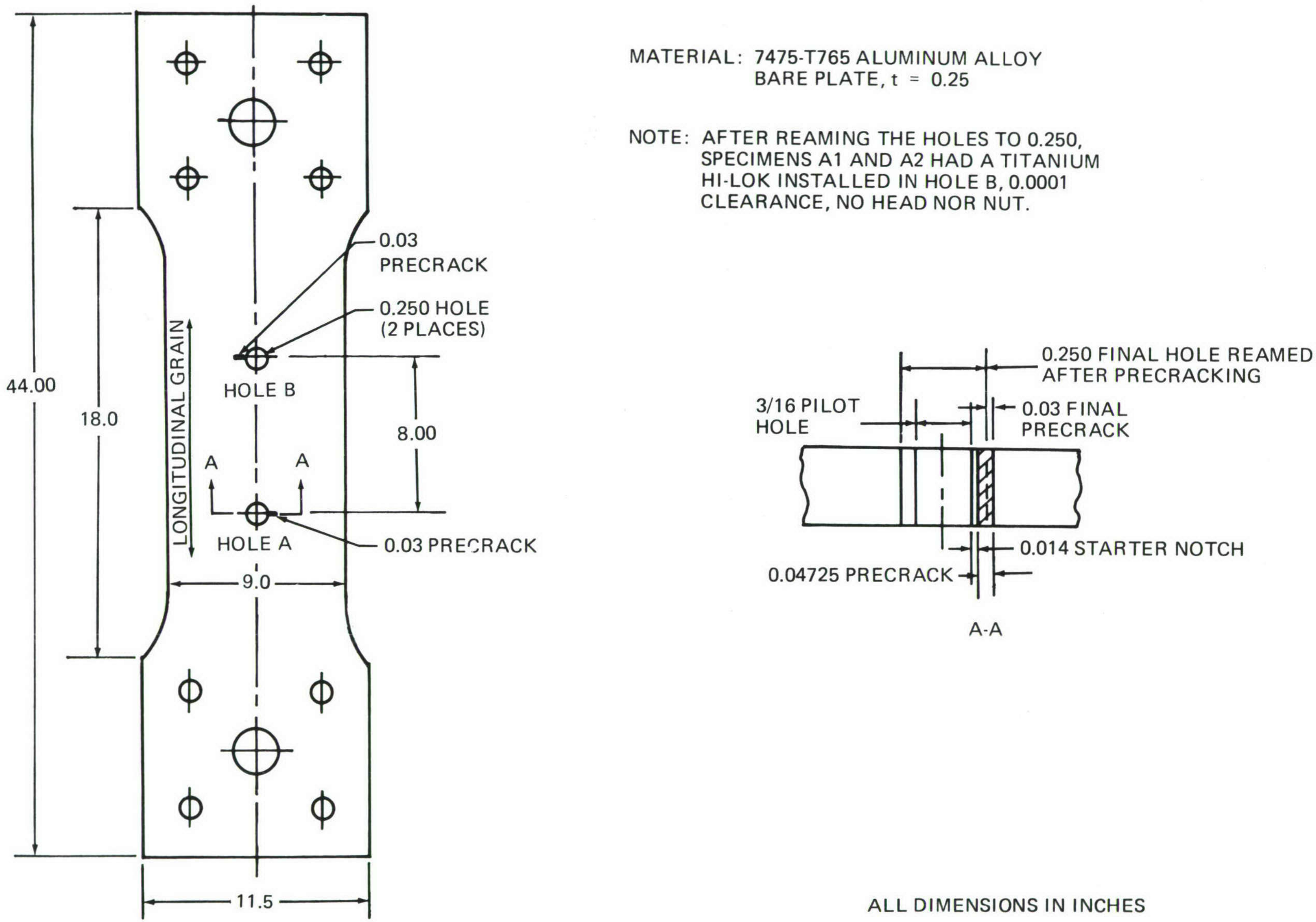


FIGURE 4-1. BASELINE SPECTRA AND SPECTRA VARIATIONS CRACK GROWTH TEST SPECIMEN

4.2.2 Testing System

The specimens were tested in a Douglas-designed testing system consisting of a 1.5-million-pound test fixture with five individually controlled 150,000-pound capacity jacks using closed-loop electrohydraulic servosystems. The system allows for testing up to five specimens simultaneously under five different loading spectra. The loading spectra, in terms of valley and peak sequences, were input into the testing system from a magnetic tape through an SEL 810A computer. The testing system, with five specimens, is illustrated in Figure 4-2.

4.2.3 Testing Procedures

The specimens were tested most of the time in groups of five. Antibuckling plates, seen in Figure 4-2, were used to prevent buckling under compression loads. The loads were applied at 4.0 Hz frequency. The loads accuracy was spot-checked through a strip chart recorder trace and monitored automatically through the computer with respect to a preset tolerance level. The tolerance level was set at ±3500 pounds (±1556 psi). In terms of baseline spectrum BS6 largest peak and valley, this tolerance represents ±6.5-percent accuracy. A sampling of a group of five specimens over four million cycles showed one out-of-tolerance load every 40,000 reversals with almost half of the out-of-tolerances occurring at the infrequent higher tension or compression loads.

The test duration was established as time to propagate the crack 1.0 inch, unless the crack growth rate was so low as to indicate a test duration significantly longer than 5.0×10^5 cycles. In that case the test was to terminate after 0.5 inch of cracking. In almost all tests at least 0.5 inch of crack growth was attained, and in most 1.0 inch, with an average test duration of 5.3×10^5 cycles. (See Appendix C.)

Surface crack lengths, on one side of specimen, were measured approximately at least 20 times per test at equal cycle intervals. In a typical test a crack length measurement was made at least every 0.05 inch of crack growth. The measurements were made with a 40X optical microscope within an accuracy of 0.001 inch.

4.2.4 Spectra Selection for Testing

The 33 spectra selected for testing, out of the 116 spectra generated, are identified in Tables 2-5 and 2-6. First, the six baseline spectra were chosen as the basic reference spectra for all the variations. The other spectra were selected, within the size of this test program, on the basis of the linear crack growth analysis (Table 3-2) indicating a large crack growth variation from the baseline spectra or on the basis that no variation was indicated but the analysis accuracy was suspect. Another consideration in the selection was to adequately cover the spectrum variables considered in developing the 116 spectra.

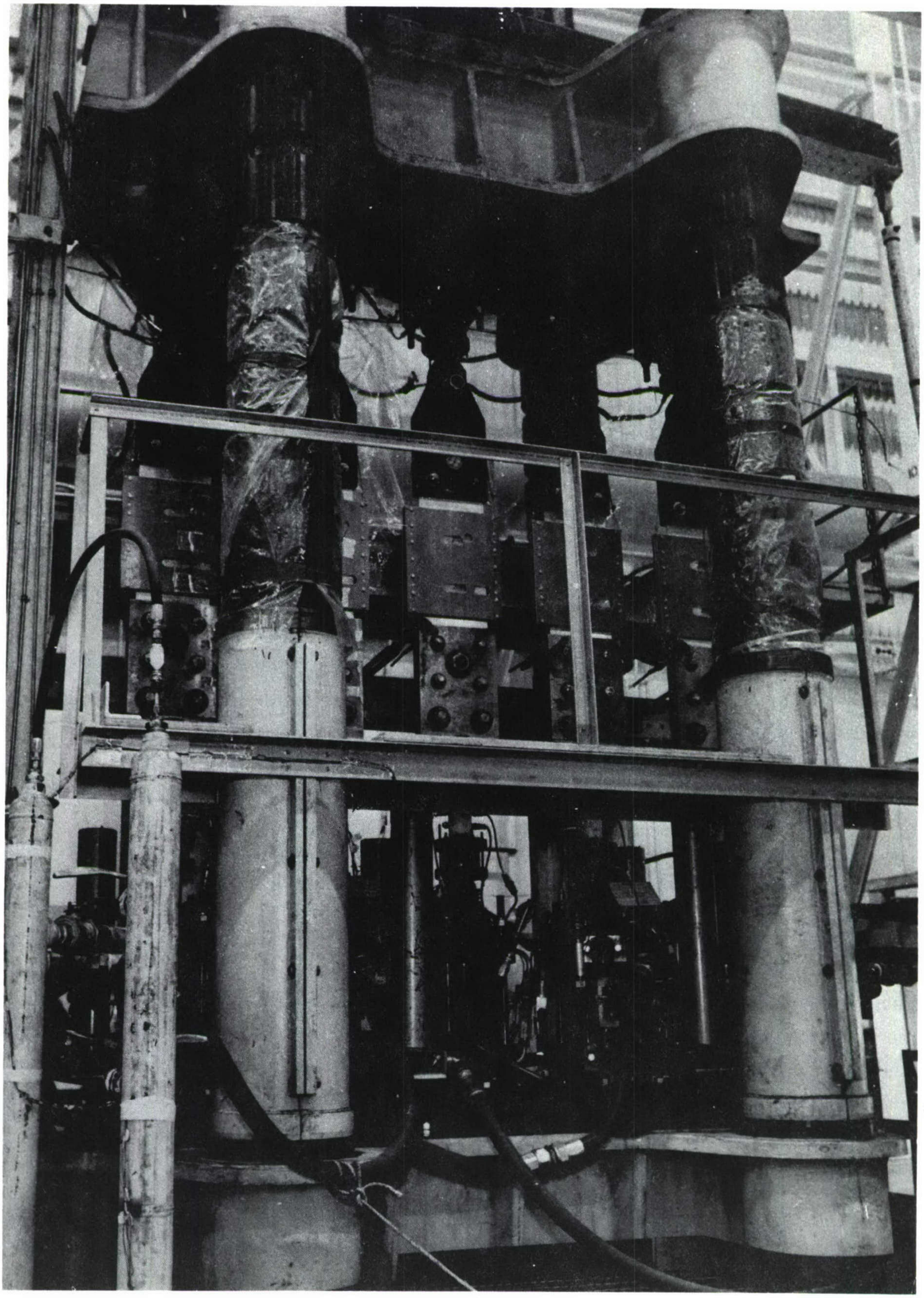


FIGURE 4-2. CRACK PROPAGATION TESTING SYSTEM

4.2.5 Test Results

The test results are presented in Appendix C. The significance of these test results with respect to analysis predictions and spectra variations is discussed in Section 5. A photograph of the fracture surfaces of some of the specimens is presented in Figure 4-3. Note the precrack on the left side of the hole and the different amount of cracking on the right side.

4.3 SUSTAINED COMPRESSION LOADING TESTS

Five tests were performed to check the effects of sustained compression loading (SCL) on crack growth under spectrum loading. The tests results are given in Table C-36.

4.3.1 Specimen

The test specimen is defined in Figure 4-4: 11.0-inch-wide panel with two 1/4-inch-diameter holes with a 0.125-inch thru-the-thickness crack on one side of each hole as well as a 0.125-inch thru-the-thickness crack at specimen's edge. One of the holes was filled with a neat fit (0.0001 to 0.0002 inch clearance) Hilok titanium fastener. The purpose of an edge crack and a crack out of a fastener-filled hole, as opposed to a crack out of an open hole, was to check the effect of SCL under different compression loading transfer paths.

Precracking was done at constant amplitude loading of S_{max} = 10,000 psi and R = 0.02. Precracking was terminated when the crack at hole B reached the required length, accepting whatever the crack length was at hole A or edge.

4.3.2 Testing System

With one addition, the same system as described in Section 4.2.2 was used for these tests. The addition was an inactive weight induced hydraulic system for the application of the SCL.

4.3.3 Loads Spectrum

The loads spectrum was based on a preliminary version of Flight 1b. The spectrum, representing 200 flight hours and flights, is summarized in Table 4-1. The spectrum, in the form of a random cycle-by-cycle sequence, was developed by the same method as used throughout this program, see Section 2.

4.3.4 Testing Procedures

Five specimens, F1 through F5, were tested, two (F1 and F2) with SCL, the other three without SCL. Before the application of the spectrum loading, the cracks were further precracked under constant amplitude loading of S_{max} = 13,091 psi and R = 0.02. This loading was applied until the crack at hole B reached 0.140 inch. At this stage, cracks at hole A and edge varied anywhere from no cracks to a 0.264-inch edge crack in specimen F1.

SPECTRUM	SPECIM	HOLE
BS6	A2	A
BS2	C2	A
BS4	C4	A
BS4.MM8	C7	B
BS6.DSL3	D17	B
BS6.DSL4	D3	A
BS6.LLT2	D13	A
BS6.HIL1	C8	B
BS6.HIL4	D9	B
BS6.HIL5	D19	A
BS6.CLP3	C9	A
BS6.MISC6	D10	B
BS6.COMB3	D11	B
BS6.COMB11	D21	B

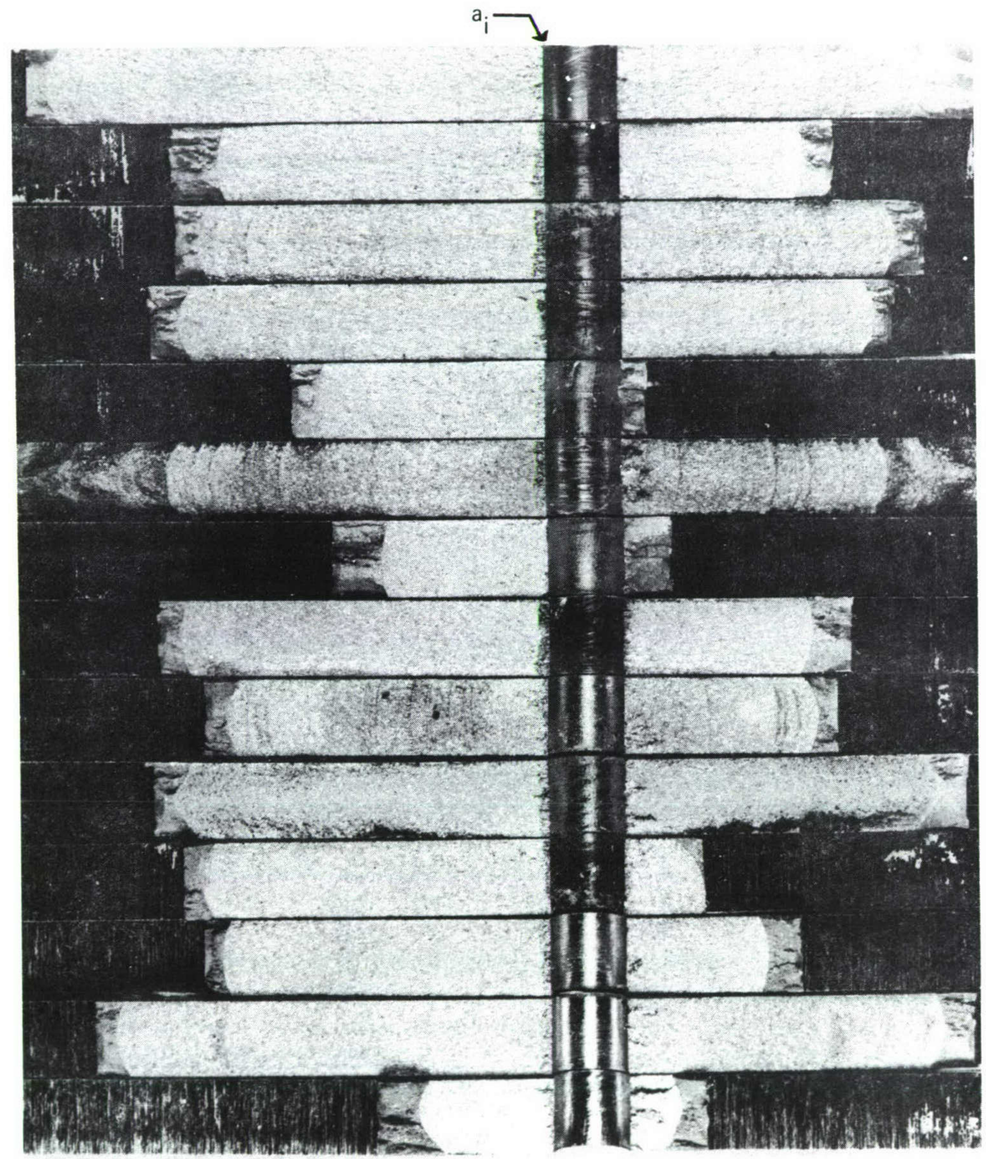


FIGURE 4-3. SPECTRA VARIATIONS CRACK GROWTH TEST SPECIMEN FRACTURE SURFACES

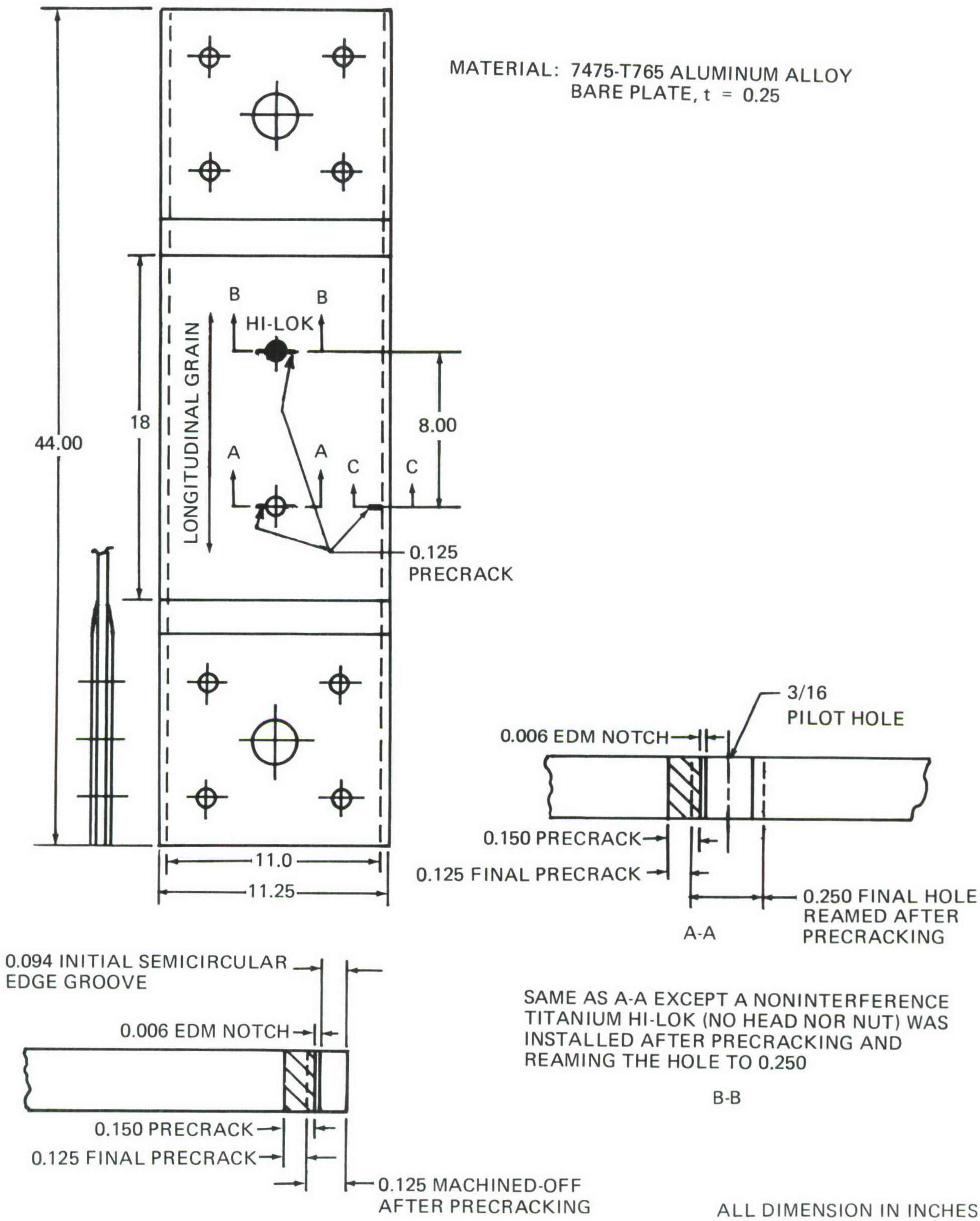


FIGURE 4-4. CRACK GROWTH TEST SPECIMEN FOR CHECKING THE EFFECT OF SUSTAINED COMPRESSION LOADING

TABLE 4-1

SPECTRUM F SUMMARY

DESCRIPTION – SPECTRUM FOR SUSTAINED COMPRESSION LOADING EFFECT TEST BASED ON PRELIMINARY VERSION OF FLIGHT 1B.

FLIGHT HOURS = 200	FLIGHTS = 200		LANDINGS	= 200
TOTAL CYCLES = 5,478	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 27.4
RANGE TRUNCATION (PSI) = 3,000			FLIGHT HOUR	= 27.4
HIGHEST PEAK (PSI) = 22,476			SMALLEST VALLEY (PSI)	= –10,592

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
PEAK (PSI)	n	RANGE (PSI)	n	R	n
–6,969		3,040		–0.9	
	345		4139		5
–5,938		4,080		–0.8	
	777		828		23
–4,906		5,120		–0.7	
	479		64		150
–3,875		6,160		–0.6	
	78		143		22
–2,844		7,200		–0.5	
	1		57		0
–1,813		8,240		0	
	0		22		3
8,500		9,280		0.1	
	1		14		3
9,531		10,320		0.2	
	0		5		7
10,563		11,360		0.3	
	30		4		20
11,594		12,400		0.4	
	1386		1		45
12,625		13,440		0.5	
	990		0		157
13,656		14,480		0.6	
	917		1		621
14,688		15,520		0.7	
	347		0		2682
15,719		18,640		0.8	
	68		21		60
16,750		19,680		0.9	
	41		5		0
17,781		20,720		> 1.0	1680
	8		124		
18,813		21,700			
	0		37		
19,844		22,800			
	6		5		
20,875		23,840			
	2		7		
21,906		24,880			
	2		1		
22,938		25,920			

The spectrum loading was applied, at 4 Hz, to all five specimens 20 times for a total loading representing 4000 flight hours and flights. However, in the first application of flight No. 51, the largest peak in the flight was increased from 14,887 to 27,750 psi. This was done to produce a relatively large plastic zone for possible interaction with the SCL.

The duration of testing with the SCL on specimens F1 and F2 was 344 hours or approximately 2 weeks. The sustained compression load of −7305 psi, representing preflight ground 1.0g stress, was applied for 1.5 hours every 200 flights, after flight No. 12, as well as after flight No. 51 first time only. This SCL was also applied during nights and weekends for a total time of 297 hours.

Back-to-back strain gages were installed on specimens F1 and F2 to determine if there was any significant bending under the SCL. No such bending was observed and the stresses were the same on both sides of specimen.

Antibuckling plates, shown in Figure 4-2, were used to restrain the specimen under compression loadings. Crack length measurements were made with a 40X optical microscope on one side of the specimen every 400 flight hours.

4.3.5 Test Results

The results are presented in Table C-36 in Appendix C. Interpretation of these results is presented in Section 6.

SECTION 5

EVALUATION OF SPECTRA VARIATIONS ANALYSIS AND EXPERIMENTAL RESULTS

The primary objective of this program was to show how spectrum variations affect crack growth. This was done analytically through crack growth analysis of the 116 spectra variations. Crack growth tests were performed with 33 of these spectra in order to check the accuracy of the analysis predicted trends. This section contains the evaluation of these results.

5.1 TEST VERSUS ANALYSIS CRACK GROWTH COMPARISON

Table 5-1 presents the test and linear analysis results of the 33 loads spectra tested. The comparison is made in terms of the crack growth life to propagate the crack, out of one side of a 1/4-inch-diameter hole, from 0.03 to 0.53 inch. Although in most of the tests the crack was propagated at least an inch, the comparison is made over the first half of the inch, because:

a. Analysis represents crack growth on only one side of the hole, whereas in the great majority of tests cracking was observed on the other side of the hole when the original crack had reached, on the average, a crack length of 0.58 inch.

b. In several tests, testing was stopped, because of the long test time, before the crack had propagated an inch.

c. The comparisons show similar trends whether the comparison is made over the first half or the one inch of cracking.

The test results, with two exceptions (BS6.MM13 and BS3.LLT2), are averages of two results. Since the initial crack in testing was not always 0.03 inch, the results shown in Table 5-1 were adjusted to correspond to $a_i = 0.03$ inch.

The linear crack growth analysis accuracy is evaluated against the test results in terms $R_{\Delta N}$ in Table 5-1, where

$$R_{\Delta N} = (\Delta N_{TEST} / \Delta N_{ANAL.})$$

where ΔN_{TEST} and ΔN_{ANAL} are the lives, as determined by test and analysis respectively, to propagate the crack from 0.03 to 0.53 inch, except in the case of spectra BS6.COMB11 and BS6.COMB13, the lives are for shorter crack growth. Histogram of the $R_{\Delta N}$ values is given in Figure 5-1. In 73 percent of the cases the test results were within ± 30 percent of the predicted values. This reflects good correlation between the test and linear analysis results in view of the scatter associated with crack growth data. The prediction is on the conservative side (predicts

TABLE 5-1

SPECTRA VARIATIONS TEST VERSUS LINEAR ANALYSIS CRACK GROWTH COMPARISON

SPECTRUM	DESCRIPTION	HIGHEST PEAK (PSI)	TEST SPECIMEN	ΔN = FLT HR FOR a = 0.03 → 0.53 IN. (EXCEPT AS NOTED) TEST	ANAL	$R_{\Delta N}$ $\left(\frac{\Delta N_{TEST}}{\Delta N_{ANAL}}\right)$
BS6	COMPOSITE BASELINE, 5 MISSIONS (RT = 4,000 PSI)	23,923	A1, A2	4,140	4,212	0.98
BS1	BASELINE, MISSION 1 (RT = 4,000 PSI)	22,114	C1	15,365	16,255	0.95
BS2	BASELINE, MISSION 2 (RT = 4,000 PSI)	17,915	C2	67,208	78,347	0.86
BS3	BASELINE, MISSION 3 (RT = 4,000 PSI)	24,588	C3, D22	1,368	1,124	1.22
BS4	BASELINE, MISSION 4 (RT = 4,000 PSI)	28,841	C4	4,044	3,518	1.15
BS5	BASELINE, MISSION 5 (RT = 4,000 PSI)	20,664	C6	6,992	8,124	0.86
BS4.MM8	MISSION MIX, TRAINING T&G LANDINGS ONLY	27,765	C7	3,957	3,011	1.31
BS6.MM13	MISSION MIX, NO LOW ALTITUDE PENETRATION FLYING	25,153	D12	15,635	14,457	1.08
BS1B.FL3	4.0-HR FLIGHT 1B	24,478	D1	32,702	27,600	1.18
BS6.ES4	MANV AND GUST EXCEED SPECTRA SLOPE REDUCED 15 PERCENT	22,694	D7	7,992	7,006	1.14
BS6.DSL1	ALL STRESSES INCREASED 15 PERCENT	27,512	D6	3,475	2,460	1.41
BS6.DSL3	ALL STRESSES DECREASED 26 PERCENT	17,703	D17	13,310	15,415	0.86
BS6.DSL4	ALL STRESSES INCREASED 35 PERCENT	32,297	D3	1,740	1,373	1.27
BS3.VPC1	DIFFERENT VALLEY/PEAK COUPLING	24,588	D4	1,247	1,024	1.22
BS3.LLT1	RANGE TRUNCATION = 4,500 PSI	24,588	D8	1,510	1,199	1.26
BS3.LLT2	RANGE TRUNCATION = 3,500 PSI	24,588	E1	816	864	0.94
BS6.LLT2	RANGE TRUNCATION = 3,500 PSI	23,923	D13	4,334	3,559	1.22
BS6.LLT5	NO. OF TAXI CYCLES/LANDING INCREASED TO 25.9	23,923	D14	3,499	4,213	0.83
BS6.LLT6	RANGE TRUNCATION = 5,000 PSI	23,923	D5	5,310	4,589	1.16
BS6.HIL1	TEN HIGHEST PEAKS n = 1 x 10	23,923	C8	5,929	4,190	1.42
BS6.HIL2	TEN HIGHEST PEAKS n = 1 x 20	23,923	D18	6,136	4,160	1.48
BS6.HIL3	TEN HIGHEST PEAKS = 33,056 PSI	33,056	D15	6,772	4,206	1.61
BS6.HIL4	TEN HIGHEST PEAKS = 27,750 PSI	27,750	D9	4,920	4,210	1.17
BS6.HIL5	TEN HIGHEST PEAKS = 33,056 PSI AND n = 1 x 20	33,056	D19	9,819	4,001	2.45
BS6.CLP3	$P_{CLIP} \leqslant 0$	23,923	C9	5,679	4,451	1.28
BS1.MISC9	NO SEGMENT SEQUENCE WITHIN FLIGHT	22,114	C10	10,265	12,721	0.81
BS6.MISC2	FLIGHT LOADS AVERAGING INTERNAL Δg = 0.2	24,790	D16	2,937	2,179	1.35
BS6.MISC6	SIMPLIFIED FLT-BY-FLT SPECTRUM	23,923	D10	4,298	5,029	0.85
BS6.COMB3	STRESSES INCREASED 15 PERCENT + RT = 3,500 (1.15)	27,512	D11	2,438	1,900	1.28
BS6.COMB6	STRESSES DECREASED 10 PERCENT + RT = 3,500 (0.9)	21,531	D20	5,290	5,261	1.01
BS6.COMB11	NO GROUND CYCLES, FLT 1.0g = 0, STRESSES INCREASED 100 PERCENT	23,419	D21	12,922*	4,836*	2.67*
BS6.COMB12	RT = 3,500 + TEN HIGHEST PEAKS n = 1 x 10	23,923	D23	3,522	3,344	1.05
BS6.COMB13	SPECTRUM BS6.COMB11 STRESSES INCREASED 35 PERCENT	31,616	D21	2,908**	873**	3.33**

*a = 0.03 → 0.188 IN.
**a = 0.213 → 0.372 IN.

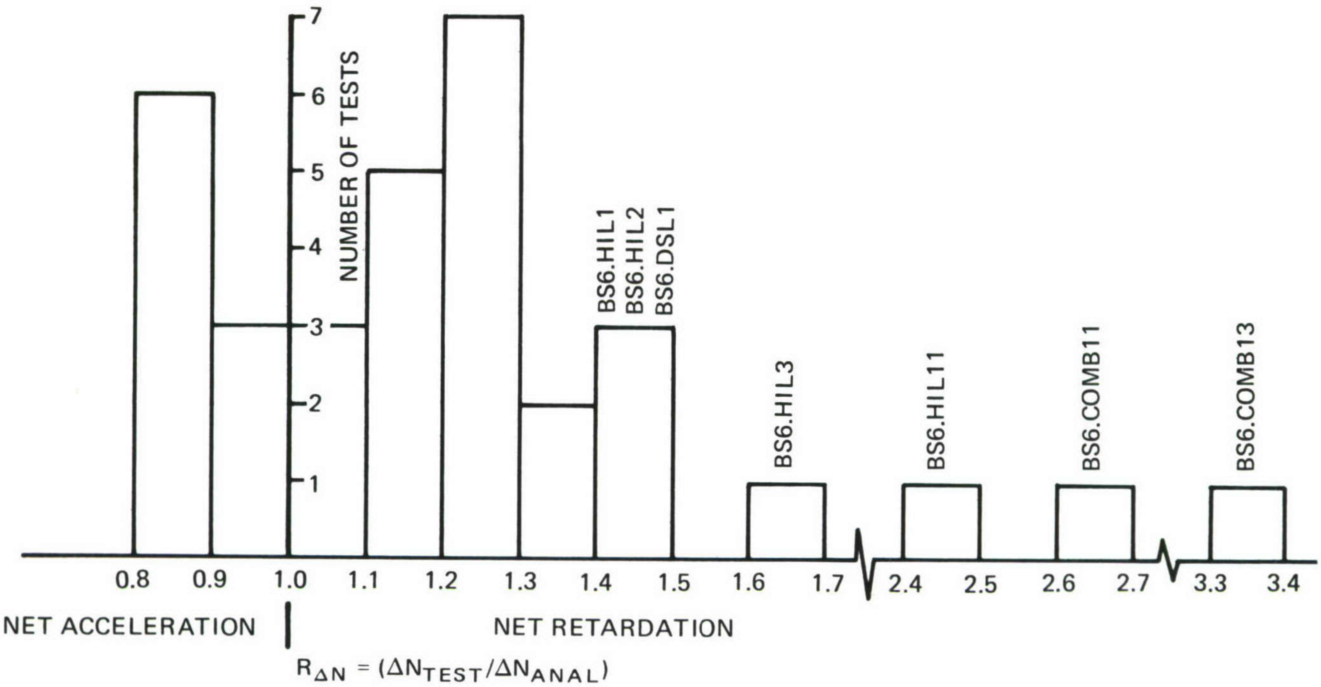


FIGURE 5-1. TEST VERSUS LINEAR ANALYSIS CRACK GROWTH COMPARISON

faster crack growth rate) in the majority of cases, 73 percent of the time. The general analysis-test correlation trends are interpreted as follows:

a. In spectrum loading the loading interaction effects on crack growth may exhibit retardation or acceleration features, or both, as compared to constant amplitude loading da/dN data. Retardation is normally associated with the infrequent high loads, whereas acceleration is considered to be due to compression loads and in some ways due to higher loads following lower loads.

b. The good correlation of the baseline spectra BS6 test and analysis results is attributed to the counterbalancing retardation and acceleration features of the spectrum and availability of representative da/dN data for analysis. The linear analysis model does not reflect these loading interaction effects whereas in the test these effects are assumed to have been self-cancelling.

c. The retardation feature in crack growth is clearly illustrated here by looking at the type of spectra represented by the largest discrepancies between test and analysis. These spectra are of two types: HIL spectra with increased frequency and/or magnitude of high infrequent loads relative to the baseline spectrum, and the spectra (BS6.COMB11 and BS6.COMB13) which were drastically changed from a wing lower surface spectrum to a mainly $-R$ spectrum. The behavior of the HIL spectra was to be expected. However, the results of the other two spectra, in particular BS6.COMB11, which does not have any higher peaks than the baseline spectrum BS6, are not readily explainable. The HIL spectra variation results indicate an increase in retardation (increasing $R_{\Delta N}$ values) with increasing magnitude and frequency of the 10 highest loads in the baseline spectrum BS6:

SPECTRUM	TEN HIGHEST PEAKS, PSI (% LIMIT DESIGN STRESS)	n	VARIATION		$R_{\Delta N}$ (TABLE 5-1)
			MAGNITUDE	FREQUENCY	
BS6	21,465 → 23,923 (69%)	10			0.98
BS6.HIL1	21,465 → 23,923	100		X	1.42
BS6.HIL2	21,465 → 23,923	200		X	1.48
BS6.HIL7	27,750 (80%)	10	X		1.17
BS6.HIL3	33,056 (95%)	10	X		1.61
BS6.HIL11	33,056	200	X	X	2.45

Note that retardation is greater by increasing the frequency of the 10 highest loads (HIL1 and HIL2) than increasing the magnitude to 27,750 psi (HIL7). Of course, with further increase in magnitude to 33,056 psi (HIL3) as well as frequency (HIL11), the retardation becomes larger.

d. That retardation is not necessarily the prime loading interaction effect in crack growth under spectrum loading is illustrated in Figure 5-2 in the plot of $R_{\Delta N}$ versus the highest peak stress in the spectrum. The data, taken from Table 5-1, exclude the $-R$ value spectra BS6.COMB11 and BS6.COMB13. As can be seen, there is a very general broad trend between these parameters, but the large scatter indicates other load interaction effects at work.

e. As stated earlier, the acceleration phenomenon is sometimes considered to be associated with compression loads. This is proven to be so by the following test data:

SPECTRUM		ΔN = FLT HR (a = 0.03 → 0.53 IN.)
BS6.CLP3	$P_{CLIP} \leq 0$, NO COMPRESSION STRESSES	5679
BS6	BASELINE SPECTRUM WITH COMPRESSION STRESSES, 3.5 TAXI CYCLES PER LANDING	4140
BS6.LLT5	INCREASED NUMBER OF COMPRESSION TAXI CYCLES PER LANDING TO 25.9	3499

Adding compression cycles, or more compression-compression cycles to the spectrum reduces the life, i.e., accelerates the crack growth.

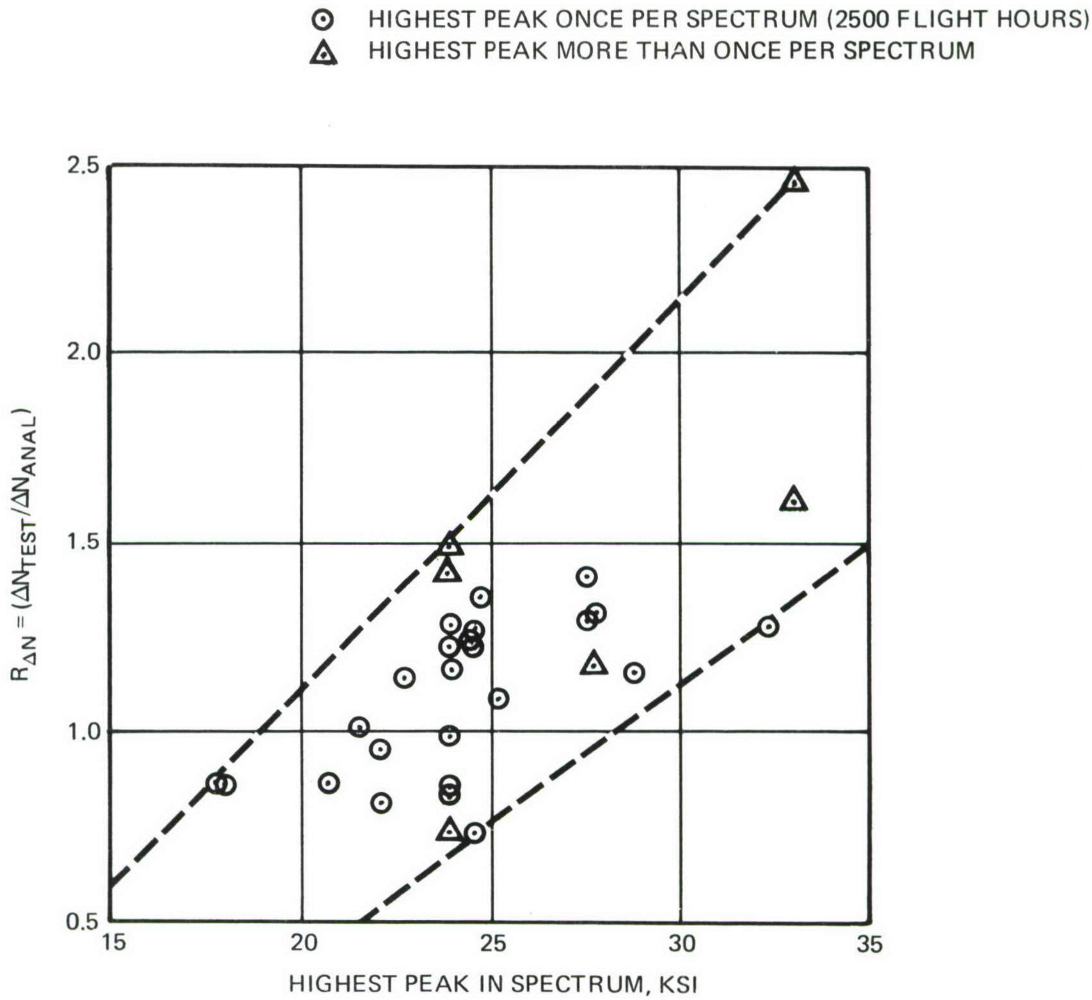


FIGURE 5-2. $R_{\Delta N}$ VERSUS THE HIGHEST PEAK IN THE SPECTRUM

f. Crack growth due to spectrum loading, with respect to loads interaction effects appears to be a function of retardation and acceleration phenomena. The only analysis model that will predict the crack growth trends properly is one which contains both retardation and acceleration features. We can view $R_{\Delta N} > 1.0$ only to mean that the spectrum has a net retardation effect or that $R_{\Delta N} < 1.0$ means a net acceleration effect, see Figure 5-1. Since most spectra inherently have both of these effects, $R_{\Delta N}$ indicates only whether one or the other is more predominant.

5.2 SPECTRA VARIATION EFFECTS ON CRACK GROWTH

Spectra variation effects on crack growth are evaluated on the basis of linear analysis results. However, if test data indicate, for a group of similar spectra variations, that the predicted values are not consistently within 30 percent of the test values ($R_{\Delta N}$ not within 1 ± 0.3), or opposite to test trends, then the evaluation of that group of spectra is based on the test results.

The spectrum variation effect on crack growth is measured in terms of the life ratio,

$R'_{\Delta N} \quad = \quad (\Delta N_{VAR} / \Delta N_{BS})$

where

ΔN = life, in terms of flight hours, to propagate the crack a specified length

VAR = refers to spectrum variation being considered

BS = refers to the baseline spectrum or a reference spectrum to which the variation is being compared.

The variation effect will be considered

	if $\lvert R'_{\Delta N} - 1 \rvert$
not significant	<0.2
significant	≥ 0.2 and ≤ 1.0
very significant	>1.0

These levels of significance are not established here as criteria, but simply for convenience in classifying the spectra variation effects in the evaluation that follows.

5.2.1 Baseline, Mission Mix and Flight Length Variations

The results are given in Table 5-2. Test to analysis correlation, in terms of $R_{\Delta N}$, for this group of spectra satisfies (with one minor exception of $R_{\Delta N} = 1.31$) the criteria established for using the analysis results. All of these spectra are initially considered in one group because the variations have a common variable. This variable is the variation in aircraft usage, from aircraft to aircraft or from one time interval to another even of the same aircraft. The variation range from different mission mixes to individual missions and flights and to variation of individual flight lengths. Comparison of all of these spectra to the baseline composite mission mix spectrum BS6 shows a very significant variation in crack growth lives,

$$R'_{\Delta N} = 0.26 \rightarrow 21.43$$

This converts to a ratio of almost 80 between the longest and shortest life. However, if the life parameter was changed from flight hours to landings, this ratio would decrease to 15. Now to look at specific variations in this group.

Amount of Training – The percent of total usage time spent in training (Missions 4 and 5) was varied from zero to 100 percent, see table on page 64. The variation in life is small (1.6 from low to high) if measured in flight hours, but much higher (8.2) if life is measured in landings, reflecting the high frequency of landings in training.

TABLE 5-2

BASELINE, MISSION MIX AND FLIGHT LENGTH SPECTRA VARIATION EFFECT ON CRACK GROWTH

SPECTRUM		ΔN = FLT HR (a = 0.03 → 0.53 IN.)		$R_{\Delta N}$	$R'_{\Delta N} = \left(\frac{\Delta N_{VAR}}{\Delta N_{BS6}}\right)$	
IDENTIFICATION	DESCRIPTION	ANALYSIS	TEST	$\left(\frac{\Delta N_{TEST}}{\Delta N_{ANAL.}}\right)$	ANAL	TEST
BS6	COMPOSITE MISSION MIX	4,212	4,140	0.98	–	–
BS1	MISSION 1, FLTS 1a AND 1b	16,255	15,365	0.95	3.86	3.71
BS2	MISSION 2, FLT 2	78,347	67,208	0.86	18.60	16.19
BS3	MISSION 3, FLTS 3a AND 3b	1,124	1,368	1.22	0.27	0.33
BS4	MISSION 4, FLTS 4a AND 4b	3,518	4,044	1.15	0.84	0.98
BS5	MISSION 5, FLT 5	8,124	6,992	0.86	1.93	1.69
BS1.MM1A	FLT 1a, 0.989 HOURS LONG	33,719			8.01	
BS1.MM1B	FLT 1b, 0.989 HOURS LONG	11,670			2.77	
BS3.MM3A	FLT 3a	1,097			0.26	
BS3.MM3B	FLT 3b	1,138			0.27	
BS4.MM4A	FLT 4a	4,812			1.14	
BS4.MM4B	FLT 4b	1,992			0.47	
BS45.MM7	TRAINING ONLY, MISSIONS 4 AND 5	4,751			1.13	
BS4.MM8	TOUCH AND GO LANDINGS ONLY	3,011	3,957	1.31	0.71	0.96
BS123.MM9	NO TRAINING, MISSIONS 1,2, AND 3	4,095			0.97	
BS6.MM10	50 PERCENT REDUCTION IN TRAINING	3,711			0.88	
BS13.MM11	FLTS 1a AND 3a ONLY	2,604			0.62	
BS123.MM12	FLTS 1b, 2, AND 3b ONLY	4,957			1.18	
BS6.MM13	NO LOW ALTITUDE PENETRATION	14,457	15,635	1.08	3.43	3.78
BS6.MM14	100 PERCENT INCREASE IN LOW ALT PENETR TIME	2,504			0.59	
BS1A.FL1	FLT 1a, 0.541 HOUR LONG	17,632			4.19	
BS1A.FL2	FLT 1a, 2.0 HOURS LONG	62,048			14.73	
BS1A.FL3	FLT 1a, 4.0 HOURS LONG	90,284			21.43	
BS1B.FL1	FLT 1b, 0.605 HOUR LONG	7,005			1.66	
BS1B.FL2	FLT 1b, 2.0 HOURS LONG	19,902			4.73	
BS1B.FL3	FLT 1b, 4.0 HOURS LONG	27,600	32,702	1.18	6.55	7.90

SPECTRUM	PERCENT OF TIME IN TRAINING	ΔN (a = 0.03 →0.53 IN.)	
		FLT HR	LANDINGS
BS123.MM9	0	4,095	3,667
BS6.MM10	10.2	3,711	4,755
BS6	20.4	4,212	6,475
BS45.MM7	100	4,751	19,228
BS4.MM8	100*	3,011	30,110

*TOUCH AND GO LANDINGS ONLY.

Low Altitude Penetration Flying – Low altitude penetration flying (LAPF) produces severe gust and maneuver loading spectra. The effect of this was investigated by varying the LAPF time in the overall usage:

SPECTRUM	PERCENT OF TIME IN LAPF	ΔN (a = 0.03 →0.53 IN.)	
		FLT HR	LANDINGS
BS6.MM13	0	14,457	21,200
BS6	20.5	4,212	6,475
BS6.MM14	41	2,504	4,116
BS3	100	1,124	2,298

The ratio in life between zero and 100 percent LAPF time is 12.9 when measuring life in flight hours, a very significant variation.

Flight Length – The length of flights 1a and 1b was varied from flights without cruise to 4.0-hour flights:

SPECTRUM	FLIGHT LENGTH – HOURS	ΔN (a = 0.03 →0.53 IN.)	
		FLT HR	LANDINGS
BS1A.FL1	0.541	17,632	32,592
BS1.MM1A	0.989	33,719	34,094
BS1A.FL2	2.0	62,048	31,024
BS1A.FL3	4.0	90,284	22,571
BS1B.FL1	0.605	7,005	11,579
BS1.MM1B	0.989	11,670	11,800
BS1B.FL2	2.0	19,902	9,951
BS1B.FL3	4.0	27,600	6,900

The variation in flight hours between the shortest and longest flights is very significant, 5.1 and 3.9 for flights 1a and 1b. However, in terms of landings it is much smaller (1.4 and 1.7), indicating that for these types of flights the crack growth per flight does not vary much with flight length.

Payload – Stresses in the wing are directly affected by the amount of payload carried. Mission mixes and individual flights with different amounts of payload were considered:

SPECTRUM	PAYLOAD, PERCENT	DESCRIPTION	ΔN (a = 0.03 →0.53 IN.)	
			FLT HR	LANDINGS
BS13.MM11	34.3	FLIGHTS 1a AND 3a	2,604	3,715
BS6	46.3	ALL MISSIONS	4,212	6,475
BS123.MM9	66.8	FLIGHTS 1a, 1b, 2, 3a, 3b	4,095	3,667
BS123.MM12	85.5	FLIGHTS 1a, 2, 3b	4,957	3,652
BS1.MM1A	21.8	FLIGHT 1a	33,719	34,094
BS1.MM1B	75.0	FLIGHT 1b	11,670	11,800
BS3.MM3A	43.5	FLIGHT 3a	1,097	2,243
BS3.MM3B	100.0	FLIGHT 3b	1,138	2,327

The expected trend is to see a decreasing life with increasing payload. No such consistent trend is seen here. It appears that other factors, such as the strong influence of the very severe flights (3a, 3b) in mission mixes, smaller gust response load factors due to higher airplane gross weights, and differences in maneuver spectra produce sufficient influences to reduce the effect of payload. Only in the case of flights 1a and 1b is the influence of payload clearly shown, a three-fold reduction in life due to approximately a three-fold increase in payload.

5.2.2 Sequence of Missions

The effect of the sequence of missions (more specifically, flights) in the spectrum was investigated by producing four variations of the baseline spectra BS1 and BS6. No spectra were tested from this group. However, because of the similarity of these spectra to those shown tested in Table 5-2, linear analysis results of these spectra are considered to be verified. The spectra are:

SPECTRUM	DESCRIPTION	ΔN (a = 0.03 →0.53 IN.) FLT HR	$R'_{\Delta N}$ $\left(\frac{\Delta N_{VAR}}{\Delta N_{BS}}\right)$
BS1	BASELINE SPECTRUM, RANDOM FLIGHT SEQUENCE	16,255	–
BS1.SM1	LO-HI-LO FLIGHT SEQUENCE BASED ON THE LARGEST PEAK PER FLIGHT	16,266	1.00
BS6	BASELINE SPECTRUM, RANDOM FLIGHT SEQUENCE	4,212	–
BS6.SM1	LO-HI-LO FLIGHT SEQUENCE BASED ON THE LARGEST PEAK PER FLIGHT	4,051	0.96
BS6.SM4	SPECIFIC ORDERED FLIGHT SEQUENCE WITH GROUPINGS OF TRAINING FLIGHTS	4,245	1.01
BS6.SM5	A DIFFERENT RANDOM SEQUENCE OF FLIGHTS	4,226	1.00

The effect of mission (flight) sequence on crack growth is not significant.

5.2.3 Flight Segments

Five spectra were generated to investigate the effect of simplifying the development of the spectrum through reduction of the number of segments or the number of load factor-stress transfer functions considered in a flight. No spectra were tested from this group. However, because of the similarity of these spectra to those shown tested in Table 5-2, linear analysis results of these spectra are considered to be verified. The spectra are:

SPECTRUM	DESCRIPTION	ΔN (a = 0.03 → 0.53 IN.) FLT HR	$R'_{\Delta N}$ $\left(\frac{(\Delta N_{VAR})}{(\Delta N_{BS})}\right)$
BS1	BASELINE SPECTRUM	16,255	–
BS1.FS3	FLAPS UP CLIMB AND DESCENT GUST SEGMENTS SIMPLIFIED INTO ONE SEGMENT FOR CLIMB AND DESCENT EACH	18,475	1.14
BS1.FS4	FLAPS UP CLIMB AND DESCENT LOAD FACTOR – STRESS TRANSFER FUNCTION SAME AS FOR CRUISE	16,021	0.99
BS1.FS5	ALL CLIMB AND DESCENT LOAD FACTOR – STRESS TRANSFER FUNCTIONS SAME AS FOR CRUISE	17,569	1.08
BS6	BASELINE SPECTRUM	4,212	--
BS6.FS1	LANDING IMPACT CYCLES EXCLUDED	4,217	1.00
BS6.FS2	FLAPS UP CLIMB AND DESCENT GUST SEGMENTS SIMPLIFIED INTO ONE SEGMENT FOR CLIMB AND DESCENT EACH	4,262	1.01

The effect of these segment orientated variations on crack growth is not significant. It must be noted that only one cycle per landing was considered in spectrum BS6.

5.2.4 Exceedance Spectra

The variation in loads occurrences and magnitude between aircraft may be viewed in terms of changing the slope or N_0 (exceedances at zero load), of the exceedances spectra, see Figure 2-7. Four such variations were generated on flight loads of the baseline spectrum BS6. Only one of the spectra was tested, see next page. $R_{\Delta N}$ = 1.14 indicates a satisfactory verification of the linear analysis results for this group. The effect of varying N_0 is almost directly proportional to the N_0 variation of 15 percent, and thus, not significant. The variation of the exceedance spectra slope by 15 percent has a larger, and a significant effect, see next page.

SPECTRUM	DESCRIPTION	ΔN = FLT HR (a = 0.03→0.53 IN.) ANAL.	TEST	$R_{\Delta N} = \left(\frac{\Delta N_{TEST}}{\Delta N_{ANAL.}}\right)$	$R'_{\Delta N} = \left(\frac{\Delta N_{VAR}}{\Delta N_{BS6}}\right)$ ANAL.	TEST
BS6	BASELINE	4212	4140	0.98	–	–
BS6.ES1	GUST AND MANEUVER SPECTRA N_0 INCREASED 15 PERCENT	3728			0.89	
BS6.ES2	GUST AND MANEUVER SPECTRA N_0 DECREASED 15 PERCENT	4843			1.15	
BS6.ES3	GUST AND MANEUVER EXCEEDANCE SPECTRA SLOPE INCREASED 15 PERCENT	2760			0.66	
BS6.ES4	GUST AND MANEUVER EXCEEDANCE SPECTRA SLOPE DECREASED 15 PERCENT	7006	7992	1.14	1.66	1.93

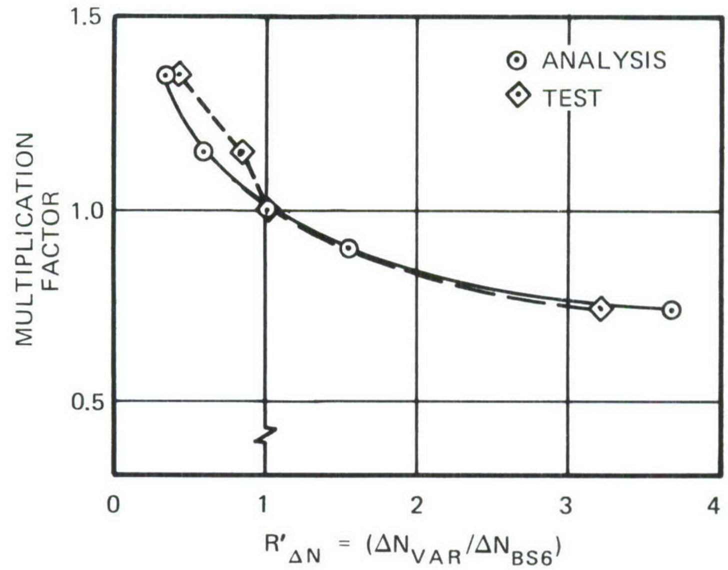
5.2.5 Design Stress Level

These variations consist of increasing or decreasing all stresses in a baseline spectrum by multiplying them by a constant. The effect of this variation on peak loads is illustrated by Figure 2-7 and analysis and test results are given in Table 5-3. These variations may be viewed as representing design stress level or usage severity change or any other cause which would change all the stresses in the spectrum by a constant. However, it should be noted that, in the way these spectra were generated, the range truncation level effectively became different for the variations, see Table 5-3. If the range truncation of 4000 psi were kept for all spectra the effect on crack growth would be even more pronounced, i.e., even shorter life for spectra with increased stress levels and longer life for spectra with lower stresses than shown in Table 5-3.

TABLE 5-3
DESIGN STRESS LEVEL SPECTRA VARIATIONS
EFFECT ON CRACK GROWTH

SPECTRUM IDENTIF	SPECTRUM DESCRIPTION	RANGE TRUNCATION (PSI)	ΔN = FLT HR (a = 0.03 → 0.53 IN.) ANAL.	TEST	$R_{\Delta N} = \left(\frac{\Delta N_{TEST}}{\Delta N_{ANAL.}}\right)$	$R'_{\Delta N} = \left(\frac{\Delta N_{VAR}}{\Delta N_{BS}}\right)$ ANAL.	TEST
BS1	BASELINE	4000	16,255	15,365	0.95	–	–
BS1.DSL1	STRESSES INCREASED 15%	4000 (1.15)	9,683			0.60	
BS1.DSL2	STRESSES DECREASED 10%	4000 (0.9)	24,838			1.53	
BS3	BASELINE	4000	1,124	1,368	1.22	–	–
BS3.DSL1	STRESSES INCREASED 15%	4000 (1.15)	653			0.58	
BS3.DSL2	STRESSES DECREASED 10%	4000 (0.9)	1,736			1.54	
BS4	BASELINE	4000	3,518	4,044	1.15	–	–
BS4.DSL1	STRESSES INCREASED 15%	4000 (1.15)	2,096			0.60	
BS4.DSL2	STRESSES DECREASED 10%	4000 (0.9)	5,378			1.53	
BS6	BASELINE	4000	4,212	4,140	0.98	–	–
BS6.DSL1	STRESSES INCREASED 15%	4000 (1.15)	2,460	3,475	1.41	0.58	0.84
BS6.DSL2	STRESSES DECREASED 10%	4000 (0.9)	6,516			1.55	
BS6.DSL3	STRESSES DECREASED 26%	4000 (0.74)	15,415	13,310	0.86	3.66	3.21
BS6.DSL4	STRESSES INCREASED 35%	4000 (1.35)	1,373	1,740	1.27	0.33	0.42

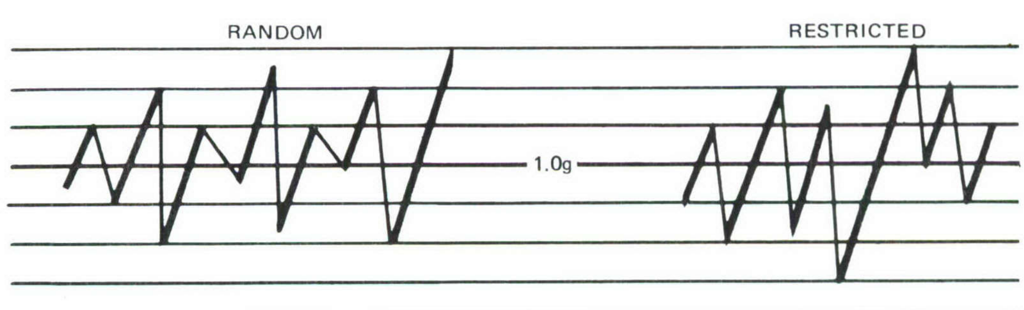
As seen in Table 5-3, correlation between test and analysis is acceptable in two of the three DSL spectra tests. In the third test (BS6.DSL1), $R_{\Delta N} = 1.41$ is larger than 1.3 established as criteria for analysis verification. However, if we look at the overall analysis and test results, see below, it is seen that the trend and the extremes of the variation are predicted sufficiently accurately, so that the analysis results are accepted as satisfactory to evaluate the effect on crack growth.



The effect of variation is about the same for all four baseline spectra considered. Remembering that with the same range truncation for all spectra, the variation of crack life would be even larger, any change of spectrum stresses by more than 10 percent is considered to have a significant ($0.8 > R'_{\Delta N} > 1.2$) effect on crack growth.

5.2.6 Valley/Peak Coupling

All spectra, except in this group, were generated using the random coupling of peaks and valleys, as defined in the spectrum generation program, Reference 1. In this group, the valley/peak coupling of the six baseline spectra was changed to the A6PA program version restricted coupling (Reference 1) so that cycles cycling about 1.0g were defined to have equal incremental stresses above and below 1.0g or 1.0g was the peak or valley:



SPECTRUM	VALLEY/PEAK COUPLING		ΔN = FLT HR (a = 0.03 → 0.53 IN.)		$R_{\Delta N} = \left(\frac{\Delta N_{TEST}}{\Delta N_{ANAL.}}\right)$	$R'_{\Delta N} = \left(\frac{\Delta N_{VAR}}{\Delta N_{BS}}\right)$	
	RANDOM	RESTRICTED	ANAL.	TEST		ANAL.	TEST
BS1	X		16,255	15,365	0.95	–	–
BS1.VPC1		X	15,501			0.95	
BS2	X		78,347	67,208	0.86	–	–
BS2.VPC1		X	72,942			0.93	
BS3	X		1,124	1,368	1.22	–	–
BS3.VPC1		X	1,024	1,247	1.22	0.91	0.91
BS4	X		3,518	4,044	1.15	–	–
BS4.VPC1		X	3,362			0.96	
BS5	X		8,124	6,992	0.86	–	–
BS5.VPC1		X	6,330			0.78	
BS6	X		4,212	4,140	0.98	–	
BS6.VPC1		X	3,843			0.91	–

The single test result, see above, verifies analysis results as acceptable for evaluation of these variations. The effect of a restricted valley/peak coupling, compared to the random coupling, is small and is not significant. It is less than 10 percent, on the conservative side, for five of the six baseline spectra, and 22 percent for the other (BS5.VPC1) spectrum.

5.2.7 Low Load Truncation

Here we are concerned with the effect of eliminating all cycles which might not contribute significantlly to crack growth. In this group the variations mainly dealt with elimination of cycles on the basis of cycle stress range, so-called range truncation (RT). The baseline spectra RT were 4000 psi. The variations covered RT from 3000 to 5000 psi. In addition to the 14 range truncation variations of four baseline spectra, two variations were concerned with the number of compression-compression taxi cycles in baseline spectrum BS6. The analysis and test results are summarized in Table 5-4.

Range Truncation – First, let us look at the effect of range truncation. Test-to-analysis correlation is good ($R_{\Delta N}$ within 1 ± 0.3). However, the trend in one of the tests (BS6.LLT2) is opposite of the analysis. The expected trend is decreasing or constant life with decreasing range truncation level, i.e., adding more cycles with smaller ranges will add to crack growth until a point is reached where additional cycles will not produce any significant crack growth and life will remain constant. Also, life may be further decreased due to reduction of the retardation effect by increasing the number of cycles between peaks producing retardation. In view of these considerations, spectrum BS6.LLT2 nonconforming test result is attributed to scatter, and analysis results are accepted as predicting the trend. Using the baseline spectra with RT = 4000 psi as the reference point, life increase by removing cycles with ranges up to 5000 psi is not very significant: up to 9 percent by analysis, up to 28 percent by testing. However, it does indicate that these cycles (stress range between 4000 and 5000 psi) do contribute to crack growth. The other question is, how significant are the cycles with ranges below 4000 psi? Decreasing the RT to 3500 psi produces a life reduction between 13 and 40 percent, depending on the baseline spectrum and analysis or test results. Decreasing the RT to 3000 psi, analysis indicates a reduction in life up to 28 percent. All of these reductions are not very significant.

TABLE 5-4

LOW LOAD TRUNCATION SPECTRA VARIATIONS EFFECT ON CRACK GROWTH

SPECTRUM		ΔN = FLT HR (a = 0.03 → 0.53 IN.)		$R_{\Delta N}$ $\left(\frac{\Delta N_{TEST}}{\Delta N_{ANAL.}}\right)$	$R'_{\Delta N} = \left(\frac{\Delta N_{VAR}}{\Delta N_{BS}}\right)$	
IDENTIF	DESCRIPTION	ANAL.	TEST		ANAL.	TEST
	RANGE TRUNCATION (PSI):					
BS1	4000	16,255	15,365	0.95	–	–
BS1.LLT1	4500	16,449			1.01	
BS1.LLT2	3500	14,008			0.86	
BS1.LLT3	3000	14,573			0.90	
BS3	4000	1,124	1,368	1.22	–	–
BS3.LLT4	5000	1,198			1.07	
BS3.LLT1	4500	1,199	1,510	1.26	1.07	1.10
BS3.LLT2	3500	864	816	0.94	0.77	0.60
BS3.LLT3	3000	810			0.72	
BS4	4000	3,518	4,044	1.15	–	–
BS4.LLT1	4500	3,587			1.02	
BS4.LLT2	3500	3,070			0.87	
BS4.LLT3	3000	3,106			0.88	
BS6	4000	4,212	4,140	0.98	–	–
BS6.LLT6	5000	4,589	5,310	1.16	1.09	1.28
BS6.LLT1	4500	4,457			1.06	
BS6.LLT2	3500	3,559	4,334	1.22	0.84	1.05
BS6.LLT3	3000	3,162			0.75	
	NUMBER OF TAXI CYCLES PER LANDING:					
BS6	3.5	4,212	4,140	0.98	–	–
BS6.LLT4	1.0	4,218			1.00	
BS6.LLT5	25.9	4,213	3,499	0.83	1.00	0.85

The remaining question seems to be, whether reduction of the RT level below 3000 psi would result in significant life reductions. Test data from Reference 9, range truncation study with a transport-tanker wing lower surface spectrum, provide more insight into this matter. RT levels down to 1500 psi were investigated. Further description of this study is given in Section 6.2 of this report. The results from Reference 9 and this program are combined and presented in Figure 5-3. The data represent cracking out of a hole, open or with a neat fit pin, on three aluminum alloys, with either through-the-thickness or corner initial cracks. Except in one series of tests, in which the crack growth was only 0.14 inch, all other data represent crack growth over 0.5-inch length, starting with an 0.03- or 0.05-inch length. Reference 9 data confirm the

TEST DATA:

SYMBOL	SPECTRUM	MATERIAL	a_i	a (IN.)	HOLE	REF
⊙	BS3	7475	TTC	0.03 → 0.53	OPEN	THIS PROGRAM
◈	BS6	7475	TTC	0.03 → 0.53	OPEN	THIS PROGRAM
△	KC10.W6	2024	CC	0.05 → 0.55	OPEN	9
⊡	KC10.W6	7075	CC	0.05 → 0.55	OPEN	9
▲	KC10.W6	2024	CC	0.05 → 0.55	FILLED	9
■	KC10.W6	7075	CC	0.05 → 0.55	FILLED	9
▼	KC10.W5	2024	CC	0.05 → 0.19	FILLED	9

TTC = THRU-THICKNESS CRACK
CC = CORNER CRACK

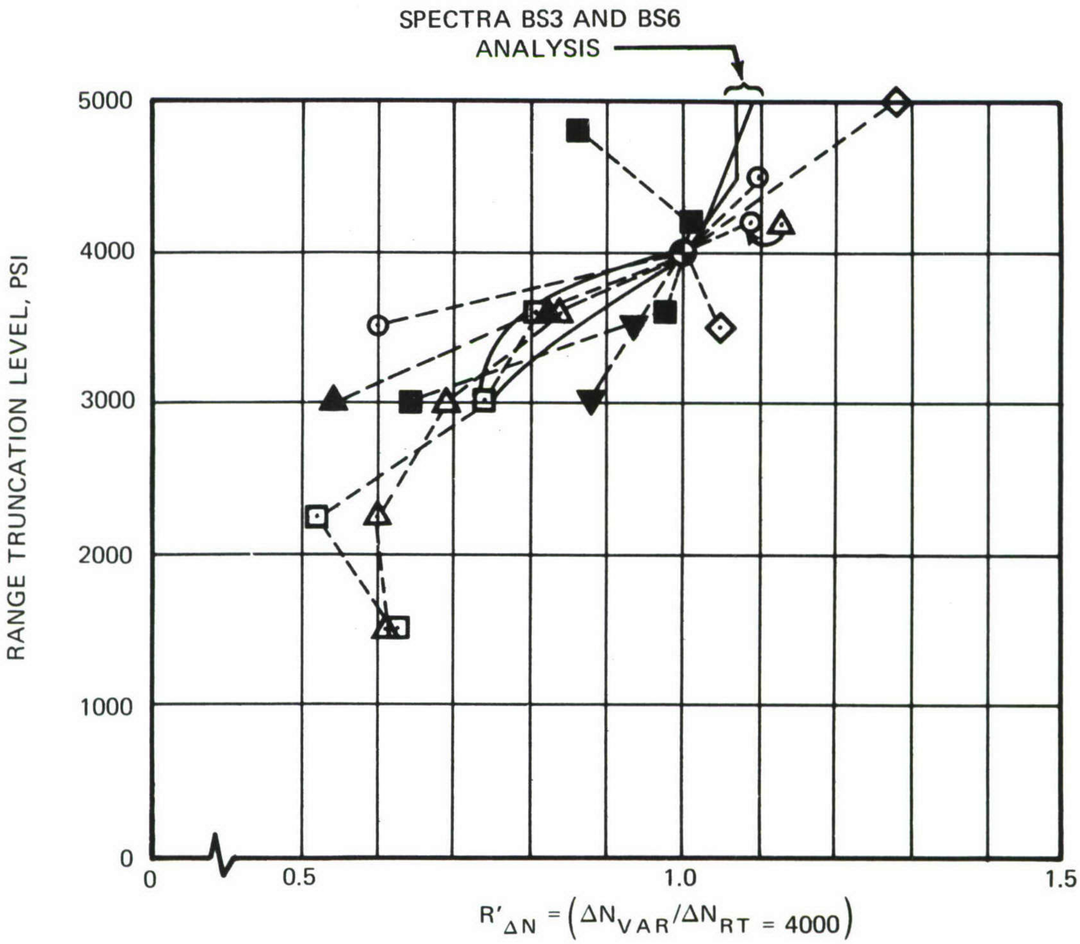
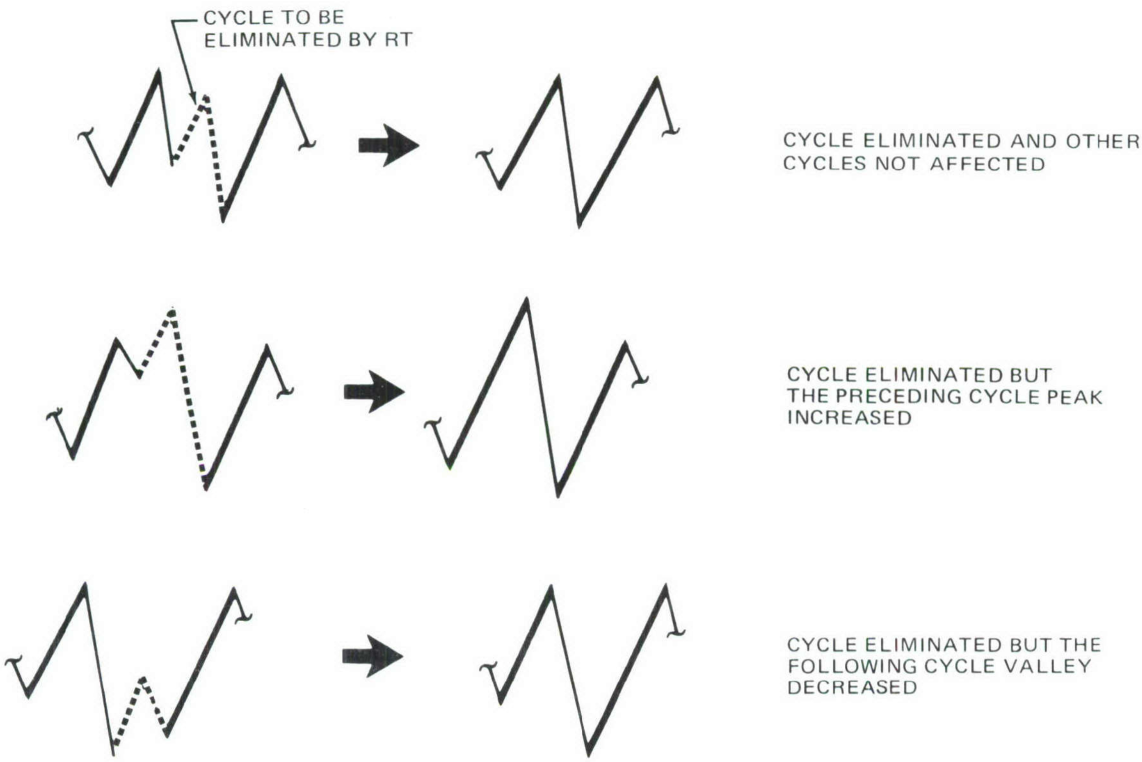


FIGURE 5-3. EFFECT OF RANGE TRUNCATION ON CRACK GROWTH (ALUMINUM ALLOYS, t = 0.25 IN., CRACK ON ONE SIDE OF 1/4-INCH-DIAMETER HOLE; ΔN = FLT HR)

findings of this program and indicate a life reduction between 40 and 50 percent when RT is reduced to 2250 psi. Further reduction of RT down to 1500 psi did not produce any further reduction in life, but just the opposite, a small increase in life. Whether this is simply scatter or a definite trend is not clear at this time. It is also interesting that this trend was predicted by linear analysis. One explanation perhaps can be found in the method of generating these spectra variations, see Reference 1. A cycle, which is defined as the loading from a valley to a peak and then to the next valley, will be eliminated if its range (first valley to peak) is less than the specified RT level, with one exception. If the peak or valley of the cycle to be eliminated is larger or smaller than the preceding or following cycle peak or valley, then the peak of the preceding cycle or the valley of the following cycle is replaced with the peak or the valley of the cycle being eliminated. Examples:



Thus, this method of range truncation will reduce the number of cycles when going from lower to higher RT level, but the spectrum at the higher RT level may have cycles with larger ranges which produce more crack growth than the two independent cycles at the lower RT. This feature of the spectrum sequence generation method needs to be investigated further, including experimental verification.

The importance of eliminating unnecessary cycles from the spectrum, with respect of analysis and testing costs, and schedules, is clearly illustrated by Figure 5-4. It shows the variation in cycles of spectra with different RT levels. Spectra from this and Reference 9 programs show the same behavior. Using RT = 4000 as the reference point, there is an eight-fold increase in the number of cycles if the RT level is lowered to 1500 psi. In actual cycle-by-cycle analysis and testing costs this would represent a similar increase in costs. Looking back at Figure 5-3, the optimum RT level would appear to be somewhere around 2250 psi. This represents around five-fold increase in the number of cycles relative to the 4000-psi truncation level and a corresponding decrease in life in the vicinity of 50 percent. In general, the optimum RT level may vary as a function of spectrum, material, geometry of the crack and structural details and crack length.

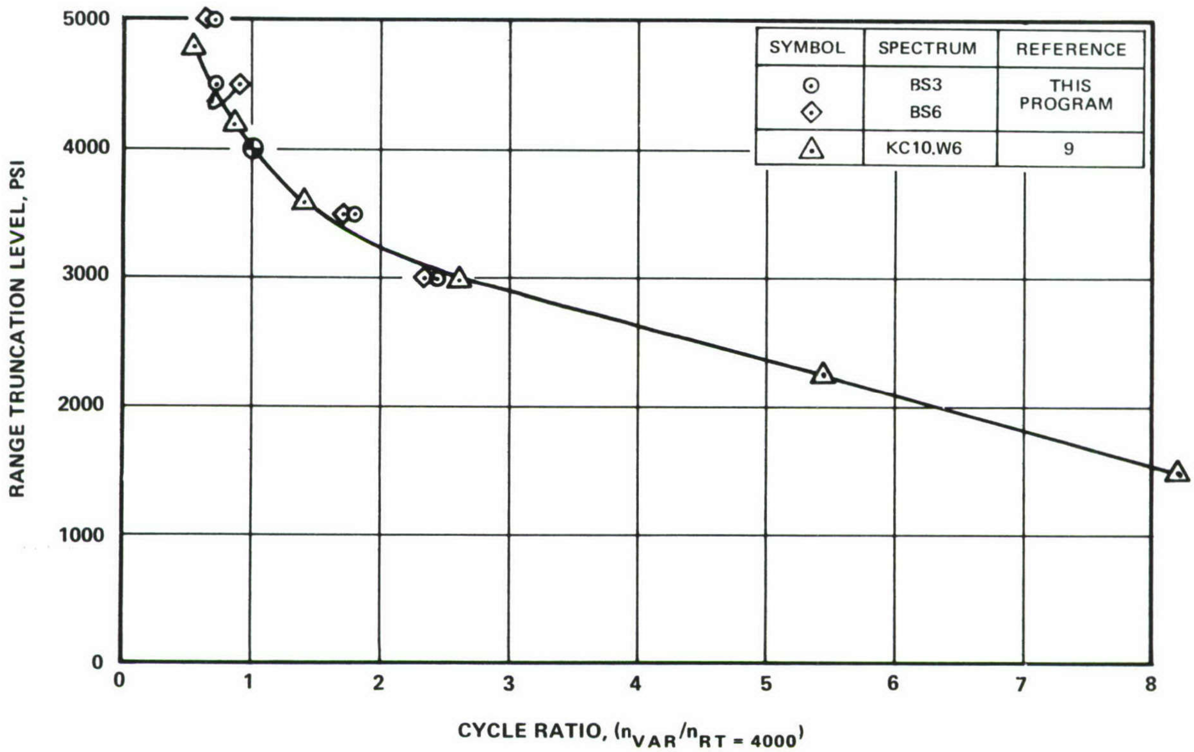


FIGURE 5-4. EFFECT OF RANGE TRUNCATION ON NUMBER OF CYCLES IN SPECTRUM

Compression Cycles – The other variation considered in this group was the number of compression-compression taxi cycles in the spectrum. Usually, in testing and analysis spectra, compression-compression cycles are left out completely, leaving only a representative compression valley so it can form, with a tension loading, a $-R$ value cycle. Analysis and test results for these variations are given in Table 5-4. The number of taxi cycles per landing was varied from 1.0 to an average of 25.9 in the baseline spectrum BS6. Analysis shows no effect on crack growth. The test of a spectrum with 25.9 cycles per landings showed a 15-percent decrease in life relative to the baseline spectrum with 3.5 cycles per landing. The effect is not significant. Whether this is just test data scatter or a real effect is not certain. However, test results with another spectrum (BS6.CLP3), in which all compression stresses were eliminated showed a 37-percent increase in life, relative to the baseline spectrum, whereas analysis predicted only 6-percent increase. This appears to confirm that compression-compression cycles do contribute indirectly to crack growth, perhaps in the form of accelerating crack growth under tension-tension cycle loadings.

5.2.8 High Infrequent Loads

The statistics of loads distributions are most uncertain in the extremes of the distribution, in the area of infrequent loads. The effect of varying the frequency and magnitude of the 10 highest peak values in baseline spectra was investigated through the 21 spectra analyses and test results summarized in Table 5-5. The effect on peak loads distribution is illustrated in Figure 2-7. As test results indicate, linear analysis does not predict the effect of increasing the magnitude and/or frequency of the high infrequent loads. The evaluation of these effects will be done only on baseline spectrum BS6 on the basis of test results. The effect is significant or very significant in most cases, with life increases, due to retardation effects, ranging from 19 to 137 percent. Increasing the number of occurrences of the 10 highest peaks, in the 2500-flight-hour spectrum, to 100 and 200 increased the life by 43 and 48 percent. Increasing the magnitude of the 10 highest peaks (21,465 through 23,923 psi) to 27,750 and 33,056 psi increased the life 19 and 64 percent. Finally, increasing the magnitude and frequency to 33,056 psi and 200 cycles produced a life increase of 137 percent, indicating that retardation is a function of the magnitude and frequency of the high loads. The final question perhaps would be: how frequent must the infrequent loads become to cause a reduction in life?

TABLE 5-5
HIGH INFREQUENT LOADS SPECTRA VARIATIONS
EFFECT ON CRACK GROWTH

SPECTRUM	BS TEN HIGHEST PEAKS IN 2,500 FLT HR*		ΔN = FLT HR (a = 0.03 → 0.53 IN.)		$R_{\Delta N}$ $\left(\frac{\Delta N_{TEST}}{\Delta N_{ANAL.}}\right)$	$R'_{\Delta N} = \left(\frac{\Delta N_{VAR}}{\Delta N_{BS}}\right)$	
	MAGNITUDE (PSI) INCREASED TO	FREQUENCY INCREASED TO	ANAL.	TEST		ANAL.	TEST
BS1	–	–	16,255	15,365	0.95	–	–
BS1.HIL1	–	100	15,867			0.98	
BS1.HIL2	–	200	15,462			0.95	
BS1.HIL4	27,750	–	16,184			1.00	
BS1.HIL3	33,056	–	16,104			0.99	
BS1.HIL6	27,750	200	14,393			0.89	
BS1.HIL5	33,056	200	13,238			0.81	
BS3	–	–	1,124	1,368	1.22	–	–
BS3.HIL1	–	100	1,121			1.00	
BS3.HIL2	–	200	1,117			0.99	
BS3.HIL4	27,750	–	1,124			1.00	
BS3.HIL3	33,056	–	1,124			1.00	
BS3.HIL6	27,750	200	1,123			1.00	
BS3.HIL5	33,056	200	1,102			0.98	
BS6	–	–	4,212	4,140	0.98	–	–
BS6.HIL1	–	100	4,190	5,929	1.42	0.99	1.43
BS6.HIL2	–	200	4,160	6,136	1.48	0.99	1.48
BS6.HIL4	27,750	–	4,210	4,920	1.17	1.00	1.19
BS6.HIL3	33,056	–	4,206	6,772	1.61	1.00	1.64
BS6.HIL6	27,750	200	4,190			0.99	
BS6.HIL5	33,056	200	4,001	9,819	2.45	0.95	2.37

*BS1: 19,657 → 22,114 PSI
BS3: 22,003 → 24,588 PSI
BS6: 21,465 → 23,923 PSI

5.2.9 Clipping of Large Loads

In the previous variations, the high infrequent loads magnitude and frequency were increased. The result was an increase in life. In this group of variations the emphasis is in the other direction, i.e., deletion of the tension or compression extreme loads. For an example illustration see Figure 2-7. Two of the variations deal with the tension loads and two with compression:

SPECTRUM	DESCRIPTION	ΔN = FLT HR ($a = 0.03 \rightarrow 0.53$ IN.) ANAL.	TEST	$R_{\Delta N}$ $\left(\frac{\Delta N_{TEST}}{\Delta N_{ANAL.}}\right)$	$R'_{\Delta N} = \left(\frac{\Delta N_{VAR}}{\Delta N_{BS6}}\right)$ ANAL.	TEST
BS6	BASELINE SPECTRUM, HIGHEST TENSION = 23,923 PSI, HIGHEST COMPRESSION = −24,298 PSI	4212	4140	0.98	–	–
BS6.CLP1	ALL STRESSES ABOVE 21,531 PSI SET EQUAL TO 21,531 PSI; AFFECTS APPROX 10 CYCLES*	4212			1.00	
BS6.CLP2	ALL STRESSES ABOVE 17,942 PSI SET EQUAL TO 17,942 PSI; AFFECTS APPROX 300 CYCLES*	4217			1.00	
BS6.CLP3	ALL STRESSES BELOW ZERO SET EQUAL TO ZERO; AFFECTS APPROX 18,000 CYCLES*	4451	5679	1.28	1.06	1.37
BS6.CLP4	ALL STRESSES BELOW −5000 PSI SET EQUAL TO −5000 PSI; AFFECTS APPROX 5000 CYCLES*	4302			1.02	

*IN 2500 FLIGHT HOURS

With respect to clipping of the tension loads, spectra CLP1 and CLP2, analysis results are considered invalid in view of the HIL spectra variations test results, see Section 5.2.8. The expectation is that clipping the high infrequent loads will decrease life by removing peaks causing retardation in the baseline spectrum.

In the other category of clipping the compression loads, spectra CLP3 and CLP4, analysis prediction which shows basically no effect, is not accepted as valid in view of 37-percent increase in life exhibited by the test result.

5.2.10 Miscellaneous Variations

Ten variations were generated mainly to investigate some of the mechanics of spectra development. They were concerned with the averaging interval of the incremental load factor spectrum, varying the repeatable spectrum length, simplifying the random spectrum, looking into the possible effect of a load alleviation system, producing a different sequence of cycles within a flight, and finally a spectrum with the elimination of all taxi, landing impact, and GAG cycles. The analysis and test results are presented in Table 5-6. In view of the good correlation of analysis and test results in this group (if not always in magnitude, at least in trends) as well as similar spectra in other groups, analysis results are used to evaluate these spectra variations, with some doubt with respect to spectrum MISC10.

TABLE 5-6

EFFECT OF MISCELLANEOUS SPECTRA VARIATIONS ON CRACK GROWTH

SPECTRUM	DESCRIPTION	ΔN = FLT HR (a = 0.03 → 0.53 IN.)		$R_{\Delta N}$ $\left(\frac{\Delta N_{TEST}}{\Delta N_{ANAL.}}\right)$	$R'_{\Delta N} = \left(\frac{\Delta N_{VAR}}{\Delta N_{BS}}\right)$	
		ANAL.	TEST		ANAL.	TEST
BS1	BASELINE SPECTRUM	16,255	15,365	0.95	–	–
BS1.MISC7	EFFECT OF LOAD ALLEVIATION SYSTEM	15,393			0.95	
BS1.MISC9	DIFFERENT SEQUENCE OF CYCLES WITHIN A FLIGHT	12,721	10,265	0.81	0.78	0.67
BS3	BASELINE SPECTRUM, 5112 FLIGHTS	1,124	1,368	1.22	–	–
BS3.MISC8	600 (293 FLIGHT HOURS) FLIGHT BS3 SPECTRUM	1,127			1.00	
BS6	BASELINE SPECTRUM; 2500 FLIGHT HOURS; FLIGHT LOADS AVERAGING INTERVAL Δg = 0.10	4,212	4,140	0.98	–	–
BS6.MISC1	FLIGHT LOADS AVERAGING INTERVAL Δg = 0.05	4,229			1.00	
BS6.MISC2	FLIGHT LOADS AVERAGING INTERVAL Δg = 0.20	2,179	2,937	1.35	0.52	0.71
BS6.MISC3	250 FLIGHT HOUR BS6 SPECTRUM	4,239			1.01	
BS6.MISC4	500 FLIGHT HOUR BS6 SPECTRUM	4,248			1.01	
BS6.MISC5	1,250 FLIGHT HOUR BS6 SPECTRUM	4,222			1.00	
BS6.MISC6	SIMPLIFIED BS6 SPECTRUM	5,029	4,298	0.85	1.19	1.04
BS6.MISC10	NO TAXI, LANDING IMPACT OR GAG CYCLES	4,848			1.15	

Load Alleviation System (Spectrum BS1.MISC7) – Use of flight loads alleviation system on an existing airplane to reduce design loads because of increase in design gross weight, without adding material, would have the tendency of increasing the flight 1.0g stresses and decreasing the incremental stress ($d\sigma$ /dLF). This situation was simulated by increasing the 1.0g stresses on the average of 14 percent and decreasing the incremental stresses by an average of 10 percent. The net result was only 5-percent life decrease indicating that the two parameter changes were almost self-canceling with respect to crack growth.

Cycle Sequence in Flight (Spectrum BS1.MISC9) – All maneuver and gust stress cycles of a flight, as developed on a segment-by-segment basis for the baseline spectrum, were combined into one segment from which the random sequence of valleys and peaks was picked. In effect, this spectrum variation eliminated the natural order of flight segments. The effect is a decrease in life, not very significant, but nevertheless consistent in analysis (22 percent) and test (33 percent) to recommend avoidance of such simplification.

Spectrum Length (Spectra BS3.MISC8 and BS6.MISC3 through MISC5) – The baseline spectra repeatable sequence of 2500 flight hours, which is one-tenth of the required service life for the airplane, were decreased to one-hundredth, one-fiftieth and one-twentieth of the service life. There was no effect on crack growth.

Loads Averaging Interval (Spectra BS6.MISC1 and MISC2) – The maneuver and gust incremental load factor averaging interval of $\Delta g = 0.10$ in the baseline spectrum was changed to $\Delta g = 0.05$ and 0.20. Decreasing the interval to 0.05 made no effect on crack growth. Increasing the interval to 0.20 produced a substantial effect, a 48-percent decrease in life by analysis (29 percent by test). The $\Delta g = 0.10$ interval appears to be a good value to use.

Simplified Spectrum (Spectrum BS6.MISC6) – The baseline spectrum was simplifed into a flight-by-flight spectrum with a reduced number of loading conditions and the cycles within a flight sequenced in a lo-hi-lo block spectrum. For more details see Section 2.3.12. The spectrum equivalence was good (19 percent increase in life by analysis, only 4 percent by test), indicating that such equivalencing can be used where practical.

Elimination of Ground and GAG Cycles (Spectrum BS6.MISC10) – What effect do the ground compression and GAG cycles have on crack growth? It was shown in other tests (Spectra BS6.LLT5, BS6.CLP3) that compression cycles decreased life. However, analysis does not show this effect. Removal of the GAG cycles is expected to increase the life. This expectation is borne out; analysis shows a 15-percent increase. A final answer for this situation could come only from experimental results, although a 15-percent contribution to the crack growth by the GAG cycle has been found from experiments, Reference 10, to be a representative value.

5.2.11 Combined Variations

Thirteen combined variation spectra, where more than one spectrum parameter is varied, were generated. Analysis and test results are presented in Table 5-7. Analysis verification must be done on a case-to-case basis.

Valley/Peak Coupling and Range Truncation (Spectra BS6.COMB1 and COMB2) – With respect to the baseline spectrum, VPC was changed from random to restricted and RT from 4000 to 3500 and 3000 psi. Since no tests were run from this group, analysis verification and, in general, evaluation of these results must be made with reference to the previously discussed individual variation results. The effect of changing the VPC from random to restricted was a small reduction (9 percent) in life, see Section 5.2.6. Reduction of RT level to 3500 and 3000 psi produced 16- and 25-percent reduction in life, see Section 5.2.7. In both variations analysis results were verified by test results. The combined variation effects of 29 and 33 percent in life reduction are not very significant and are approximated by the sum of the effects of the individual variation (25 and 34 percent).

Design Stress Level and Range Truncation (Spectra BS6.COMB3 through COMB6) – There is good correlation between the analysis and the test results. The combined effects are significant,

TABLE 5-7

EFFECT OF COMBINED VARIATIONS SPECTRA ON CRACK GROWTH

SPECTRUM	DESCRIPTION		ΔN = FLT HR ($a = 0.03 \rightarrow 0.53$ IN.)		$R_{\Delta N}$ $\left(\frac{\Delta N_{TEST}}{\Delta N_{ANAL.}}\right)$	$R'_{\Delta N} = \left(\frac{\Delta N_{VAR}}{\Delta N_{BS6}}\right)$	
			ANAL.	TEST		ANAL.	TEST
BS6	BASELINE SPECTRUM: VPC = RANDOM, RT = 4000 PSI, TEN HIGHEST PEAKS = 21,465 → 23,923 PSI		4,212	4,140	0.98	–	–
BS6.COMB1	VALLEY/PEAK COUPLING (RESTRICTED) AND RANGE TRUNCATION	RT = 3500 PSI	2,990			0.71	
BS6.COMB2		RT = 3000 PSI	2,830			0.67	
BS6.COMB3	DESIGN STRESS LEVEL AND RANGE TRUNCATION	MF = 1.15, RT = 3500 (1.15)	1,900	2,438	1.28	0.45	0.59
BS6.COMB4		MF = 1.15, RT = 3000 (1.15)	1,797			0.43	
BS6.COMB5		MF = 0.9, RT = 4500 (0.9)	6,874			1.63	
BS6.COMB6		MF = 0.9, RT = 3500 (0.9)	5,260	5,290	1.01	1.25	1.28
BS6.COMB7	HIGH INFREQUENT LOADS AND RANGE TRUNCATION (3500 PSI)	TEN HIGHEST PEAKS: 33,056 PSI AND n = 200	3,219			0.76	
BS6.COMB8		TEN HIGHEST PEAKS: 27,750 PSI AND n = 200	3,286			0.78	
BS6.COMB12		TEN HIGHEST PEAKS: SAME AS BS6, n = 100	3,344	3,522	1.05	0.79	0.85
BS6.COMB9	DESIGN STRESS LEVEL AND HIGH INFREQUENT LOADS (TEN HIGHEST PEAKS = 27,750 PSI AND n = 200)	MF = 1.15	2,421			0.57	
BS6.COMB10		MF = 0.74	13,584			3.23	
BS6.COMB11	NO GROUND OR GAG CYCLES, FLIGHT 1.0 g STRESS = 0, STRESSES INCREASED 100 PERCENT		4,836*	12,922*	2.67*	2.20*	6.65*
BS6.COMB13	SPECTRUM BS6.COMB11 WITH 35 PERCENT HIGHER STRESSES		873**	2.908**	3.33**	0.84**	2.60**

*$a = 0.03 \rightarrow 0.188$ IN.

**$a = 0.213 \rightarrow 0.372$ IN.

with life increases or decreases up to 63 percent. The effect of range truncation is similar at the two design stress levels (MF = 1.15 and 0.9) as for the baseline spectrum (MF = 1.0):

	$(R'_{\Delta N})_{ANAL.} = (\Delta N_{VAR}/\Delta N_{BS})$		
RT (PSI)	MF = 0.9	MF = 1.0	MF = 1.15
4500	1.05	1.06	
4000	–	–	–
3500	0.81	0.84	0.78
3000		0.75	0.74

High Infrequent Loads and Range Truncation (Spectra BS6.COMB7, COMB8, and COMB12) – There is good correlation between the analysis and the one test result, BS6.COMB12. However, the test result does not appear to follow the trends established in the individual variation tests. Effect of HIL was to increase the life, and there was no correlation between test and analysis results, see Section 5.2.8. The effect of lowering the RT from 4000 to 3500 psi is to decrease the life, see Section 5.2.7. However, this decrease is much lower than the increase due to HIL, so that the expected trend in these combined variations would be an overall increase in life. Is this just scatter in test data or a loading interaction effect not well understood and of course not accounted by the linear analysis? The loading interaction effect might be, as discussed in Section 5.2.7, a decreased retardation due to having less frequent retarding peaks in terms of the number of cycles between these peaks. As a consequence of these observations, no conclusions are made about the results in this group. More refined analysis and confirmation of the test result are needed.

Design Stress Level and High Infrequent Loads (Spectra BS6.COMB9 and COMB10) – In view of the noncorrelation of HIL effect by analysis (Section 5.2.8), analysis results of this group are also considered to be unverified. The analysis results only reflect the effect of the DSL changes, similar as in the individual variations, see Section 5.2.5.

Highly –R Value Spectrum (Spectra BS6.COMB11 and COMB13) – These spectra are drastically different from all the previous spectra. The basic features of these spectra are: no taxi, landing impact, or GAG cycles; flight 1.0g stresses set to zero and then the stresses increased 100 and 135 percent. Almost all cycles have a negative stress ratio R. The spectrum does not represent the wing loading. It can be viewed, in general terms, and not specifically with respect to the C-15 aircraft, as an example of a vertical tail spectrum. There is no correlation between test and analysis results. Test life is very significantly longer, in the vicinity of 300 percent. With respect to the wing baseline spectrum BS6, life is very significantly longer by a factor of 6.65 and 2.60 for the two spectra. Note that the crack lengths over which the comparisons are made for these spectra are shorter than for the other spectra, approximately 0.15 versus 0.50 inch.

SECTION 6

SUSTAINED COMPRESSION AND FASTENER EFFECTS

This section contains the interpretation of experimental results on the effect of sustained compression loadings and of fasteners in holes on crack growth under spectrum loading.

6.1 SUSTAINED COMPRESSION LOADING

Many aircraft structures in service are subjected to sustained compression loadings (SCL). The wing lower surface, which is the structure selected for this program, is a prime example of such loading while the aircraft is on the ground. Evidence (Reference 7) of life-shortening effects of such loadings on the fatigue life under constant amplitude loading prompted the experimental crack growth investigation described in Section 4.3.

Crack growth tests were performed on five specimens loaded by a random cycle-by-cycle, flight-by-flight C-15 wing lower surface spectrum. The test represented 4000 flight hours and flights of loading. Two of the specimens were subjected to sustained compression loading, represented by the 1.0 g preflight ground stress, for 297 out of 344 hours of test duration. Each specimen was designed to have three through-the-thickness cracks: a crack out of an open hole, a crack out of a hole with a neat fit fastener, and a crack at the edge of specimen. However, in precracking, not all cracks initiated at the same time and consequently, not all of the test data is usable for comparative evaluation. For further details of the experimental program and results see Section 4.3 and Table C-36.

The experimental data which is directly comparable is shown in Figure 6-1. The comparisons show (see Figure 6-2) that on the average, the crack out of the hole with the fastener, in 4000 flight hours, propagated only 2.8 percent faster when the SCL were applied. Similar comparison of crack growth out of an open hole, over shorter lifetimes, indicates the opposite trend; the SCL reduced crack growth by about 14 percent. Within the scope and scatter of this experimental data, it must be concluded that there is no significant effect of sustained compression loading on crack growth under a realistic spectrum loading.

6.2 FASTENER EFFECT

What effect does a fastener in a hole have on the growth of a crack out of the hole? In real structures the effect is a function of several factors: amount of interference, torque-clamping force, and bearing load. However, what is the effect in the most simple case if the above factors, except a neat fit straight-shank fastener with no torque applied (no head or nut), are eliminated? Stress intensity factor K solution, based on finite element analysis, for this simple case indicates (Reference 8, Figure 16) a reduction in K up to $(a/r) = 0.3$. To check this simple case, two

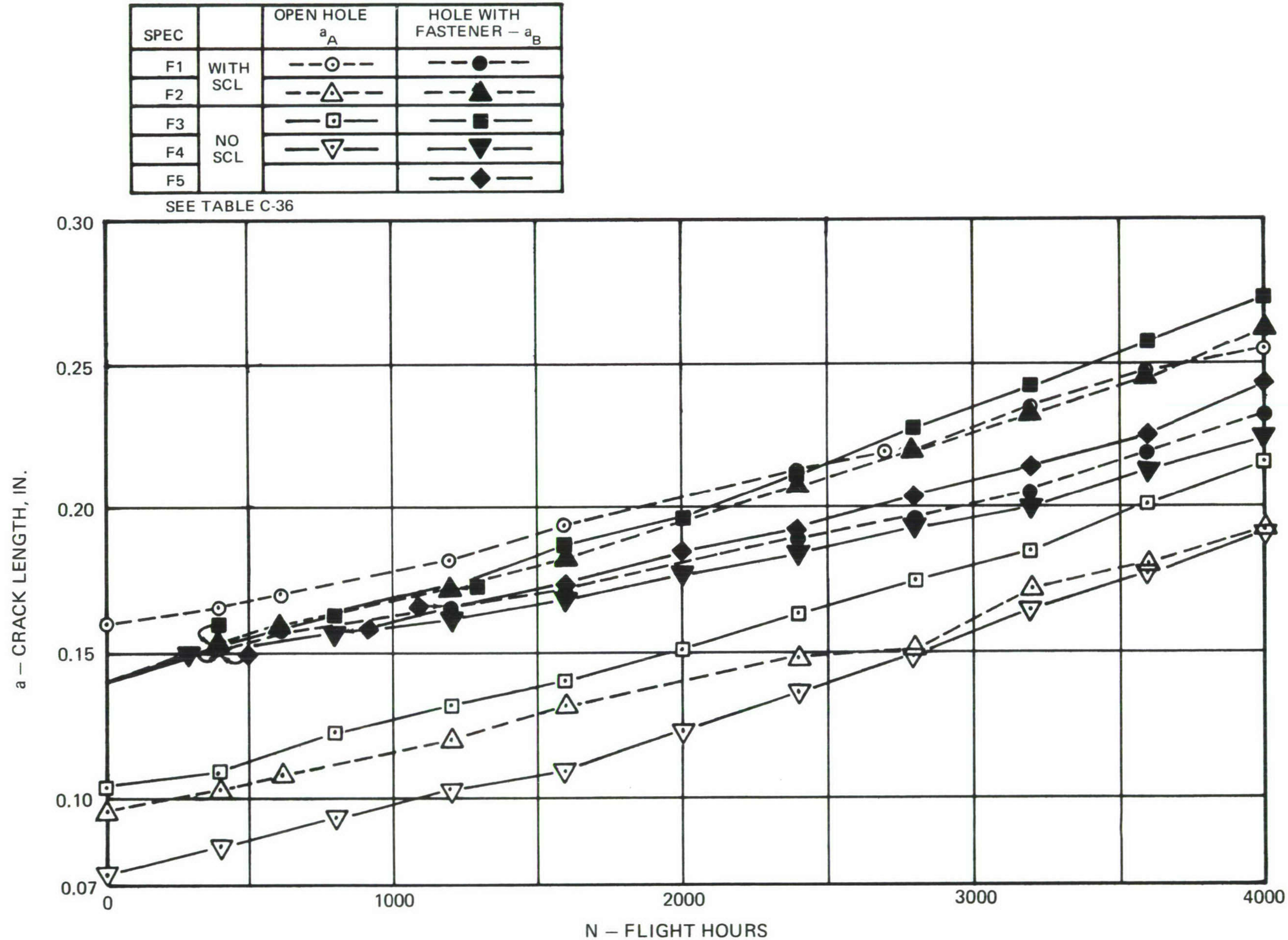


FIGURE 6-1. CRACK GROWTH UNDER SPECTRUM LOADING WITH AND WITHOUT SUSTAINED COMPRESSION LOADING

MATERIAL: 7475-T7651, t = 0.25 IN.
THE AMOUNT (Δa) THAT A THRU-THE-THICKNESS CRACK ON ONE SIDE OF A HOLE GREW IN ΔN FLIGHT HOURS OF SPECTRUM LOADING, STARTING WITH CRACK LENGTH a_i:

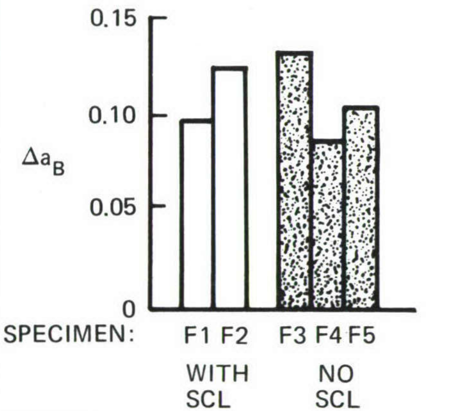
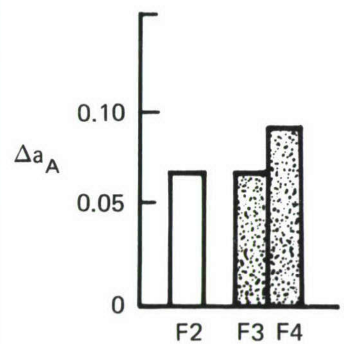
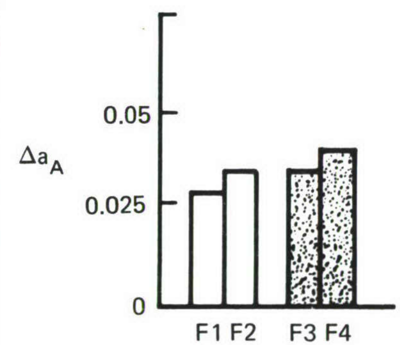
HOLE WITH FASTENER	OPEN HOLE	
a_i (IN.) = 0 0.140 ΔN (FLTS) = 4,000	0.104 2,700	0.160 1,100
		
AVE Δa = 0.109 0.106	0.068 0.079	0.031 0.036
RATIO = (Δa WITH SCL/Δa NO SCL):		
AVE 1.028	0.861	0.859

FIGURE 6-2. EFFECT OF SUSTAINED COMPRESSION LOADING (SCL) ON CRACK GROWTH UNDER SPECTRUM LOADING

specimens (A1 and A2) in the spectrum variation test series had a titanium Hilok fastener installed in one of the holes, neat fit (0.0001-inch clearance), no head or nut. The starting point of (a/r) in these tests was (0.03/0.125) = 0.24. According to the above-mentioned stress intensity factor solution, the effect of the fastener at this crack length is less than 5 percent. Figure 6-3 shows specimen A1 and A2 test results, with the comparison of crack growth out of a hole with and without a fastener. Comparison of crack growth lives, over comparable crack lengths, shows the following:

SPECIMEN	a(IN.)	OPEN HOLE	FILLED HOLE	$\frac{N_{FILLED}}{N_{OPEN}}$
A1	0.132→0.53	2710	3678	1.36
A2	0.036→0.353	3100	6017	1.94

Comparison of specimen A1 data is only up to a = 0.53 inch, because of the cracking assumed to have started on the other side of the open hole after this point, whereas there was no cracking on the other side of the filled hole. The comparison shows a large slowdown in crack growth due to the presence of a neat fit pin in the hole. This is a much larger effect than any available stress intensity factor solution would indicate. The smaller effect in specimen A1 is attributed to the longer initial crack length. A similar comparison can be made with the sustained compression loading test data of Figure 6-1:

SPECIMEN	a(IN.)	OPEN HOLE	FILLED HOLE	$\frac{N_{FILLED}}{N_{OPEN}}$
F1	0.160→0.232	3125	3191	1.02
F2	0.140→0.193	2000	1920	0.96
F3	0.140→0.216	2400	2525	1.05
F4	0.140→0.192	1467	2756	1.88

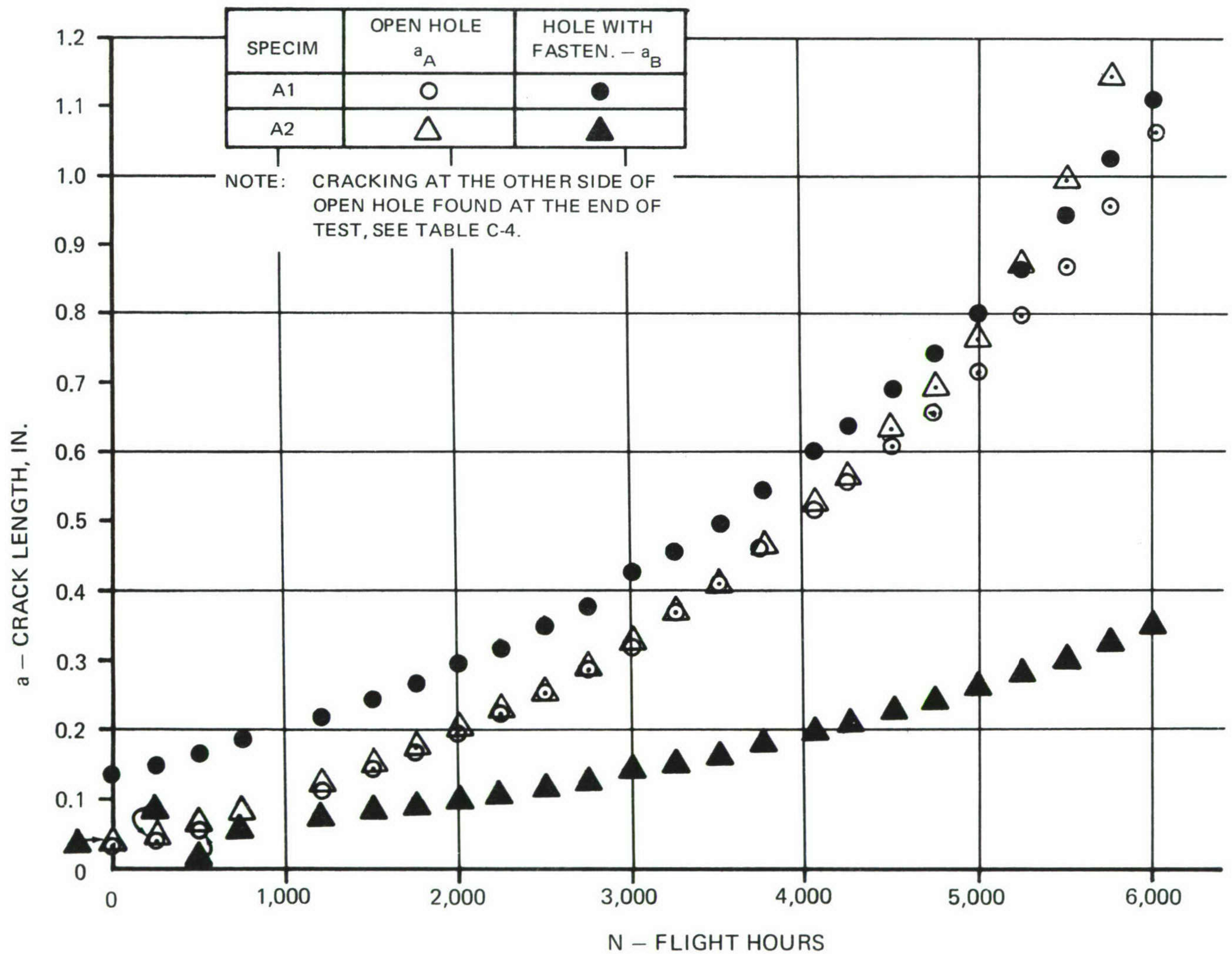


FIGURE 6-3. EFFECT OF FASTENER IN HOLE ON CRACK GROWTH, SPECTRUM BS6

Here, in three out of four specimens the pin showed very little effect. In the fourth specimen, the effect was a substantial reduction in crack growth rate, similar to the previous data. The large differences and lack of crack growth rate reduction in three of the tests may be attributed to scatter and the longer initial cracks.

Additional test data on this subject are available from Reference 9. These data are presented here to clarify the findings of this program. The specimens were 9.0-inch-wide panels with a 1/4-inch-diameter hole with a 0.05-inch (0.12-inch-deep) corner precrack. Two materials were tested: 2024-T351 bare plate and 7075-T651 plate machined from an extrusion, both 0.25 inch thick. The titanium Hilok was installed neat fit with a resulting interference between 0.0001 and 0.0002 inch. The spectrum was a transport/tanker (KC-10A) wing lower surface random cycle-by-cycle, flight-by-flight loading sequence. Tests were performed with three different spectra with the range truncation (RT) being the variable. The results:

MATERIAL	SPECTRUM RT (PSI)	a(IN.)	$\frac{N_{FILLED}}{N_{OPEN}}$
2024	3000	0.048→0.415	2.34
2024	3600	0.053→0.577	2.55
2024	4200	0.054→0.574	1.70
7075	3000	0.052→0.572	1.30
7075	3600	0.053→0.579	1.89
7075	4200	0.052→0.572	1.40

These results definitely indicate that the installation of a neat fit pin in a hole results in a significant reduction of the crack growth rate of a crack out of the hole. This reduction is greatest at short cracks, but is still prevalent even at a $>$ 0.5 inch, see Figure 6-4.

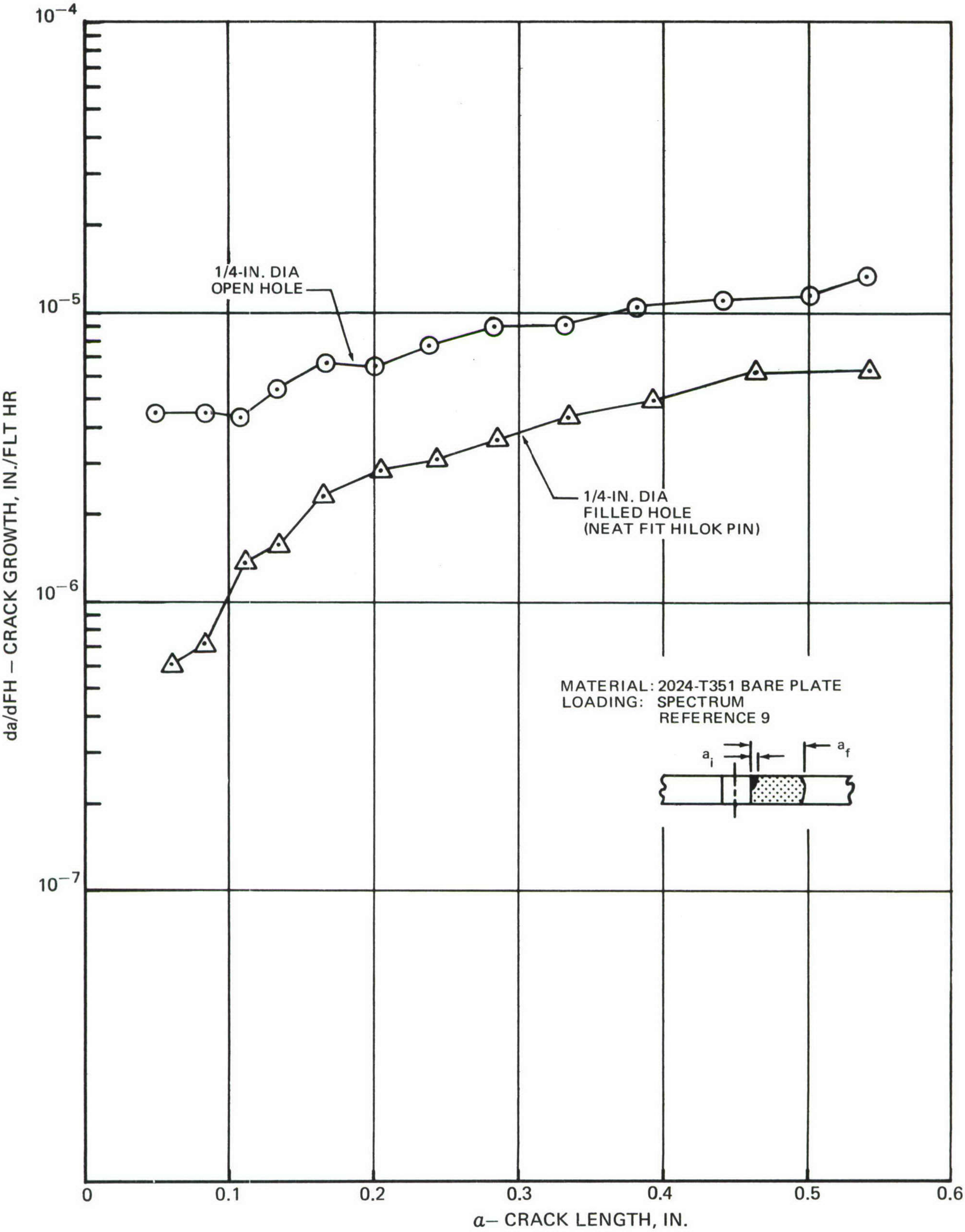


FIGURE 6-4. EFFECT OF NEAT FIT PIN IN A HOLE ON CRACK GROWTH OF A CRACK OUT OF THE HOLE

SECTION 7

SUMMARY AND RECOMMENDATIONS

The program consisted of generating 116 spectrum variations of a baseline spectrum representing a transport wing lower surface loading. The loading was modeled for the C-15 advanced medium STOL aircraft. The effect of these variations on crack growth was established analytically and experimentally using a crack growing out of a 1/4-inch-diameter hole in 7475-T7651 aluminum alloy 0.25-inch-thick plate. Analysis and experimental data were produced to represent 1.0 inch of cracking, starting with a through-the-thickness crack of 0.03 inch. The first half inch of this cracking was used to evaluate the spectrum variation effects.

In addition to the above major part of the program, experiments were performed to determine the effect of sustained compression loading and fasteners in holes on crack growth

This section presents a summary of the findings of this program and recommendations for the development of loads spectra for transport/bomber aircraft.

7.1 CRACK GROWTH PREDICTION

As designated at the outset of the program, the analysis crack growth prediction model was to be chosen on the basis of the baseline spectrum test results. This procedure resulted in the selection of the linear model as opposed to models with retardation features. Subsequent analysis of the other 32 spectra which were tested showed good correlation between analysis and test results for all categories of spectra variations with the exception of variations on high infrequent loads and spectra which were drastically changed from a wing spectrum to a spectrum representative of the vertical tail. For the majority (73 percent) of spectra the analysis prediction was conservative, i.e., faster crack growth than test data. In 73 percent of the cases the test results were within ±30 percent of analysis.

The spectrum loading interaction effects are exhibited in the form of crack growth retardation and acceleration phenomena. The baseline spectra test results correlated well with linear analysis results because the retardation and acceleration features of the spectrum canceled each other. The highest peak in the 2500-flight-hour baseline spectrum was 23,923 psi or 69 percent of the design limit stress. Test results reflect the following:

1. Retardation – Produced by increased magnitude and frequency of high infrequent loads.

2. Acceleration – Due to compression loads and increase in the number of compression-compression cycles. The effect was not as large as the retardation due to high infrequent loads. Also, acceleration is assumed to exist during high-loading cycles following low-loading cycles.

7.2 EFFECT OF SPECTRA VARIATIONS ON CRACK GROWTH

The 116 spectra variations were divided into 13 categories. A summary of the effect of these variations on crack growth within each category is presented in Table 7-1. The effects of these variations are classified as not significant, significant or very significant on the basis of the crack growth variation with respect to the baseline or a reference spectrum being less than 20 percent, between 20 and 100 percent, and more than 100 percent. The classification is arbitrary. It is simply a relative classification of the effects on crack growth. Note that the life in this evaluation is measured in terms of flight hours. Flight hour is considered to be the most common parameter used in keeping track of transport and bomber aircraft life. Use of any other parameter, such as landings, could produce in some instances a different interpretation of the results. The evaluation is based on analysis results with the exception of those cases where analysis results were not verified by the test results. The spectrum categories in each of the three classifications are:

Not Significant:

- **SEQUENCE OF MISSIONS. Negligible effect of having different random or ordered sequences of individual flights.**

- **FLIGHT SEGMENTS. Reduction of the number of climb and descent gust segments, application of cruise segment load factor-stress transfer function to climb and descent segments or elimination of landing impact cycles produced small effect.**

- **LOW LOAD TRUNCATION. COMPRESSION LOADS. Decreasing the number of compression-compression taxi cycles from 25.9 to 3.5 per landing increased life 18 percent. This is a test result. Analysis shows no effect in varying the number of compression- compression cycles in the spectrum.**

- **LOAD ALLEVIATION SYSTEM. Simulation of a load alleviation effect on flight loads (14-percent increase in 1.0g stresses and 10 percent decrease in incremental stresses) produced only a 5-percent decrease in life.**

- **SPECTRUM LENGTH. Negligible effect resulted from the variation in the repeatable spectrum length from 2500 to 293 flight hours, where 2500 flight hours are one-tenth of required service life.**

- **SIMPLIFIED SPECTRUM. Simplification of the random spectrum into an equivalent flight-by-flight spectrum, with a lo-hi-lo block cycle arrangement within a flight, produced good correlation with the random spectrum, only a 4-percent increase in life (test result).**

- **NO GROUND OR GAG CYCLE. Elimination of ground compression and GAG cycles produced only a 15-percent increase in life (analysis result).**

TABLE 7-1
EFFECT OF SPECTRA VARIATIONS ON CRACK GROWTH – SUMMARY

SPECTRUM VARIATION	NO. OF SPECTRA	NUMBER TESTED	$R'_{\Delta N} = (\Delta N_{VAR}/\Delta N_{BS})$ (ΔN = FLT HR, a = 0.03 → 0.53 IN.) ANAL	TEST	LEVEL OF EFFECT ON CRACK GROWTH $\Delta R'_{\Delta N} = \lvert(R'_{\Delta N})_{HIGH} - 1\rvert$ OR $= \lvert(R'_{\Delta N})_{LOW} - 1\rvert$: $\Delta R'_{\Delta N} < 0.2$ NOT SIGNIFICANT	$0.2 \leq \Delta R'_{\Delta N} \leq 1.0$ SIGNIFICANT	$\Delta R'_{\Delta N} > 1.0$ VERY SIGNIFICANT
BASELINE SPECTRA (BS)	6	6	0.27 → 18.60	0.33 → 16.19			X
MISSION MIX (MM):	14	2	0.26 → 8.01	0.96 → 3.78			X
AMOUNT OF TRAINING	(4)	(1)	(0.71 → 1.13)	(0.96)		X	
LOW ALTITUDE PENETRATION TIME	(3)	(2)	(0.27 → 3.43)	(0.33 → 3.78)			X
SEQUENCE OF MISSION (SM)	4	0	0.96 → 1.01	–	X		
INDIVIDUAL FLIGHT LENGTH (FL)	6	1	1.66 → 21.43	7.90			X
FLIGHT SEGMENTS (FS)	5	0	0.99 → 1.14	–	X		
EXCEEDANCE SPECTRA (ES)	4	1	0.66 → 1.66	1.93		X	
DESIGN STRESS LEVEL (DSL)	10	3	0.33 → 3.66	0.42 → 3.21			X
VALLEY/PEAK COUPLING (VPC)	6	1	0.78 → 0.95	0.91		X	
LOW LOAD TRUNCATION (LLT):							
RANGE TRUNCATION (RT)	14	4	0.72 → 1.09	0.60 → 1.28		X	
TAXI CYCLES	2	1	1.00 → 1.00*	0.85	X		
HIGH INFREQUENT LOADS (HIL)	18	5	0.81 → 1.00*	1.19 → 2.37			X
CLIPPING LARGE LOADS (CLP)	4	1	1.00 → 1.06*	1.37		X	
MISCELLANEOUS (MISC):							
LOAD ALLEVIATION SYSTEM	1	0	0.95	–	X		
CYCLE SEQUENCE IN FLIGHT	1	1	0.78	0.67		X	
SPECTRUM LENGTH	4	0	1.00 → 1.01	–	X		
LOADS AVERAGING INTERVAL	2	1	0.52 → 1.00	0.71		X	
SIMPLIFIED SPECTRUM	1	1	1.19	1.04	X		
NO GROUND OR GAG CYCLES	1	0	1.15	–	X		
COMBINED (COMB):							
VPC + RT	2	0	0.67 → 0.71	–		X	
DSL + RT	4	2	0.43 → 1.63	0.59 → 1.28		X	
HIL + RT	3	1	0.76 → 0.79*	0.85(?)		X	
DSL + HIL	2	0	0.57 → 3.23*	–			X
VERTICAL TAIL SPECTRUM	2	2	0.84 → 2.20*	2.60 → 6.65			X
TOTAL	116	33					

*ANALYSIS RESULTS NOT VERIFIED BY TEST RESULTS.

Significant:

- MISSION MIX – AMOUNT OF TRAINING. Variation in the percentage of the total time spent in training produced relatively small variation (29 percent) in life when measured in flight hours. However, if life is measured in landings, then the effect appears to be much more significant. For example, an almost five-fold increase in number of landings when going from the baseline spectrum (20.4-percent time in training) to 100-percent training with touch-and-go landings only.

- EXCEEDANCE SPECTRA. Increasing or decreasing the number of cycles of flight loads by 15 percent produced approximately the same percentage decrease and increase in life. However, variation of the flight loads exceedance curve slopes by 15 percent produced life changes up to 66 percent.

- VALLEY/PEAK COUPLING. The random valley/peak couplings in the six baseline spectra were changed to a restricted coupling. In five of the six spectra the effect was small, a decrease in life up to 9 percent, but in spectrum BS5 the decrease was 22 percent.

- LOW LOAD TRUNCATION – RANGE TRUNCATION. Life reduction of close to 50 percent was observed when the range truncation level was lowered from 4000 psi in the baseline spectra toward 2000 psi in the variations at the expense of a six-fold increase in the number of cycles in the spectrum. An optimum truncation level appears to be around 2250 psi.

- CLIPPING LARGE LOADS. Analysis showed no effect when tension loads were clipped. In view of other test results, a decrease in life is expected due to this variation. Clipping all the loads below zero (excluding compression) produced a 37-percent increase in life (test result).

- CYCLE SEQUENCE IN FLIGHT. The cycles within a flight were chosen at random from any flight segment, without regard to the normal sequence of flight segments. The result (test) was a 33-percent decrease in life.

- LOADS AVERAGING INTERVAL. The averaging interval of the incremental load factors in the exceedance spectra of the baseline spectra was $\Delta g = 0.10$. The variations were generated with $\Delta g = 0.05$ and 0.20. Use of $\Delta g = 0.05$ produced no effect. Use of $\Delta g = 0.20$ resulted in 48 percent decrease in life. Use of $\Delta g = 0.10$ in transport/bomber spectra development is recommended.

- COMBINED VARIATIONS. Combined variations of valley/peak coupling, design stress level, and high infrequent loads with different range truncation level than the 4000 psi of the baseline spectra produced life variations with changes up to 63 percent. Variation involving HIL was not verified.

Very Significant:

- BASELINE SPECTRA. Baseline spectra, consisting of individual missions as compared to the composite mission mix spectrum BS6, produced variations from a 73-percent decrease to an almost 19-fold increase in life.

- MISSION MIX. Different mission mixes, including individual flights, produced large life variations, ranging from a 74-percent decrease to an eight-fold increase in life. The mission with the largest influence on crack growth was Mission 3 which is exclusively composed of low-altitude penetration flying. Variation of this flying time in a mission mix from zero to 100 percent produces almost a 13-fold decrease in life.

- INDIVIDUAL FLIGHT LENGTH. Variation of Mission 1 flight lengths from approximately 0.5 to 4.0 hours produced up to five-fold increase in life. However, if life is measured in terms of landings, this increase in flight length reduces life only up to 30 percent, indicating that the crack growth per flight is not very sensitive to flight length when other factors are held constant or adjusted to reflect the flight length.

- DESIGN STRESS LEVEL. Changing the loads spectrum by multiplying all the streses in the spectrum can be viewed as the effect of basic change in design stress level or change in usage severity. Decreasing the stresses by 26 percent or increasing by 35 percent produced a life increase of at least 266 percent and a decrease of at least 67 percent.

- HIGH INFREQUENT LOADS. Increase of the magnitude and/or frequency of the 10 highest peaks in the baseline spectra produced retardation effects which increased life up to 137 percent. Linear analysis did not account for this effect.

- COMBINED VARIATION – DESIGN STRESS LEVEL AND HIGH INFREQUENT LOADS. The large effect on crack growth life, from 43-percent decrease to 223-percent increase, established by analysis, represents only a partial effect, since analysis does not account for the HIL variation effect.

- VERTICAL TAIL SPECTRUM. A drastic change from a wing lower surface spectrum to one typical of a vertical tail loading produced a very large increase in life (up to 665 percent) which the linear analysis was not able to predict by a large margin.

7.3 TRANSPORT VERSUS BOMBER SPECTRA

Fatigue loads spectra vary as a function of aircraft type and its usage. Also, different parts of the aircraft experience different spectra. The study in this program was based on a transport high wing root lower surface spectrum. How applicable are the findings of this program to a bomber wing spectrum or to any other transport or bomber structure spectrum? The varieties of spectra as a function of aircraft and structure type are too numerous to have been evaluated within the scope of this program. However, a comparison was made of several transport and bomber wing lower surface spectra for the purpose of evaluating the same structure spectra between the two types of aircraft. For general completeness, a fighter wing lower surface spectrum was also considered. The aircraft and spectra were:

Aircraft	Spectrum	Reference
STOL Transport (C-15) (High Wing)	Composite mission mix, BS6, RT = 3000 and 4000 psi. Wing root.	This Program
Tanker-Cargo (KC-10A) (Low Wing)	Composite mission mix, RT = 2250 psi. Outboard of main landing gear.	9
Fighter (F-15)	Composite mission mix baseline. Wing mid-span.	3
Bomber (B-1) (Variable Sweep Wing)	Center wing and wing root.	11, 12
Bomber (B-52) (High Wing)	Test spectrum. Wing mid-span.	13

The spectra represent different types of wings: high wing with main landing gear in fuselage, low wing with main landing gear in wing, and variable sweep wing with main landing gear in the fuselage. Location of the landing gear influences the magnitude of the ground stresses. Landing gear in the fuselage means higher compression stresses.

Wing lower surface spectrum cycles can be grouped into flight, ground, and ground-to-air transition (GAG) cycles. Stress ratio (R) and peak distribution of the flight loads cycles are compared in Figures 7-1 and 7-2. Noting that some of the differences between these spectra are due to different methods of spectrum generation and truncation, and in the case of the B-52 spectrum, simplifications for a test spectrum, transport and bomber spectra are considered to be similar as opposed to the fighter spectrum. Stress ratios (R) of most cycles in the transport and bomber spectra fall between 0.6 and 0.8 whereas in the fighter spectrum the Rs are distributed approximately evenly between 0.0 and 0.8. The distribution of peak loads with respect to the highest peak in the spectrum shows similar trends for all spectra with most cycles falling in the 40 to 60 percent of the highest peak interval. Some deviations from this general observation, in the case of the B-52 and B-1 (center wing), are attributed to simplification of the B-52 spectrum for testing purposes and the effect of the variable wing sweep on the B-1 center wing. However, the highest peak in the spectrum, when considering aluminum alloys only, is significantly higher in the fighter spectrum (over 30,000 psi) than for transport and bomber spectra (approximately 20,000 to 24,000 psi).

The magnitude of the ground cycles, and indirectly of the GAG cycles, depends on the location of the landing gear, usually related to the type of the wing (high or low), and the spanwise location represented by the spectrum. Transport and bomber ground stresses tend to be higher in compression than for fighter spectra. This produces higher negative R GAG cycles in transport and bomber spectra than in fighter spectra.

In conclusion, limiting ourselves to the wing lower surface, it can be stated that the transport and bomber spectra are similar and the findings of this program are applicable to both types of aircraft.

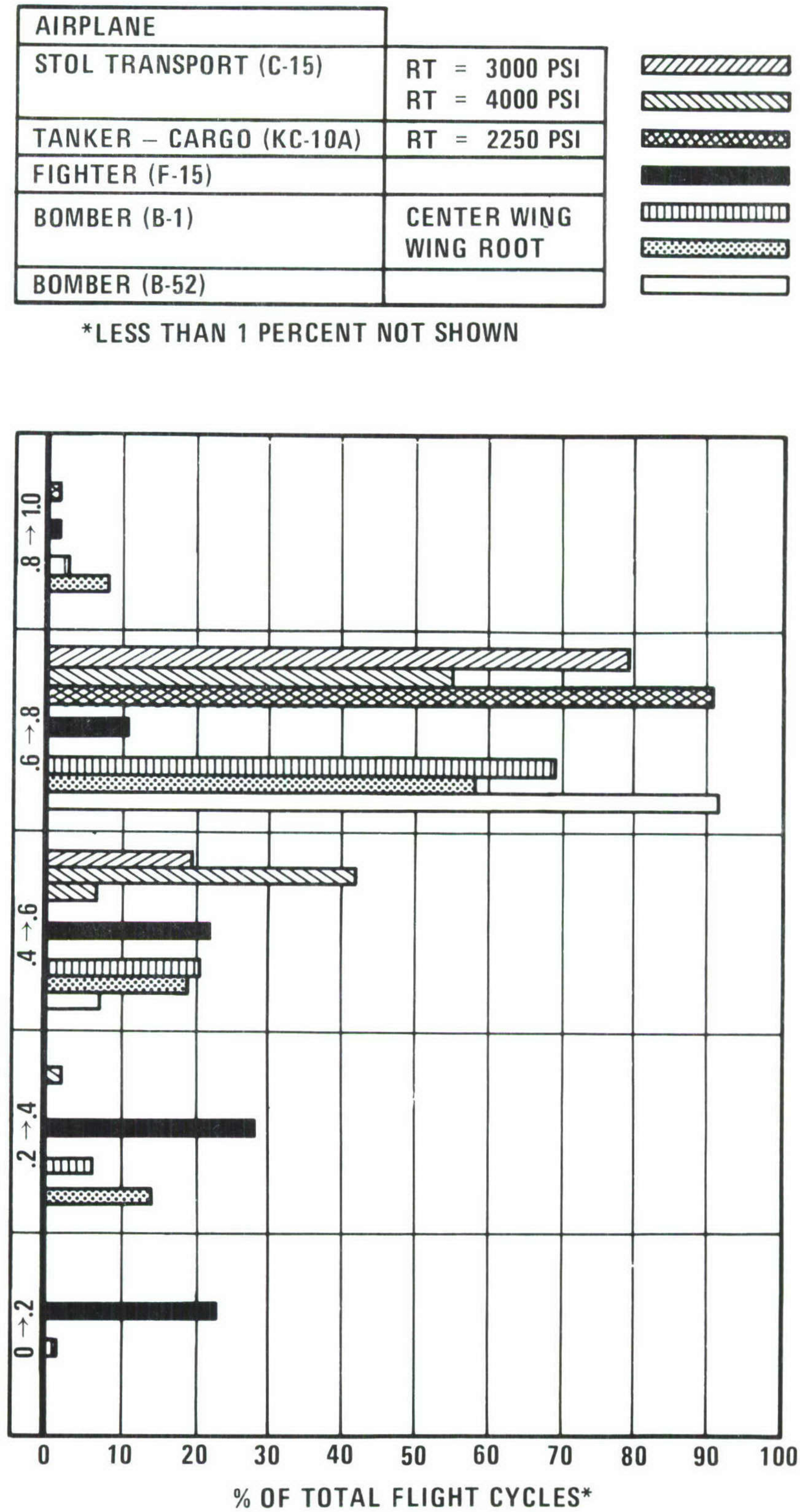


FIGURE 7-1. R DISTRIBUTION OF FLIGHT LOADS CYCLES FOR VARIOUS AIRPLANE TYPES, WING LOWER SURFACE

AIRPLANE		MATERIAL	HIGHEST PEAK, PSI
STOL TRANSPORT (C-15)	RT = 3000 PSI RT = 4000 PSI	7475 ALUM	23,923
TANKER – CARGO (KC-10A)	RT = 2250 PSI	2024 ALUM	19,914
FIGHTER (F-15)		7075 ALUM	30,420
BOMBER (B-1)	CENTER WING WING ROOT	6A-4V Ti 2219 ALUM	51,842 21,660
BOMBER (B-52)		2024 ALUM	24,200

*LESS THAN 1 PERCENT NOT SHOWN

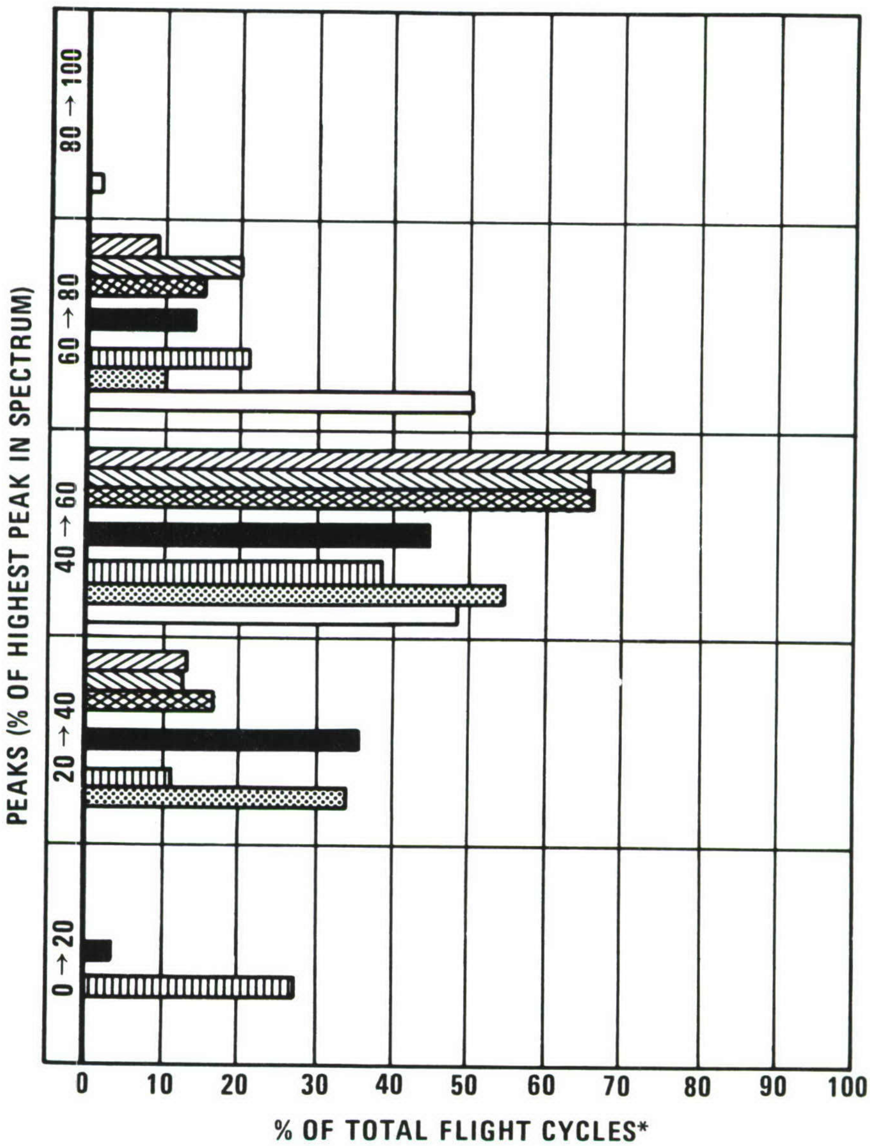


FIGURE 7-2. PEAK DISTRIBUTION OF FLIGHT LOADS CYCLES FOR VARIOUS AIRPLANE TYPES, WING LOWER SURFACE

7.4 SUSTAINED COMPRESSION EFFECT ON CRACK GROWTH

Crack growth tests were performed to check the effect of sustained compression loading (SCL) on crack growth under representative spectrum loading conditions. In the case of the wing lower surface, the SCL is viewed as representing the loading while the airplane is stationary on the ground.

The test showed no significant effect of the SCL on crack growth of a crack out of a 1/4-inch-diameter hole in a 0.25-inch plate, 7475-T7651 aluminum alloy. The SCL, represented by the pre-flight 1.0g ground stress, was applied 86 percent of the time in a 344-hour test representing 4000 flight hours of spectrum loading, during which the crack was propagated approximately 0.1 inch. Cracking data were obtained from open and fastener-filled holes.

7.5 EFFECT OF A FASTENER IN A HOLE ON THE CRACK GROWTH OF A CRACK OUT OF THE HOLE

Tests with spectrum loadings were performed on open and fastener-filled (neat fit) hole specimens, 7475-T7651 material, to check the effect of the fastener on the crack growth out of the hole. The tests, substantiated by similar results with 2024 and 7075 aluminum alloys from another program, indicate a significant crack growth rate reduction due to the presence of a neat fit pin in the hole. Life to propagate a crack from a fastener-filled hole over 0.5 inch of cracking was found to be up to 2.5 times longer than for a crack from an open hole. Such magnitude effect is not predictable using presently available stress intensity solutions for cracks out of fastener-filled holes.

7.6 ESTIMATE OF CRACK GROWTH VARIATION IN A FLEET OF AIRCRAFT DUE TO LOADS SPECTRUM VARIATION.

What is the loads spectra variation in a fleet of aircraft and how much such variations affect crack growth? This question is answered here in the light of the results of this program

The variations in loads spectra can be considered as short term or long term. Short term is viewed as the variation between spectra over a short period of time, say one-tenth of lifetime or less, on the same or different aircraft in the fleet. Long term is viewed as the variation between spectra of different aircraft over a time period approaching the service life of the aircraft. Short-term variations are considered with respect to crack growth in structures with frequent inspection requirements, while the long-term variations are considered to apply to slow crack growth structures which require very few or no inspections during the lifetime of the airplane.

Of the 116 spectrum variations considered in this program, 47 are considered as representing realistic variations in a fleet of aircraft. The remaining variations were generated in order to establish spectrum development procedures. The 47 variations, listed in Table 7-2, are considered to apply to short-term variations. Long-term variations are represented by 24 of these spectra, Table 7-2. An example of short- and long-term variations is that in the former, a spectrum based on a single flight type or mission will be considered, whereas only a mix of missions is considered in the long-term variations.

Based on the overall low and high $R'_{\Delta N}$ values given in Table 7-2 for the short- and long-term variations, the following crack growth variations can be expected in a fleet of aircraft:

SPECTRUM VARIATION	CRACK GROWTH VARIATION FACTOR			
	SHORT LIFE	BASELINE	HIGH LIFE	OVERALL
SHORT-TERM	3.85	1.00	21.43	82.42
LONG-TERM	3.03	1.00	3.06	11.09

In conclusion, thinking in terms of round numbers, crack growth variation overall factors of 100 and 10 appear to be appropriate numbers to express the difference between the fastest and slowest crack growth rates due to short-term and long-term spectra variations.

TABLE 7-2
SPECTRUM VARIATIONS APPLICABLE TO FLEETWIDE VARIATION

SPECTRUM VARIATION	SHORT-TERM VARIATION		LONG-TERM VARIATION	
	NO. OF SPECTRA	$R'_{\Delta N}$*	NO. OF SPECTRA	$R'_{\Delta N}$*
BASELINE SPECTRA	6	0.27 → 18.60	0	—
MISSION MIX	14	0.26 → 8.01	5	0.59 → 3.43
SEQUENCE OF MISSIONS	4	0.96 → 1.01	4	0.96 → 1.01
FLIGHT LENGTH	6	1.66 → 21.43	0	—
EXCEEDANCE SPECTRA	4	0.66 → 1.66	4	0.66 → 1.66
DESIGN STRESS LEVEL	4	0.33 → 3.66	4	0.33 → 3.66
LOW-LOAD TRUNCATION – TAXI CYCLES	2	0.85	2	0.85
HIGH INFREQUENT LOADS	5	1.19 → 2.37	5	1.19 → 2.37
COMBINED – DSL + HIL	2	0.57 → 3.23**	0	—
TOTAL	47	0.26 → 21.43	24	0.33 → 3.66

*ANALYSIS, EXCEPT TEST WHERE ANALYSIS NOT VERIFIED.
**PARTIAL EFFECT

7.7 RECOMMENDATIONS FOR SPECTRUM DEVELOPMENT

Development of a fatigue loads spectrum for a transport or a bomber aircraft is an involved process consisting of the following steps:

1. Definition of expected utilization and mission profiles. The utilization and mission profiles are taken to be averages.

2. Exceedance data of the loading environments in which the aircraft will operate. For transport and bomber aircraft, the loadings to consider are:

   a. Ground loads – taxi, takeoff run, landing rollout, landing impact, and ground maneuvers (turning, braking, pivoting, towing, steering).

   b. Flight maneuvers, function of mission type and flight segment.

   c. Gusts, turbulence parameters are a function of altitude.

   d. Fuselage pressurization.

   Exceedance data for these loading environments for transport and bomber aircraft are given in MIL-A-008866B. These data should be modified if not directly applicable or more reliable data are available.

3. Mission profiles are divided into segments. A segment is a portion of the mission profile that can be represented by average exceedance spectra and stress parameters without jeopardizing the integrity of the spectrum. Examples of typical segmentation are shown in Appendix A. Climb and descent segments are a function of the flaps position and gust turbulence parameters which are specified for specific altitude intervals. In the case of the structural element considered in this program (root lower surface of a straight wing), reduction in the number of climb and descent segments was found to be possible without any significant effects on crack growth. However, no generalization can be made on this point. Each spectrum must be evaluated individually to see if such simplifications are acceptable.

4. Conversion from exceedance data parameters into loads or stress units applicable to the type of spectrum desired. Typical exceedance data parameters are: airplane cg load factors, gust velocities, landing sink rates, runway-taxiway roughness, braking coefficients, etc. Use of these parameters in conjunction with the specific airplane configurations defined in mission profile segments in terms of gross weight, fuel, payload, speed and time or distance traveled produce unique sets of loads spectra. Transfer functions between the exceedance data general parameters and load-stress should reflect, where appropriate and significant, the dynamic response characteristics of the rigid and elastic modes of the airplane.

5. Generation of the loading sequence should be as realistic as possible with respect to cycle and flight-mission sequence. Based on results of this program, the following guidelines should be used in generating the loading sequence.

   a. Make the length of the spectrum repeatable sequence approximately one-tenth of the projected service lifetime requirement. This implies that the highest loads in the spectrum are those normally encountered in that time interval. Increasing the length would increase the highest load magnitude and produce more retardation. This would tend to produce a slower crack growth rate dependent on encountering the higher loads. This could be viewed as unconservative. On the other hand, decreasing the length would tend to produce conservative crack growth estimates, unless the less frequent loads are added in after a number of the spectrum repetitions.

   b. Unless there is a specific requirement, sequence the missions in a random manner.

   c. Sequence the segments within a flight in a natural sequence.

   d. Choose the sequence of cycles within a segment in a random manner.

   e. Use the random valley/peak coupling.

   f. Use of the above guidelines will produce a random cycle-by-cycle, flight-by-flight spectrum. In any simplificiation of such spectrum, if desired for cost effectiveness in testing or analysis, should retain the 25 highest peaks as they were, average other loading cycles into a fewer number of different loadings while retaining the same number of cycles, average transition cycles of large periodic mean load changes (such as GAG cycle) separately from other loading cycles, retain flight-by-flight format and use a lo-hi-lo sequence of cycles within a flight. Distribute the 25 highest peaks in the spectrum at equal intervals.

   g. Use $\Delta g = 0.10$ as the averaging interval in the incremental load factor exceedance spectra usage.

   h. In order to eliminate cycles which do not contribute to crack growth, exclude cycles with ranges less than 2250 psi, tension-tension, and tension-compression cycles. The optimum truncation level is a function of spectrum type, material, structural detail and crack length. The value quoted here is considered to be applicable to aluminum alloys of 2000 and 7000 series.

   i. Compression loadings. Retain all compression valleys (do not clip) in compression-tension cycles. Compression-compression cycles appear to increase crack growth rate. Range truncation level was not established for these types of cycles.

6. With the availability of computers for analysis and testing, simplification of random cycle-by-cycle, flight-by-flight realistic sequence spectra should be kept to a minimum. Simplifications will always raise the question of equivalence.

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APPENDIX A
MISSION PROFILE AND STRESS DATA

This appendix contains a detail description of the five missions used in the formulation of the loads spectra in this study. Each flight is divided into segments. A segment represents a portion of the flight, in-air or on the ground, during which the parameters which define the loads-stress spectra are constant or can be represented by an average. Pertinent information needed for the development of the spectrum is specified for each segment. This information is:

Segment description
Altitude
Average gross weight
Average speed
Time spent in segment
Distance traveled in segment
F and P constants which define the stress-load factor relationship, where
    stress = F (load factor) + P
One g stress
The stress is gross area stress.

TABLE A-1

MISSION PROFILE AND STRESS DATA
MISSION 1, FLIGHT 1A – BASIC AND ALTERNATE EMPLOYMENT

SEGMENT	ALTITUDE (FT x 10^{-3})	AVE GW (LB)	AVERAGE SPEED (M)	AVERAGE SPEED (KEAS)	TIME (HR)	DISTANCE (N MI)	F (PSI)	P (PSI)	1.0g STRESS (PSI)
PREFLIGHT GROUND, STOL TAKEOFF	SL	166,021	–	–	–	–	–8,736	0	–8,736
INITIAL CLIMB, FLAPS DOWN, 23 DEG	0-1	166,021	0.175	115	0.012	1.39	8,043	413	8,456
CLIMB	1-2.5	163,109	0.435	282	0.007	2.01	8,415	–1,716	6,699
	2.5-5		0.446	278	0.009	2.63			
	5-10		0.468	269	0.020	6.03			
	10-20		0.522	259	0.049	16.03			
	20-30		0.589	237	0.069	24.47			
CLIMB	30-37.7	163,109	0.652	216	0.120	45.40	8,415	–1,716	6,699
CRUISE	37.7-38.1	158,677	0.686	205	0.438	172.40	8,828	–2,021	6,807
DESCENT	38.1-30	156,213	0.685	225	0.044	17.46	8,927	–1,625	7,302
	30-20		0.621	250	0.064	23.92			
	20-10		0.503		0.069	21.76			
	10-5		0.434		0.037	10.36			
DESCENT	5-3		0.407	250	0.015	3.98	8,927	–1,625	7,302
DESCENT, FLAPS DOWN, 23 DEG	3-1.5		0.260	165	0.015	2.56	8,877	239	9,116
APPROACH, FLAPS DOWN, 33 DEG	1.5-5		0.208	135	0.011	1.51	8,877	322	9,199
APPROACH, FLAPS DOWN, 45 DEG	0.5-0	156,213	0.159	105	0.010	1.05	8,877	–256	8,621
LANDING, STOL	SL	155,609	–	85	–	–	8,910	–3,805	5,105
POSTFLIGHT GROUND	SL	155,609	–	–	–	–	–6,765	0	–6,765
			TOTAL:		0.989	352.96			

TABLE A-2

MISSION PROFILE AND STRESS DATA
MISSION 1, FLIGHT 1B – BASIC AND ALTERNATE EMPLOYMENT

SEGMENT	ALTITUDE (FT x 10^{-3})	AVE GW (LB)	AVERAGE SPEED (M)	AVERAGE SPEED (KEAS)	TIME (HR)	DISTANCE (N MI)	F (PSI)	P (PSI)	1.0g STRESS (PSI)
PREFLIGHT GROUND, CTOL TAKEOFF	SL	190,762	–	–	–	–	–7,070	0	–7,070
INITIAL CLIMB, FLAPS DOWN, 14 DEG	0-1	190,762	0.213	140	0.017	2.40	12,086	–1,089	10,997
CLIMB	1-2.5	187,441	0.449	291	0.007	2.07	12,227	–1,873	10,354
↕	2.5-5	↕	0.461	288	0.011	3.32	↕	↕	↕
	5-10		0.483	278	0.024	7.47			
	10-20		0.529	263	0.057	18.90			
	20-30		0.597	241	0.089	32.00			
CLIMB	30-35.2	187,441	0.661	225	0.101	38.92	12,227	–1,873	10,354
CRUISE	35.2-35.9	182,588	0.689	218	0.384	152.22	12,441	–2,228	10,213
DESCENT	35.9-30	179,764	0.690	233	0.033	13.26	12,284	–1,840	10,444
↕	30-20	↕	0.621	250	0.067	25.04	↕	↕	↕
	20-10		0.503	↕	0.073	23.02			
	10-5		0.434		0.039	10.92			
DESCENT	5-3		0.407	250	0.017	4.51	12,284	–1,840	10,444
DESCENT, FLAPS DOWN, 23 DEG	3-1.5		0.260	165	0.030	5.12	12,243	–149	12,094
APPROACH, FLAPS DOWN, 33 DEG	1.5-0	179,764	0.193	126	0.040	5.10	12,243	182	12,425
LANDING, CTOL	SL	178,884	–	102	–	–	6,765	1,393	8,158
POSTFLIGHT GROUND	SL	178,884	–	–	–	–	–5,709	0	–5,709
			TOTAL:		0.989	344.27			

TABLE A-3

MISSION PROFILE AND STRESS DATA
MISSION 2, FLIGHT 2 – LONG-RANGE LOGISTICS

SEGMENT	ALTITUDE ($FT \times 10^{-3}$)	AVE GW (LB)	AVERAGE SPEED (M)	AVERAGE SPEED (KEAS)	TIME (HR)	DISTANCE (N MI)	F (PSI)	P (PSI)	1.0g STRESS (PSI)
PREFLIGHT GROUND, CTOL TAKEOFF	SL	231,313	–	–	–	–	–11,534	0	–11,534
INITIAL CLIMB, FLAPS DOWN, 14 DEG	0-1	231,313	0.222	146	0.019	2.79	11,690	–1,411	10,279
CLIMB	1-2.5	227,558	0.467	302	0.008	2.46	11,435	–2,096	9,339
	2.5-5		0.475	296	0.013	4.04			
	5-10		0.482	277	0.030	9.32			
	10-20		0.529	263	0.080	26.52			
CLIMB	20-30.6	227,558	0.617	249	0.134	49.79	11,435	–2,096	9,339
CRUISE	30.6-36.4	195,510	0.687	229	5.055	2,016.44	9,677	–2,219	7,458
DESCENT	36.4-30	165,840	0.688	230	0.050	20.00	10,766	–1,691	9,075
	30-20		0.621	250	0.066	24.66			
	20-10		0.503		0.072	22.70			
	10-5		0.434		0.038	10.64			
	5-2.5		0.401		0.019	4.98			
DESCENT	2.5-1.5		0.392	250	0.008	2.06	10,766	–1,691	9,075
APPROACH, FLAPS DOWN, 23 DEG	1.5		0.233	150	0.083	12.73	10,709	33	10,742
APPROACH, FLAPS DOWN, 33 DEG	1.5-0	165,840	0.170	111	0.050	5.61	10,709	289	10,998
LANDING IMPACT, CTOL	SL	164,950	–	102	–	–	7,178	–117	7,061
POSTFLIGHT GROUND	SL	164,950	–	–	–	–	–5,858	0	–5,858
			TOTAL:		5.725	2,214.74			

TABLE A-4

MISSION PROFILE AND STRESS DATA
MISSION 3, FLIGHTS 3A AND 3B – LOW ALTITUDE RESUPPLY

SEGMENT	ALTITUDE ($FT \times 10^{-3}$)	AVE GW (LB)	AVERAGE SPEED (M)	(KEAS)	TIME (HR)	DISTANCE (N MI)	F (PSI)	P (PSI)	1.0g STRESS (PSI)
FLIGHT 3A:									
PREFLIGHT GROUND, STOL TAKEOFF	SL	166,352	–	–	–	–	–6,394	0	–6,394
INITIAL CLIMB, FLAPS DOWN, 23 DEG	0-1	166,352	0.175	115	0.012	1.39	10,354	429	10,783
CRUISE, LOW LEVEL	1	163,103	0.424	275	0.448	125.26	10,362	–1,287	9,075
APPROACH, FLAPS DOWN, 23 DEG	1	159,738	0.262	170	0.011	1.90	10,280	141	10,421
APPROACH, FLAPS DOWN, 33 DEG	1	159,738	0.208	135	0.008	1,10	10,280	342	10,622
APPROACH, FLAPS DOWN, 45 DEG	1-0	159,738	0.160	105	0.010	1.06	10,280	–262	10,018
LANDING, STOL	SL	159,230	–	85	–	–	6,683	–321	6,362
POSTFLIGHT GROUND	SL	159,230	–	–	–	–	–5,693	0	–5,693
			TOTAL:		0.489	130.71			
FLIGHT 3B:									
PREFLIGHT GROUND, CTOL TAKEOFF	SL	218,106	–	–	–	–	–9,323	0	–9,323
INITIAL CLIMB, FLAPS DOWN, 14 DEG	0-1	218,106	0.219	144	0.018	2.60	12,573	–1,238	11,335
CRUISE, LOW LEVEL	1	214,512	0.409	266	0.432	116.51	12,928	–1,914	11,014
APPROACH, FLAPS DOWN, 23 DEG	1	211,021	0.262	170	0.011	1.90	13,291	–357	12,934
APPROACH, FLAPS DOWN, 33 DEG	1-0	211,021	0.192	126	0.028	3.55	13,291	26	13,317
LANDING, CTOL	SL	210,600	–	102	–	–	9,776	–1,367	8,409
POSTFLIGHT GROUND	SL	210,600	–	–	–	–	–7,838	0	–7,838
			TOTAL:		0.489	124.56			

TABLE A-5

MISSION PROFILE AND STRESS DATA
MISSION 4, FLIGHT 4A – BASIC TRAINING

SEGMENT	ALTITUDE (FT x 10^{-3})	AVE GW (LB)	AVERAGE SPEED (M)	AVERAGE SPEED (KEAS)	TIME (HR)	DISTANCE (N MI)	F (PSI)	P (PSI)	1.0g STRESS (PSI)
PREFLIGHT GROUND, STOL TAKEOFF	SL	167,630	–	–	–	–	–8,910	0	–8,910
INITIAL CLIMB, FLAPS DOWN, 23 DEG	0-1	167,630	0.175	115	0.012	1.39	7,920	446	8,366
CLIMB	1-2.5	166,424	0.435	282	0.005	1.43	8,011	–1,452	6,559
↕	2.5-5	↕	0.446	278	0.009	2.63	↕	↕	↕
↕	5-10	↕	0.468	269	0.020	6.03	↕	↕	↕
CLIMB	10-15	166,424	0.498	260	0.023	7.25	8,011	–1,452	6,559
CRUISE	15	164,732	0.522	259	0.123	40.23	8,234	–2,063	6,171
DESCENT (SPIRAL), FD, 23 DEG	15-8	163,482	0.253	135	0.078	12.55	8,333	64	8,397
DESCENT (SPIRAL), FD, 33 DEG	8-1	163,482	0.172	105	0.078	8.76	8,333	315	8,648
APPROACH, FLAPS DOWN, 45 DEG	1-0	163,482	0.137	90	0.017	1.54	8,333	289	8,044
LANDING, STOL, TOUCH AND GO	SL	163,050	–	85	–	–	9,818	–5,402	4,416
GROUND, STOL TAKEOFF	SL	163,050	–	–	–	–	–8,044	0	–8,044
(1) INITIAL CLIMB, FLAPS DOWN, 23 DEG	0-1	162,032	0.175	115	0.012	1.39	8,432 8,687	464 480	8,896 9,167
(1) GO-AROUND CRUISE	1.0	↕	0.385	250	0.059	14.98	8,440 8,698	–1,345 –1,312	7,095 7,386
(1) APPROACH, FLAPS DOWN, 23 DEG	1.0	↕	0.262	170	0.011	1.90	8,432 8,687	111 118	8,543 8,805
(1) APPROACH, FLAPS DOWN, 33 DEG	1.0	↕	0.208	135	0.008	1.10	8,432 8,687	363 340	8,795 9,027
(1) APPROACH, FLAPS DOWN, 45 DEG	1-0	↕	0.160	105	0.010	1.06	8,432 8,687	–241 –214	8,191 8,473
(1) LANDING, STOL	SL	↕	–	85	–	–	9,776 9,529	–5,201 –4,651	4,575 4,878
(1) GROUND, TOUCH AND GO, STOL TAKEOFF	SL	162,032	–	–	–	–	–7,838 –7,260	0 0	–7,838 –7,260

(1) REPEATED TWICE IN A ROW. AVERAGE GW = 160,051 SECOND TIME.

– CONTINUED ON NEXT PAGE

TABLE A-5 (CONT)

MISSION PROFILE AND STRESS DATA
MISSION 4, FLIGHT 4A – BASIC TRAINING

	SEGMENT	ALTITUDE (FT x 10^{-3})	AVE GW (LB)	AVERAGE SPEED (M)	AVERAGE SPEED (KEAS)	TIME (HR)	DISTANCE (N MI)	F (PSI)	P (PSI)	1.0g STRESS (PSI)
(1)	INITIAL CLIMB, FLAPS DOWN, 23 DEG	0-1	158,092	0.175	115	0.012	1.39	8,737 8,828	507 504	9,244 9,332
	GO-AROUND CRUISE	1.0		0.385	250	0.059	14.98	8,745 8,836	–1,361 –1,328	7,384 7,508
	APPROACH, FLAPS DOWN, 23 DEG	1.0		0.262	170	0.011	1.90	8,737 8,828	135 252	8,872 9,080
	APPROACH, FLAPS DOWN, 33 DEG	1.0		0.208	135	0.008	1.10	8,737 8,828	356 403	9,093 9,231
	APPROACH, FLAPS DOWN, 45 DEG	1-0		0.160	105	0.010	1.06	8,737 8,828	217 –200	8,520 8,628
	LANDING, STOL	SL		–	85	–	–	9,240 8,910	–4,278 –3,808	4,962 5,102
	GROUND, TOUCH AND GO, STOL TAKEOFF	SL	158,092	–	–	–	–	–7,013 –6,724	0 0	–7,013 –6,724
(2)	INITIAL CLIMB, FLAPS DOWN, 23 DEG	0-1	154,242	0.175	115	0.012	1.39	8,902 9,001	493 531	9,395 9,532
	GO-AROUND CRUISE	1.0		0.385	250	0.059	14.98	8,910 9,009	–1,386 –1,361	7,524 7,648
	APPROACH, FLAPS DOWN, 23 DEG	1.0		0.262	170	0.011	1.90	8,902 9,001	191 229	9,093 9,230
	APPROACH, FLAPS DOWN, 33 DEG	1.0		0.208	135	0.008	1.10	8,902 9,001	442 431	9,344 9,432
	APPROACH, FLAPS DOWN, 45 DEG	1-0		0.160	105	0.010	1.06	8,902 9,001	–111 –173	8,791 8,828
	LANDING, STOL	SL		–	85	–	–	8,580 8,168	–3,305 –2,805	5,275 5,363
	GROUND, TOUCH AND GO, STOL TAKEOFF	SL	154,242	–	–	–	–	–6,435 –6,188	0 0	–6,435 –6,188
				TOTAL:		0.965	204.39			

(1) REPEATED TWICE IN A ROW. AVERAGE GW = 156,156 SECOND TIME.
(2) REPEATED TWICE IN A ROW. AVERAGE GW = 152,353 SECOND TIME.
AFTER LAST LANDING, FULL CTOL LANDING ROLL AND TAXI.

TABLE A-6

MISSION PROFILE AND STRESS DATA
MISSION 4, FLIGHT 4B – BASIC TRAINING

SEGMENT	ALTITUDE (FT x 10^{-3})	AVE GW (LB)	AVERAGE SPEED (M)	AVERAGE SPEED (KEAS)	TIME (HR)	DISTANCE (N MI)	F (PSI)	P (PSI)	1.0g STRESS (PSI)
PREFLIGHT GROUND, CTOL TAKEOFF	SL	187,422	–	–	–	–	–6,600	0	–6,600
INITIAL CLIMB, FLAPS DOWN, 14 DEG	0-1	187,422	0.213	140	0.017	2.40	12,202	–978	11,224
CLIMB	1-2.5	186,470	0.442	286	0.006	1.75	12,251	–1,650	10,601
CLIMB	2.5-5	186.470	0.451	281	0.010	2.95	12,251	–1,650	10,609
CLIMB	5-10	186,470	0.451	260	0.021	6.10	12,251	–1,650	10,601
CRUISE	10	184,346	0.452	248	0.203	58.61	12,326	–1,848	10,478
DESCENT	10-5	182,210	0.434	250	0.039	10.88	12,201	–1,716	10,585
DESCENT	5-2.5	182,210	0.401	250	0.020	5.25	12,201	–1,716	10,585
DESCENT	2.5-1.5	182,210	0.392	250	0.008	2.06	12,201	–1,716	10,585
APPROACH, FLAPS DOWN, 23 DEG	1.5	182,210	0.233	150	0.083	12.73	12,293	–48	12,245
APPROACH, FLAPS DOWN, 33 DEG	1.5-0	182,210	0.170	111	0.050	5.61	12,293	204	12,497
LANDING, CTOL	SL	181,565	–	102	–	–	7,508	665	8,173
GROUND, TOUCH AND GO, CTOL TAKEOFF	SL	181,565	–	–	–	–	–5,957	0	–5,957
INITIAL CLIMB, FLAPS DOWN, 14 DEG	0-1	180,227	0.213	140	0.017	2.40	12,251	–907	11,344
GO-AROUND CRUISE	1.0		0.385	250	0.044	11.17	12,260	–1,353	10,907
APPROACH, FLAPS DOWN, 23 DEG	1.0		0.262	170	0.011	1.90	12,251	–51	12,200
APPROACH, FLAPS DOWN, 33 DEG	1.0	180,227	0.192	126	0.028	3.55	12,251	200	12,451
LANDING, CTOL	SL	178,890	–	102	–	–	6,724	1,446	8,170
POSTFLIGHT GROUND	SL	178,890	–	–	–	–	–5,709	0	–5,709
			TOTAL:		0.540	127.36			

APPENDIX B
STRESS SPECTRA SUMMARIES

This appendix contains the summaries of the 116 spectra developed in the study of spectrum variation. All stresses shown are gross area stresses. The summary for each spectrum presents the following information:

Spectrum identification (coding) and number
Spectrum description
Flight hours, flights and landings represented by the spectrum
Total cycles in the spectrum
Average number of cycles per flight and per flight hour
Range truncation level
Highest peak and lowest valley in the spectrum
Spectrum peak, range and R distributions.

TABLE B-1
SPECTRUM BS1 (NO. 1)

DESCRIPTION: BASELINE SPECTRUM, MISSION 1 (FLIGHTS 1A & 1B), BASIC AND ALTERNATE EMPLOYMENT

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	= 2,528
TOTAL CYCLES	= 45,807	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 18.1
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 18.3
HIGHEST PEAK (PSI)	= 22,114			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000				-1.5	71
-11,000				-1.2	1,088
-10,000		1,000		-1.0	28
-9,000		2,000		-.9	51
-8,000		3,000		-.8	98
-7,000		4,000	0	-.7	791
-6,000		5,000	22,091	-.6	231
-5,000	0	6,000	4,489	-.5	303
-4,000	5,151	7,000	10,241	-.4	47
-3,000	6,386	8,000	4,614	-.3	52
-2,000	110	9,000	1,362	-.2	0
-1,000	18	10,000	316	-.1	47
0	0	11,000	45	0	4
1,000		12,000	52	.1	89
2,000		13,000	9	.2	30
3,000		14,000	19	.3	235
4,000		15,000	0	.4	500
5,000	0	16,000	12	.5	3,897
6,000	499	17,000	7	.6	13,076
7,000	0	18,000	0	.7	12,294
8,000	212	19,000	19	.8	1,210
9,000	1,912	20,000	199	.9	0
10,000	4,795	21,000	101	1.0	0
11,000	2,676	22,000	298		11,665
12,000	1,111	23,000	1,372		
13,000	6,423	24,000	469		
14,000	11,103	25,000	77		
15,000	3,496	26,000	11		
16,000	1,528	27,000	0		
17,000	214	28,000	2		
18,000	123	29,000	0		
19,000	28	30,000	2		
20,000	14	31,000	0		
21,000	6	32,000			
22,000	1	33,000			
23,000	1	34,000			
24,000	0	35,000			
25,000					
26,000					
27,000					

TABLE B-2
SPECTRUM BS2 (NO. 2)

DESCRIPTION: BASELINE SPECTRUM, MISSION 2 (FLIGHT 2), LONG-RANGE LOGISTICS

FLIGHT HOURS	= 2,500	FLIGHTS = 437		LANDINGS	= 437
TOTAL CYCLES	= 10,422	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 23.9
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 4.2
HIGHEST PEAK (PSI)	= 17,915			SMALLEST VALLEY (PSI)	= −17,878

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	7
-11,000	142			-1.2	281
-10,000	0	1,000		-1.0	56
-9,000	0	2,000		-.9	82
-8,000	0	3,000		-.8	10
-7,000	569	4,000	0	-.7	1
-6,000	29	5,000	6,970	-.6	0
-5,000	1	6,000	1,945	-.5	0
-4,000	0	7,000	454	-.4	0
-3,000	688	8,000	100	-.3	0
-2,000	2	9,000	441	-.2	0
-1,000	0	10,000	65	-.1	1
0		11,000	9	0	2
1,000		12,000	1	.1	5
2,000		13,000	0	.2	14
3,000		14,000		.3	37
4,000		15,000		.4	166
5,000		16,000		.5	937
6,000		17,000		.6	3,753
7,000		18,000		.7	3,578
8,000	0	19,000		.8	61
9,000	149	20,000		.9	0
10,000	813	21,000	0	1.0	0
11,000	1,536	22,000	2		1,431
12,000	2,337	23,000	0		
13,000	2,788	24,000	82		
14,000	1,104	25,000	10		
15,000	209	26,000	7		
16,000	39	27,000	1		
17,000	13	28,000	263		
18,000	3	29,000	65		
19,000	0	30,000	6		
20,000		31,000	0		
21,000		32,000	1		
22,000		33,000	0		
23,000		34,000			
24,000		35,000			
25,000					
26,000					
27,000					

TABLE B-3
SPECTRUM BS3 (NO. 3)

DESCRIPTION: BASELINE SPECTRUM, MISSION 3 (FLIGHTS 3A AND 3B), LOW-ALTITUDE RESUPPLY

FLIGHT HOURS = 2,500	FLIGHTS = 5,112	LANDINGS	= 5,112
TOTAL CYCLES = 649,353	AVERAGE NO. OF CYCLES PER:	FLIGHT	= 127.0
RANGE TRUNCATION (PSI) = 4,000		FLIGHT HOUR	= 259.7
HIGHEST PEAK (PSI) = 24,588		SMALLEST VALLEY (PSI)	= −15,692

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	0
-9,000	50
-8,000	0
-7,000	4
-6,000	3,104
-5,000	4,878
-4,000	249
-3,000	14,651
-2,000	2,401
-1,000	206
0	5
1,000	0
2,000	
3,000	
4,000	
5,000	
6,000	0
7,000	480
8,000	0
9,000	29
10,000	2
11,000	144,790
12,000	146,858
13,000	159,844
14,000	13,959
15,000	124,574
16,000	25,754
17,000	6,108
18,000	353
19,000	814
20,000	186
21,000	38
22,000	1
23,000	12
24,000	2
25,000	1
26,000	0
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	217,955
6,000	300,738
7,000	91,063
8,000	25,321
9,000	3,504
10,000	4,183
11,000	1,051
12,000	270
13,000	85
14,000	13
15,000	26
16,000	11
17,000	7
18,000	0
19,000	5
20,000	3
21,000	225
22,000	1,227
23,000	995
24,000	239
25,000	18
26,000	1,928
27,000	83
28,000	355
29,000	35
30,000	12
31,000	1
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	21
-1.2	17
-1.0	150
-.9	1,963
-.8	760
-.7	1,920
-.6	334
-.5	43
-.4	0
-.3	39
-.2	2
-.1	86
0	16
.1	115
.2	359
.3	1,797
.4	7,276
.5	29,081
.6	166,302
.7	411,674
.8	1,850
.9	0
1.0	0
	25,548

TABLE B-4
SPECTRUM BS4 (NO. 4)

DESCRIPTION: BASELINE SPECTRUM, MISSION 4 (FLIGHTS 4A AND 4B), BASIC TRAINING

FLIGHT HOURS = 2,500	FLIGHTS = 3,111	LANDINGS	= 15,872
TOTAL CYCLES = 199,036	AVERAGE NO. OF CYCLES PER:	FLIGHT	= 64.0
RANGE TRUNCATION (PSI) = 4,000		FLIGHT HOUR	= 79.6
HIGHEST PEAK (PSI) = 28,841		SMALLEST VALLEY (PSI)	= −27,983

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	0
-4,000	15,272
-3,000	24,656
-2,000	2,360
-1,000	83
0	5
1,000	0
2,000	0
3,000	0
4,000	0
5,000	3,476
6,000	2,105
7,000	0
8,000	235
9,000	7,291
10,000	32,869
11,000	30,123
12,000	14,962
13,000	18,600
14,000	28,443
15,000	8,610
16,000	5,569
17,000	2,841
18,000	793
19,000	316
20,000	211
21,000	106
22,000	42
23,000	33
24,000	11
25,000	8
26,000	8
27,000	5
28,000	2
29,000	1
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	92,619
6,000	33,050
7,000	30,804
8,000	13,673
9,000	10,238
10,000	1,114
11,000	510
12,000	207
13,000	268
14,000	98
15,000	108
16,000	60
17,000	88
18,000	30
19,000	76
20,000	492
21,000	2,961
22,000	6,542
23,000	3,432
24,000	1,806
25,000	661
26,000	107
27,000	40
28,000	12
29,000	13
30,000	7
31,000	8
32,000	4
33,000	8
34,000	0
35,000	

R DISTRIBUTION

R	n
-1.5	762
-1.2	2,176
-1.0	4,165
-.9	4,124
-.8	2,767
-.7	1,221
-.6	1,762
-.5	617
-.4	693
-.3	341
-.2	439
-.1	308
0	623
.1	502
.2	889
.3	733
.4	3,240
.5	25,574
.6	59,546
.7	44,815
.8	1,363
.9	0
1.0	0
	42,376

TABLE B-5
SPECTRUM BS5 (NO. 5)

DESCRIPTION: BASELINE SPECTRUM, MISSION 5 (FLIGHT 5), COMBAT TRAINING

FLIGHT HOURS	= 2,500	FLIGHTS = 3,205		LANDINGS	= 3,205
TOTAL CYCLES	= 197,169	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 61.5
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 78.9
HIGHEST PEAK (PSI)	= 20,664			SMALLEST VALLEY (PSI)	= −14,897

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	0
-10,000	49
-9,000	0
-8,000	1
-7,000	3,069
-6,000	4,909
-5,000	260
-4,000	13
-3,000	0
-2,000	
-1,000	
0	
1,000	
2,000	
3,000	
4,000	0
5,000	29
6,000	32
7,000	1,667
8,000	31,263
9,000	130,988
10,000	18,611
11,000	4,300
12,000	1,275
13,000	417
14,000	191
15,000	48
16,000	22
17,000	16
18,000	4
19,000	3
20,000	2
21,000	0
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	157,762
5,000	23,243
6,000	10,146
7,000	1,920
8,000	625
9,000	200
10,000	43
11,000	14
12,000	5
13,000	4
14,000	2
15,000	0
16,000	0
17,000	173
18,000	499
19,000	36
20,000	617
21,000	1,255
22,000	459
23,000	152
24,000	11
25,000	1
26,000	1
27,000	1
28,000	0
29,000	
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	1,932
-1.5	717
-1.2	519
-1.0	33
-.9	3
-.8	1
-.7	2
-.6	0
-.5	3
-.4	3
-.3	6
-.2	17
-.1	71
0	191
.1	741
.2	2,828
.3	12,845
.4	69,076
.5	99,234
.6	646
.7	0
.8	0
.9	0
1.0	8,301

TABLE B-6
SPECTRUM BS6 (NO. 6)

DESCRIPTION: BASELINE SPECTRUM, COMPOSITE OF MISSIONS 1 THROUGH 5

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,644	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.0
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
	0
-12,000	47
-11,000	0
-10,000	9
-9,000	0
-8,000	201
-7,000	914
-6,000	1,373
-5,000	3,084
-4,000	7,026
-3,000	736
-2,000	54
-1,000	2
0	0
1,000	0
2,000	0
3,000	0
4,000	384
5,000	358
6,000	95
7,000	246
8,000	4,197
9,000	17,220
10,000	34,344
11,000	31,833
12,000	36,061
13,000	9,016
14,000	26,378
15,000	6,028
16,000	1,565
17,000	186
18,000	197
19,000	63
20,000	16
21,000	4
22,000	6
23,000	1
24,000	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	74,958
5,000	66,142
6,000	24,930
7,000	7,864
8,000	2,346
9,000	1,048
10,000	273
11,000	92
12,000	53
13,000	20
14,000	14
15,000	10
16,000	11
17,000	31
18,000	85
19,000	117
20,000	435
21,000	1,113
22,000	971
23,000	427
24,000	117
25,000	367
26,000	22
27,000	167
28,000	24
29,000	6
30,000	1
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	277
-1.5	698
-1.2	559
-1.0	869
-.9	490
-.8	654
-.7	333
-.6	197
-.5	92
-.4	58
-.3	49
-.2	63
-.1	79
0	119
.1	243
.2	793
.3	3,155
.4	16,125
.5	52,775
.6	89,731
.7	839
.8	0
.9	0
1.0	13,446

TABLE B-7
SPECTRUM BS1.MM1A (NO. 7)

DESCRIPTION: MISSION 1, FLIGHT 1A

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	= 2,528
TOTAL CYCLES	= 49,544	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 19.6
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 19.8
HIGHEST PEAK (PSI)	= 18,461			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	0
-5,000	8,579
-4,000	13,890
-3,000	244
-2,000	38
-1,000	1
0	0
1,000	0
2,000	0
3,000	0
4,000	0
5,000	1,140
6,000	0
7,000	477
8,000	4,424
9,000	10,981
10,000	5,917
11,000	2,517
12,000	874
13,000	371
14,000	65
15,000	17
16,000	7
17,000	1
18,000	1
19,000	0
20,000	
21,000	
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	15,378
5,000	6,167
6,000	13,542
7,000	8,406
8,000	2,637
9,000	577
10,000	98
11,000	78
12,000	5
13,000	33
14,000	0
15,000	28
16,000	15
17,000	0
18,000	11
19,000	0
20,000	11
21,000	187
22,000	1,627
23,000	598
24,000	122
25,000	13
26,000	1
27,000	4
28,000	0
29,000	6
30,000	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	166
-1.5	2,471
-1.2	66
-1.0	105
-.9	0
-.8	0
-.7	58
-.6	0
-.5	76
-.4	119
-.3	0
-.2	104
-.1	7
0	191
.1	34
.2	463
.3	780
.4	6,381
.5	15,306
.6	465
.7	0
.8	0
.9	0
1.0	22,752

TABLE B-8
SPECTRUM BS1.MM1B (NO. 8)

DESCRIPTION: MISSION 1, FLIGHT 1B

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	= 2,528
TOTAL CYCLES	= 41,426	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 16.4
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 16.6
HIGHEST PEAK (PSI)	= 22,114			SMALLEST VALLEY (PSI)	= −10,959

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	0
-5,000	2,448
-4,000	524
-3,000	8
-2,000	0
-1,000	
0	
1,000	
2,000	
3,000	
4,000	
5,000	
6,000	
7,000	0
8,000	6
9,000	0
10,000	164
11,000	0
12,000	10,746
13,000	18,344
14,000	5,980
15,000	2,534
16,000	371
17,000	215
18,000	48
19,000	23
20,000	10
21,000	3
22,000	2
23,000	0
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	26,146
5,000	2,872
6,000	7,605
7,000	1,658
8,000	430
9,000	124
10,000	10
11,000	31
12,000	13
13,000	8
14,000	1
15,000	0
16,000	0
17,000	0
18,000	32
19,000	383
20,000	192
21,000	365
22,000	1,116
23,000	349
24,000	71
25,000	16
26,000	0
27,000	3
28,000	1
29,000	0
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	
-1.2	0
-1.0	5
-.9	174
-.8	1,391
-.7	374
-.6	565
-.5	19
-.4	0
-.3	0
-.2	1
-.1	4
0	10
.1	20
.2	65
.3	300
.4	1,883
.5	11,680
.6	20,728
.7	1,227
.8	0
.9	0
1.0	2,980

TABLE B-9
SPECTRUM BS3.MM3A (NO. 9)

DESCRIPTION: MISSION 3, FLIGHT 3A

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112		LANDINGS	= 5,112
TOTAL CYCLES	= 979,124	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 191.5
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 391.6
HIGHEST PEAK (PSI)	= 23,064			SMALLEST VALLEY (PSI)	= −15,692

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	0
-4,000	39,100
-3,000	6,333
-2,000	557
-1,000	18
0	0
1,000	
2,000	
3,000	
4,000	
5,000	0
6,000	1,275
7,000	0
8,000	0
9,000	8
10,000	385,245
11,000	391,383
12,000	113,586
13,000	29,945
14,000	8,491
15,000	2,289
16,000	628
17,000	177
18,000	50
19,000	27
20,000	8
21,000	0
22,000	3
23,000	1
24,000	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	574,975
5,000	269,551
6,000	87,765
7,000	28,579
8,000	8,897
9,000	2,854
10,000	793
11,000	333
12,000	113
13,000	31
14,000	39
15,000	24
16,000	21
17,000	0
18,000	13
19,000	8
20,000	454
21,000	3,363
22,000	1,067
23,000	187
24,000	41
25,000	11
26,000	5
27,000	0
28,000	
29,000	
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	57
-1.5	44
-1.2	2
-1.0	118
-.9	970
-.8	3,490
-.7	607
-.6	78
-.5	1
-.4	104
-.3	6
-.2	223
-.1	38
0	260
.1	822
.2	4,254
.3	14,897
.4	55,360
.5	275,917
.6	575,866
.7	0
.8	0
.9	0
1.0	46,008

TABLE B-10
SPECTRUM BS3.MM3B (NO. 10)

DESCRIPTION: MISSION 3, FLIGHT 3B

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112		LANDINGS	= 5,112
TOTAL CYCLES	= 451,627	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 88.4
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 180.7
HIGHEST PEAK (PSI)	= 24,588			SMALLEST VALLEY (PSI)	= −15,383

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	0
-10,000	68
-9,000	0
-8,000	4
-7,000	5,013
-6,000	7,837
-5,000	402
-4,000	21
-3,000	1
-2,000	0
-1,000	
0	
1,000	
2,000	
3,000	
4,000	
5,000	
6,000	
7,000	0
8,000	46
9,000	0
10,000	0
11,000	182
12,000	188,247
13,000	4,355
14,000	194,209
15,000	39,741
16,000	9,402
17,000	460
18,000	1,272
19,000	282
20,000	58
21,000	3
22,000	18
23,000	5
24,000	1
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	3,124
5,000	320,338
6,000	92,920
7,000	23,428
8,000	257
9,000	4,987
10,000	1,061
11,000	307
12,000	73
13,000	0
14,000	16
15,000	4
16,000	0
17,000	0
18,000	0
19,000	0
20,000	37
21,000	0
22,000	983
23,000	285
24,000	6
25,000	3,029
26,000	148
27,000	547
28,000	56
29,000	19
30,000	2
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	0
-1.2	267
-1.0	3,038
-.9	551
-.8	1,052
-.7	179
-.6	25
-.5	0
-.4	0
-.3	0
-.2	1
-.1	4
0	25
.1	144
.2	361
.3	2,484
.4	13,469
.5	100,163
.6	313,634
.7	2,884
.8	0
.9	0
1.0	13,346

TABLE B-11
SPECTRUM BS4.MM4A (NO. 11)

DESCRIPTION: MISSION 4, FLIGHT 4A

FLIGHT HOURS = 2,500
TOTAL CYCLES = 187,935
RANGE TRUNCATION (PSI) = 4,000
HIGHEST PEAK (PSI) = 21,564

FLIGHTS = 2,591
AVERAGE NO. OF CYCLES PER: FLIGHT = 72.5; FLIGHT HOUR = 75.2

LANDINGS = 18,137
SMALLEST VALLEY (PSI) = −27,983

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
	0
-8,000	
	254
-7,000	
	44
-6,000	
	0
-5,000	
	22,798
-4,000	
	30,502
-3,000	
	3,282
-2,000	
	122
-1,000	
	9
0	
	0
1,000	
	0
2,000	
	0
3,000	
	0
4,000	
	4,680
5,000	
	2,836
6,000	
	0
7,000	
	339
8,000	
	9,795
9,000	
	44,048
10,000	
	40,362
11,000	
	20,156
12,000	
	5,884
13,000	
	1,811
14,000	
	609
15,000	
	218
16,000	
	90
17,000	
	53
18,000	
	25
19,000	
	14
20,000	
	2
21,000	
	2
22,000	
	0
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
	0
4,000	
	69,700
5,000	
	41,415
6,000	
	24,252
7,000	
	17,491
8,000	
	13,883
9,000	
	1,153
10,000	
	621
11,000	
	134
12,000	
	289
13,000	
	101
14,000	
	131
15,000	
	78
16,000	
	131
17,000	
	1,124
18,000	
	1,121
19,000	
	426
20,000	
	3,058
21,000	
	6,114
22,000	
	3,872
23,000	
	1,789
24,000	
	818
25,000	
	120
26,000	
	47
27,000	
	10
28,000	
	18
29,000	
	9
30,000	
	12
31,000	
	6
32,000	
	12
33,000	
	0
34,000	
35,000	

R DISTRIBUTION

R	n
	1,045
-1.5	
	2,882
-1.2	
	5,044
-1.0	
	4,510
-.9	
	3,079
-.8	
	1,536
-.7	
	1,942
-.6	
	1,022
-.5	
	373
-.4	
	426
-.3	
	591
-.2	
	414
-.1	
	828
0	
	654
.1	
	1,166
.2	
	910
.3	
	3,967
.4	
	32,624
.5	
	62,782
.6	
	5,042
.7	
	87
.8	
	0
.9	
	0
1.0	
	57,011

TABLE B-12
SPECTRUM BS4.MM4B (NO. 12)

DESCRIPTION: MISSION 4, FLIGHT 4B

FLIGHT HOURS = 2,500
TOTAL CYCLES = 239,057
RANGE TRUNCATION (PSI) = 4,000
HIGHEST PEAK (PSI) = 32,529

FLIGHTS = 4,630
AVERAGE NO. OF CYCLES PER: FLIGHT = 51.6; FLIGHT HOUR = 95.6

LANDINGS = 9,260
SMALLEST VALLEY (PSI) = −10,890

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
	0
-5,000	
	4,399
-4,000	
	2,754
-3,000	
	29
-2,000	
	1
-1,000	
	0
0	
1,000	
2,000	
3,000	
4,000	
5,000	
6,000	
7,000	
	0
8,000	
	30
9,000	
	0
10,000	
	18
11,000	
	84
12,000	
	55,744
13,000	
	106,120
14,000	
	32,068
15,000	
	21,125
16,000	
	10,872
17,000	
	2,955
18,000	
	1,170
19,000	
	813
20,000	
	414
21,000	
	169
22,000	
	140
23,000	
	41
24,000	
	33
25,000	
	33
26,000	
	19
27,000	
	25
32,000	
	1
33,000	
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
	0
4,000	
	160,540
5,000	
	8,267
6,000	
	44,061
7,000	
	11,352
8,000	
	3,244
9,000	
	1,288
10,000	
	141
11,000	
	403
12,000	
	267
13,000	
	123
14,000	
	52
15,000	
	25
16,000	
	7
17,000	
	33
18,000	
	6
19,000	
	1,627
20,000	
	645
21,000	
	4,423
22,000	
	1,104
23,000	
	1,166
24,000	
	181
25,000	
	54
26,000	
	33
27,000	
	8
28,000	
	6
29,000	
	1
30,000	
	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	
-1.2	
	0
-1.0	
	1
-.9	
	1
-.8	
	209
-.7	
	5,382
-.6	
	1,965
-.5	
	1,607
-.4	
	92
-.3	
	3
-.2	
	0
-.1	
	24
0	
	66
.1	
	85
.2	
	210
.3	
	934
.4	
	5,294
.5	
	49,978
.6	
	160,876
.7	
	5,147
.8	
	0
.9	
	0
1.0	
	7,183

TABLE B-13
SPECTRUM BS45.MM7 (NO. 13)

DESCRIPTION: TRAINING, MISSIONS 4 AND 5

FLIGHT HOURS	= 2,500	FLIGHTS = 3,152		LANDINGS	= 10,118
TOTAL CYCLES	= 198,239	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 62.9
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 79.3
HIGHEST PEAK (PSI)	= 27,611			SMALLEST VALLEY (PSI)	= −27,983

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	0
-9,000	17
-8,000	601
-7,000	2
-6,000	1,411
-5,000	2,170
-4,000	8,689
-3,000	12,758
-2,000	1,254
-1,000	42
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	1,900
6,000	1,164
7,000	15
8,000	883
9,000	18,128
10,000	77,596
11,000	24,830
12,000	10,182
13,000	10,772
14,000	15,604
15,000	4,790
16,000	3,036
17,000	4,557
18,000	441
19,000	166
20,000	117
21,000	54
22,000	22
23,000	19
24,000	5
25,000	4
26,000	5
27,000	2
28,000	1
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	123,414
6,000	28,078
7,000	21,265
8,000	8,315
9,000	5,466
10,000	682
11,000	280
12,000	106
13,000	143
14,000	56
15,000	63
16,000	32
17,000	50
18,000	99
19,000	327
20,000	307
21,000	1,899
22,000	4,164
23,000	2,071
24,000	1,003
25,000	306
26,000	59
27,000	27
28,000	5
29,000	8
30,000	4
31,000	4
32,000	2
33,000	4
34,000	0
35,000	

R DISTRIBUTION

R	n
-1.5	1,287
-1.2	1,409
-1.0	2,449
-.9	2,351
-.8	1,596
-.7	683
-.6	969
-.5	305
-.4	383
-.3	194
-.2	245
-.1	175
0	370
.1	362
.2	822
.3	1,680
.4	7,511
.5	45,432
.6	77,671
.7	24,690
.8	709
.9	0
1.0	0
	26,946

TABLE B-14
SPECTRUM BS4.MM8 (NO. 14)

DESCRIPTION: TOUCH AND GO LANDINGS, MISSION 4

FLIGHT HOURS	= 2,500	FLIGHTS = 6,095		LANDINGS	= 25,000
TOTAL CYCLES	= 248,187	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 40.7
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 99.3
HIGHEST PEAK (PSI)	= 27,765			SMALLEST VALLEY (PSI)	= −27,686

PEAK DISTRIBUTION

Peak (psi)	n
~~-12,000~~	
~~-11,000~~	
~~-10,000~~	
~~-9,000~~	
-8,000	244
-7,000	339
-6,000	54
-5,000	0
-4,000	11,264
-3,000	44,630
-2,000	4,658
-1,000	166
0	13
1,000	0
2,000	0
3,000	0
4,000	0
5,000	5,109
6,000	4,125
7,000	0
8,000	0
9,000	9,527
10,000	54,346
11,000	53,749
12,000	25,607
13,000	12,127
14,000	11,833
15,000	3,872
16,000	4,643
17,000	1,256
18,000	344
19,000	114
20,000	74
21,000	47
22,000	23
23,000	12
24,000	1
25,000	4
26,000	3
27,000	2
28,000	1
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	100,979
6,000	57,857
7,000	38,077
8,000	19,410
9,000	3,753
10,000	871
11,000	633
12,000	205
13,000	342
14,000	150
15,000	144
16,000	114
17,000	158
18,000	1,644
19,000	2,047
20,000	1,439
21,000	4,645
22,000	9,596
23,000	4,250
24,000	1,217
25,000	414
26,000	111
27,000	54
28,000	16
29,000	20
30,000	13
31,000	12
32,000	8
33,000	8
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	1,195
-1.2	747
-1.0	6,249
-.9	6,532
-.8	4,209
-.7	2,874
-.6	3,851
-.5	2,057
-.4	1,079
-.3	658
-.2	594
-.1	598
0	711
.1	949
.2	1,668
.3	1,194
.4	4,459
.5	39,734
.6	86,133
.7	20,640
.8	688
.9	0
1.0	0
	61,368

TABLE B-15
SPECTRUM BS123.MM9 (NO. 15)

DESCRIPTION: MISSION 1, 2 AND 3 MIX (NO TRAINING)

FLIGHT HOURS	= 2,500	FLIGHTS = 2,239		LANDINGS	= 2,239
TOTAL CYCLES	= 177,528	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 79.3
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 71.0
HIGHEST PEAK (PSI)	= 23,296			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	28
-11,000	48			-1.2	425
-10,000	0	1,000		-1.0	65
-9,000	13	2,000		-.9	582
-8,000	34	3,000		-.8	224
-7,000	262	4,000	0	-.7	673
-6,000	791	5,000	63,344	-.6	142
-5,000	1,141	6,000	75,767	-.5	153
-4,000	1,593	7,000	25,556	-.4	27
-3,000	5,159	8,000	7,580	-.3	25
-2,000	595	9,000	1,454	-.2	1
-1,000	59	10,000	1,165	-.1	35
0	2	11,000	275	0	6
1,000	0	12,000	85	.1	60
2,000	0	13,000	27	.2	104
3,000	0	14,000	8	.3	538
4,000	0	15,000	7	.4	1,997
5,000	0	16,000	6	.5	8,815
6,000	156	17,000	5	.6	46,552
7,000	117	18,000	8	.7	106,539
8,000	64	19,000	98	.8	840
9,000	671	20,000	84	.9	0
10,000	1,869	21,000	84	1.0	0
11,000	36,975	22,000	349		9,697
12,000	37,374	23,000	617		
13,000	42,544	24,000	221		
14,000	7402	25,000	29		
15,000	31,863	26,000	485		
16,000	6,823	27,000	27		
17,000	1,576	28,000	213		
18,000	125	29,000	29		
19,000	209	30,000	5		
20,000	50	31,000	0		
21,000	9	32,000			
22,000	0	33,000			
23,000	3	34,000			
24,000	1	35,000			
25,000					
26,000					
27,000					

TABLE B-16
SPECTRUM BS6.MM10 (NO. 16)

DESCRIPTION: SPECTRUM NO. 6 WITH 50 PERCENT REDUCTION IN TRAINING

FLIGHT HOURS	= 2,500	FLIGHTS = 2,489		LANDINGS	= 3,203
TOTAL CYCLES	= 200,604	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 80.6
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 80.2
HIGHEST PEAK (PSI)	= 23,296			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	148
-11,000	50			-1.2	529
-10,000	0	1,000		-1.0	307
-9,000	15	2,000		-.9	833
-8,000	28	3,000		-.8	370
-7,000	216	4,000	0	-.7	782
-6,000	936	5,000	76,226	-.6	244
-5,000	1,425	6,000	81,015	-.5	130
-4,000	2,324	7,000	27,938	-.4	43
-3,000	6,912	8,000	8,498	-.3	43
-2,000	757	9,000	2,000	-.2	25
-1,000	63	10,000	1,204	-.1	52
0	2	11,000	331	0	42
1,000	0	12,000	96	.1	91
2,000	0	13,000	43	.2	196
3,000	0	14,000	9	.3	747
4,000	0	15,000	11	.4	2,763
5,000	180	16,000	8	.5	13,460
6,000	249	17,000	9	.6	54,790
7,000	121	18,000	10	.7	111,377
8,000	145	19,000	63	.8	904
9,000	2,470	20,000	92	.9	0
10,000	9,598	21,000	257	1.0	0
11,000	40,275	22,000	851		12,728
12,000	39,190	23,000	830		
13,000	44,411	24,000	305		
14,000	8,647	25,000	59		
15,000	33,080	26,000	510		
16,000	7,272	27,000	18		
17,000	1,767	28,000	184		
18,000	160	29,000	28		
19,000	230	30,000	6		
20,000	60	31,000	1		
21,000	14	32,000	2		
22,000	2	33,000	0		
23,000	4	34,000			
24,000	1	35,000			
25,000	0				
26,000					
27,000					

TABLE B-17
SPECTRUM BS13.MM11 (NO. 17)

DESCRIPTION: FLIGHTS 1A AND 3A MIX (LOW PAYLOAD), NO TRAINING

FLIGHT HOURS	= 2,500	FLIGHTS = 3,567		LANDINGS	= 3,567
TOTAL CYCLES	= 423,414	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 118.7
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 169.4
HIGHEST PEAK (PSI)	= 22,028			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	0
-4,000	5,168
-3,000	23,973
-2,000	2,703
-1,000	251
0	8
1,000	0
2,000	0
3,000	0
4,000	0
5,000	0
6,000	679
7,000	514
8,000	272
9,000	2,580
10,000	6,565
11,000	158,472
12,000	158,999
13,000	46,232
14,000	12,256
15,000	3,449
16,000	929
17,000	257
18,000	73
19,000	21
20,000	10
21,000	2
22,000	0
23,000	1
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	240,410
6,000	112,143
7,000	43,417
8,000	16,538
9,000	5,077
10,000	1,489
11,000	398
12,000	196
13,000	39
14,000	36
15,000	16
16,000	26
17,000	17
18,000	0
19,000	12
20,000	3
21,000	205
22,000	1,426
23,000	1,425
24,000	434
25,000	88
26,000	8
27,000	3
28,000	5
29,000	0
30,000	3
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	119
-1.2	1,491
-1.0	45
-.9	104
-.8	427
-.7	1,376
-.6	277
-.5	31
-.4	46
-.3	113
-.2	2
-.1	152
0	19
.1	219
.2	359
.3	1,951
.4	6,508
.5	26,034
.6	120,136
.7	231,902
.8	0
.9	0
1.0	0
	32,103

TABLE B-18
SPECTRUM BS123.MM12 (NO. 18)

DESCRIPTION: FLIGHTS 1B, 2 AND 3B MIX (HIGH PAYLOAD), NO TRAINING

FLIGHT HOURS	= 2,500	FLIGHTS = 1,842		LANDINGS	= 1,842
TOTAL CYCLES	= 105,785	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 57.4
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 42.3
HIGHEST PEAK (PSI)	= 23,296			SMALLEST VALLEY (PSI)	= −17,878

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	79
-10,000	0
-9,000	11
-8,000	0
-7,000	345
-6,000	1,038
-5,000	1,507
-4,000	691
-3,000	504
-2,000	3
-1,000	0
0	
1,000	
2,000	
3,000	
4,000	
5,000	
6,000	
7,000	
8,000	0
9,000	99
10,000	451
11,000	922
12,000	1,389
13,000	41,550
14,000	5,850
15,000	40,312
16,000	8,573
17,000	1,976
18,000	143
19,000	266
20,000	60
21,000	12
22,000	0
23,000	3
24,000	1
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	10,691
6,000	65,804
7,000	20,601
8,000	5,065
9,000	416
10,000	1,047
11,000	235
12,000	57
13,000	21
14,000	1
15,000	5
16,000	0
17,000	0
18,000	0
19,000	4
20,000	92
21,000	41
22,000	78
23,000	466
24,000	196
25,000	20
26,000	587
27,000	36
28,000	253
29,000	56
30,000	12
31,000	0
32,000	1
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	5
-1.2	152
-1.0	106
-.9	626
-.8	163
-.7	536
-.6	117
-.5	132
-.4	5
-.3	0
-.2	0
-.1	1
0	3
.1	10
.2	32
.3	118
.4	658
.5	3,646
.6	24,791
.7	69,416
.8	1,090
.9	0
1.0	0
	4,178

TABLE B-19
SPECTRUM BS6.MM13 (NO. 19)

DESCRIPTION: SPECTRUM NO. 6 WITHOUT LOW-ALTITUDE PENETRATION FLYING

FLIGHT HOURS	= 2,500	FLIGHTS = 1,835		LANDINGS	= 3,666
TOTAL CYCLES	= 51,896	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 28.3
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 20.8
HIGHEST PEAK (PSI)	= 25,153			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	61
-10,000	0
-9,000	5
-8,000	37
-7,000	273
-6,000	392
-5,000	544
-4,000	3,728
-3,000	5,650
-2,000	375
-1,000	16
0	0
1,000	0
2,000	0
3,000	0
4,000	0
5,000	496
6,000	463
7,000	10
8,000	315
9,000	2,777
10,000	7,742
11,000	6,734
12,000	3,699
13,000	5,957
14,000	8,122
15,000	2,464
16,000	1,302
17,000	473
18,000	147
19,000	51
20,000	34
21,000	16
22,000	6
23,000	4
24,000	1
25,000	1
26,000	1
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	25,639
6,000	8,222
7,000	8,238
8,000	3,485
9,000	2,090
10,000	269
11,000	78
12,000	53
13,000	42
14,000	21
15,000	15
16,000	12
17,000	16
18,000	51
19,000	108
20,000	130
21,000	502
22,000	1,215
23,000	957
24,000	437
25,000	122
26,000	24
27,000	6
28,000	124
29,000	31
30,000	5
31,000	1
32,000	1
33,000	2
34,000	0
35,000	

R DISTRIBUTION

R	n
-1.5	361
-1.2	837
-1.0	684
-.9	676
-.8	456
-.7	435
-.6	346
-.5	165
-.4	111
-.3	64
-.2	62
-.1	57
0	89
.1	104
.2	154
.3	232
.4	945
.5	6,592
.6	15,931
.7	11,909
.8	605
.9	0
1.0	0
	11,020

TABLE B-20
SPECTRUM BS6.MM14 (NO. 20)

DESCRIPTION: SPECTRUM NO. 6 WITH 100 PERCENT INCREASE IN LOW-ALTITUDE PENETRATION FLYING TIME

FLIGHT HOURS	= 2,500	FLIGHTS = 3,263		LANDINGS	= 4,109
TOTAL CYCLES	= 312,646	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 95.8
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 125.1
HIGHEST PEAK (PSI)	= 23,296			SMALLEST VALLEY (PSI)	= −18,165

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	31
-10,000	0
-9,000	26
-8,000	0
-7,000	126
-6,000	1,852
-5,000	2,799
-4,000	1,960
-3,000	8,451
-2,000	1,107
-1,000	87
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	232
6,000	219
7,000	194
8,000	374
9,000	6,617
10,000	27,379
11,000	62,480
12,000	59,780
13,000	65,803
14,000	9,246
15,000	49,948
16,000	10,663
17,000	2,606
18,000	209
19,000	340
20,000	86
21,000	21
22,000	2
23,000	5
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	125,152
6,000	125,469
7,000	41,103
8,000	11,890
9,000	2,400
10,000	1,812
11,000	454
12,000	129
13,000	59
14,000	11
15,000	13
16,000	9
17,000	9
18,000	35
19,000	117
20,000	67
21,000	414
22,000	1,183
23,000	911
24,000	308
25,000	69
26,000	754
27,000	32
28,000	211
29,000	28
30,000	6
31,000	1
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	419
-1.2	511
-1.0	429
-.9	1,078
-.8	497
-.7	973
-.6	270
-.5	94
-.4	61
-.3	47
-.2	31
-.1	63
0	60
.1	129
.2	342
.3	1,330
.4	5,470
.5	26,683
.6	89,827
.7	166,932
.8	959
.9	0
1.0	0
	16,441

TABLE B-21
SPECTRUM BS1.SM1 (NO. 21)

DESCRIPTION: SPECTRUM NO. 1 WITH LO-HI-LO FLIGHT SEQUENCE

FLIGHT HOURS = 2,500	FLIGHTS = 2,528	LANDINGS = 2,528	
TOTAL CYCLES = 45,807	AVERAGE NO. OF CYCLES PER:	FLIGHT = 18.1	
RANGE TRUNCATION (PSI) = 4,000		FLIGHT HOUR = 18.3	
HIGHEST PEAK (PSI) = 22,114		SMALLEST VALLEY (PSI) = −24,298	

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	0
-4,000	5,151
-3,000	6,386
-2,000	110
-1,000	18
0	0
1,000	
2,000	
3,000	
4,000	
5,000	0
6,000	499
7,000	0
8,000	212
9,000	1,912
10,000	4,795
11,000	2,676
12,000	1,111
13,000	6,423
14,000	11,103
15,000	3,496
16,000	1,528
17,000	214
18,000	123
19,000	28
20,000	14
21,000	6
22,000	1
23,000	1
24,000	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	22,091
6,000	4,489
7,000	10,241
8,000	4,614
9,000	1,362
10,000	316
11,000	45
12,000	52
13,000	9
14,000	19
15,000	0
16,000	12
17,000	7
18,000	0
19,000	19
20,000	199
21,000	101
22,000	298
23,000	1,372
24,000	469
25,000	77
26,000	11
27,000	0
28,000	2
29,000	0
30,000	2
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	71
-1.2	1,088
-1.0	28
-.9	51
-.8	98
-.7	791
-.6	231
-.5	303
-.4	47
-.3	52
-.2	0
-.1	47
0	4
.1	89
.2	30
.3	235
.4	500
.5	3,897
.6	13,076
.7	12,294
.8	1,210
.9	0
1.0	0
	11,665

TABLE B-22
SPECTRUM BS6.SM1 (NO. 22)

DESCRIPTION: SPECTRUM NO. 6 WITH LO-HI-LO FLIGHT SEQUENCE

FLIGHT HOURS = 2,500	FLIGHTS = 2,422	LANDINGS = 3,843	
TOTAL CYCLES = 181,644	AVERAGE NO. OF CYCLES PER:	FLIGHT = 75.0	
RANGE TRUNCATION (PSI) = 4,000		FLIGHT HOUR = 72.7	
HIGHEST PEAK (PSI) = 23,923		SMALLEST VALLEY (PSI) = −24,298	

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	47
-10,000	0
-9,000	9
-8,000	0
-7,000	201
-6,000	914
-5,000	1,423
-4,000	3,050
-3,000	7,014
-2,000	732
-1,000	54
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	358
7,000	95
8,000	246
9,000	4,197
10,000	17,220
11,000	34,344
12,000	31,833
13,000	36,061
14,000	9,016
15,000	26,378
16,000	6,028
17,000	1,565
18,000	186
19,000	197
20,000	63
21,000	16
22,000	4
23,000	6
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	74,959
6,000	66,165
7,000	24,919
8,000	7,851
9,000	2,346
10,000	1,048
11,000	273
12,000	92
13,000	53
14,000	20
15,000	14
16,000	10
17,000	11
18,000	31
19,000	85
20,000	117
21,000	435
22,000	1,113
23,000	971
24,000	427
25,000	117
26,000	367
27,000	22
28,000	167
29,000	24
30,000	6
31,000	1
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	277
-1.2	698
-1.0	559
-.9	869
-.8	490
-.7	654
-.6	333
-.5	197
-.4	92
-.3	58
-.2	49
-.1	63
0	79
.1	119
.2	243
.3	793
.4	3,155
.5	16,125
.6	52,775
.7	89,731
.8	839
.9	0
1.0	0
	13,446

TABLE B-23
SPECTRUM BS6.SM4 (NO. 23)

DESCRIPTION: SPECTRUM NO. 6 WITH SPECIFIC FLIGHT SEQUENCE

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,802	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.1
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	278
-11,000	49			-1.2	693
-10,000	0	1,000		-1.0	558
-9,000	16	2,000		-.9	909
-8,000	0	3,000		-.8	452
-7,000	208	4,000	0	-.7	656
-6,000	917	5,000	75,232	-.6	331
-5,000	1,450	6,000	66,231	-.5	204
-4,000	3,049	7,000	24,686	-.4	91
-3,000	7,006	8,000	7,899	-.3	55
-2,000	742	9,000	2,357	-.2	49
-1,000	56	10,000	1,044	-.1	64
0	2	11,000	270	0	78
1,000	0	12,000	99	.1	118
2,000	0	13,000	45	.2	251
3,000	0	14,000	19	.3	784
4,000	0	15,000	16	.4	3,088
5,000	384	16,000	10	.5	16,174
6,000	358	17,000	11	.6	52,908
7,000	95	18,000	29	.7	89,728
8,000	240	19,000	111	.8	838
9,000	4,273	20,000	121	.9	0
10,000	17,233	21,000	444	1.0	0
11,000	34,449	22,000	1,114		13,495
12,000	31,847	23,000	943		
13,000	36,076	24,000	404		
14,000	8,990	25,000	93		
15,000	26,285	26,000	405		
16,000	6,040	27,000	21		
17,000	1,564	28,000	171		
18,000	186	29,000	22		
19,000	197	30,000	5		
20,000	63	31,000	0		
21,000	16	32,000			
22,000	4	33,000			
23,000	6	34,000			
24,000	1	35,000			
25,000	0				
26,000					
27,000					

TABLE B-24
SPECTRUM BS6.SM5 (NO. 24)

DESCRIPTION: SPECTRUM NO. 6 WITH A DIFFERENT RANDOM FLIGHT SEQUENCE

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,859	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.1
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	275
-11,000	49			-1.2	685
-10,000	0	1,000		-1.0	547
-9,000	13	2,000		-.9	906
-8,000	0	3,000		-.8	475
-7,000	206	4,000	0	-.7	686
-6,000	930	5,000	75,224	-.6	302
-5,000	1,364	6,000	66,219	-.5	192
-4,000	3,089	7,000	24,858	-.4	102
-3,000	7,053	8,000	7,782	-.3	57
-2,000	733	9,000	2,373	-.2	50
-1,000	53	10,000	1,066	-.1	62
0	2	11,000	271	0	79
1,000	0	12,000	79	.1	120
2,000	0	13,000	52	.2	238
3,000	0	14,000	17	.3	788
4,000	0	15,000	14	.4	3,049
5,000	384	16,000	10	.5	16,340
6,000	358	17,000	11	.6	52,833
7,000	94	18,000	33	.7	89,753
8,000	265	19,000	102	.8	828
9,000	4,202	20,000	110	.9	0
10,000	17,257	21,000	460	1.0	0
11,000	34,441	22,000	1,101		13,492
12,000	31,869	23,000	983		
13,000	36,066	24,000	384		
14,000	9,025	25,000	106		
15,000	26,327	26,000	390		
16,000	6,049	27,000	20		
17,000	1,557	28,000	154		
18,000	186	29,000	34		
19,000	197	30,000	5		
20,000	63	31,000	0		
21,000	16	32,000	1		
22,000	4	33,000	0		
23,000	6	34,000			
24,000	1	35,000			
25,000	0				
26,000					
27,000					

TABLE B-25
SPECTRUM BS1A.FL1 (NO. 25)

DESCRIPTION: FLIGHT 1A – 0.541 HOUR DURATION

FLIGHT HOURS = 2,500	FLIGHTS = 4,621		LANDINGS =	4,621
TOTAL CYCLES = 85,331	AVERAGE NO. OF CYCLES PER:		FLIGHT =	18.5
RANGE TRUNCATION (PSI) = 4,000			FLIGHT HOUR =	34.1
HIGHEST PEAK (PSI) = 19,353			SMALLEST VALLEY (PSI) =	–24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	0
-5,000	15,707
-4,000	25,073
-3,000	691
-2,000	116
-1,000	2
0	0
1,000	0
2,000	0
3,000	0
4,000	0
5,000	2,079
6,000	0
7,000	0
8,000	1,941
9,000	14,612
10,000	17,115
11,000	5,307
12,000	1,871
13,000	650
14,000	116
15,000	33
16,000	10
17,000	6
18,000	1
19,000	1
20,000	0
21,000	
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	23,929
5,000	9,899
6,000	24,965
7,000	19,637
8,000	1,516
9,000	390
10,000	35
11,000	105
12,000	1
13,000	61
14,000	1
15,000	51
16,000	28
17,000	0
18,000	21
19,000	0
20,000	281
21,000	3,023
22,000	1,033
23,000	259
24,000	69
25,000	9
26,000	3
27,000	5
28,000	0
29,000	10
30,000	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	231
-1.5	888
-1.2	3,685
-1.0	314
-.9	8
-.8	3
-.7	106
-.6	0
-.5	139
-.4	217
-.3	0
-.2	190
-.1	11
0	345
.1	54
.2	788
.3	1,040
.4	10,565
.5	24,301
.6	857
.7	0
.8	0
.9	0
1.0	41,589

TABLE B-26
SPECTRUM BS1A.FL2 (NO. 26)

DESCRIPTION: FLIGHT 1A – 2.0 HOUR DURATION

FLIGHT HOURS = 2,500	FLIGHTS = 1,250		LANDINGS =	1,250
TOTAL CYCLES = 27,461	AVERAGE NO. OF CYCLES PER:		FLIGHT =	22.0
RANGE TRUNCATION (PSI) = 4,000			FLIGHT HOUR =	11.0
HIGHEST PEAK (PSI) = 17,568			SMALLEST VALLEY (PSI) =	–24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	0
-6,000	4,254
-5,000	648
-4,000	6,209
-3,000	119
-2,000	20
-1,000	0
0	0
1,000	0
2,000	0
3,000	0
4,000	0
5,000	565
6,000	25
7,000	1,266
8,000	3,900
9,000	5,335
10,000	3,027
11,000	1,346
12,000	519
13,000	181
14,000	35
15,000	8
16,000	3
17,000	1
18,000	0
19,000	
20,000	
21,000	
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	8,681
5,000	4,621
6,000	6,879
7,000	615
8,000	3,850
9,000	1,209
10,000	214
11,000	71
12,000	8
13,000	16
14,000	0
15,000	14
16,000	8
17,000	0
18,000	6
19,000	0
20,000	5
21,000	0
22,000	96
23,000	795
24,000	257
25,000	91
26,000	18
27,000	4
28,000	0
29,000	3
30,000	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	1,124
-1.5	212
-1.2	2
-1.0	50
-.9	0
-.8	0
-.7	29
-.6	0
-.5	38
-.4	59
-.3	0
-.2	56
-.1	14
0	120
.1	77
.2	430
.3	1,121
.4	5,097
.5	7,535
.6	247
.7	0
.8	0
.9	0
1.0	11,250

TABLE B-27
SPECTRUM BS1A.FL3 (NO. 27)

DESCRIPTION: FLIGHT 1A – 4.0 HOUR DURATION

FLIGHT HOURS = 2,500	FLIGHTS = 625		LANDINGS	= 625
TOTAL CYCLES = 16,469	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 26.4
RANGE TRUNCATION (PSI) = 4,000			FLIGHT HOUR	= 6.6
HIGHEST PEAK (PSI) = 16,675			SMALLEST VALLEY (PSI)	= –24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-~~12,000~~				-1.5	176
-~~11,000~~				-1.2	489
-~~10,000~~		1,000		-1.0	5
~~-9,000~~		2,000		-.9	25
-8,000	1	3,000		-.8	0
-7,000	0	4,000	0	-.7	0
-6,000	0	5,000	5,315	-.6	14
-5,000	2,123	6,000	2,905	-.5	0
-4,000	324	7,000	4,370	-.4	24
-3,000	3,165	8,000	418.	-.3	37
-2,000	60	9,000	180	-.2	19
-1,000	10	10,000	1,902	-.1	61
0	0	11,000	560	0	73
1,000		12,000	133	.1	188
2,000		13,000	0	.2	292
3,000		14,000	31	.3	683
4,000		15,000	6	.4	2,056
5,000	0	16,000	7	.5	3,560
6,000	282	17,000	4	.6	3,027
7,000	314	18,000	0	.7	117
8,000	1,180	19,000	3	.8	0
9,000	3,817	20,000	0	.9	0
10,000	2,118	21,000	3	1.0	0
11,000	1,901	22,000	0		5,622
12,000	865	23,000	2		
13,000	238	24,000	0		
14,000	103	25,000	75		
15,000	22	26,000	2		
16,000	5	27,000	385		
17,000	1	28,000	123		
18,000	0	29,000	35		
19,000		30,000	6		
20,000		31,000	4		
21,000		32,000	0		
22,000		33,000			
23,000		34,000			
24,000		35,000			
25,000					
26,000					
27,000					

TABLE B-28
SPECTRUM BS1B.FL1 (NO. 28)

DESCRIPTION: FLIGHT 1B – 0.605 HOUR DURATION

FLIGHT HOURS = 2,500	FLIGHTS = 4,132		LANDINGS	= 4,132
TOTAL CYCLES = 68,368	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 16.6
RANGE TRUNCATION (PSI) = 4,000			FLIGHT HOUR	= 27.3
HIGHEST PEAK (PSI) = 23,603			SMALLEST VALLEY (PSI)	= –10,959

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000				-1.5	
-11,000				-1.2	
-10,000		1,000		-1.0	
-9,000		2,000		-.9	0
-8,000		3,000		-.8	202
-7,000		4,000	0	-.7	634
-6,000		5,000	44,882	-.6	2,265
-5,000	0	6,000	3,987	-.5	738
-4,000	3,992	7,000	11,875	-.4	289
-3,000	840	8,000	2,584	-.3	4
-2,000	26	9,000	634	-.2	0
-1,000	1	10,000	181	-.1	0
0	0	11,000	7	0	4
1,000		12,000	52	.1	12
2,000		13,000	19	.2	25
3,000		14,000	13	.3	51
4,000		15,000	1	.4	303
5,000		16,000	0	.5	1,532
6,000		17,000	1	.6	13,068
7,000		18,000	54	.7	40,925
8,000	0	19,000	0	.8	3,457
9,000	10	20,000	588	.9	0
10,000	0	21,000	466	1.0	0
11,000	14	22,000	1,931		4,859
12,000	256	23,000	459		
13,000	15,067	24,000	528		
14,000	32,730	25,000	83		
15,000	9,958	26,000	18		
16,000	3,696	27,000	4		
17,000	1,304	28,000	0		
18,000	341	29,000	1		
19,000	74	30,000	0		
20,000	35	31,000			
21,000	9	32,000			
22,000	8	33,000			
23,000	6	34,000			
24,000	1	35,000			
25,000	0				
26,000					
27,000					

TABLE B-29
SPECTRUM BS1B.FL2 (NO. 29)

DESCRIPTION: FLIGHT 1B – 2.0 HOUR DURATION

FLIGHT HOURS = 2,500	FLIGHTS = 1,250	LANDINGS	= 1,250
TOTAL CYCLES = 27,275	AVERAGE NO. OF CYCLES PER:	FLIGHT	= 21.8
RANGE TRUNCATION (PSI) = 4,000		FLIGHT HOUR	= 10.9
HIGHEST PEAK (PSI) = 25,617		SMALLEST VALLEY (PSI)	= −13,811

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
~~-12,000~~				-1.5	0
~~-11,000~~				-1.2	676
~~-10,000~~		1,000		-1.0	231
~~-9,000~~	16	2,000		-.9	34
-8,000	0	3,000	0	-.8	241
-7,000	0	4,000	15,661	-.7	65
-6,000	1,238	5,000	3,350	-.6	3
-5,000	71	6,000	5,057	-.5	1
-4,000	188	7,000	1,085	-.4	2
-3,000	4	8,000	482	-.3	4
-2,000	0	9,000	207	-.2	10
-1,000		10,000	33	-.1	23
0		11,000	59	0	27
1,000		12,000	48	.1	64
2,000		13,000	22	.2	171
3,000		14,000	8	.3	446
4,000		15,000	1	.4	1,624
5,000		16,000	8	.5	6,146
6,000		17,000	4	.6	12,619
7,000	0	18,000	2	.7	1,171
8,000	3	19,000	0	.8	0
9,000	6	20,000	209	.9	0
10,000	11	21,000	80	1.0	1,517
11,000	3,012	22,000	14		
12,000	9,642	23,000	637		
13,000	8,363	24,000	256		
14,000	2,746	25,000	45		
15,000	1,449	26,000	1		
16,000	307	27,000	5		
17,000	74	28,000	1		
18,000	71	29,000	0		
19,000	32	30,000			
20,000	25	31,000			
21,000	9	32,000			
22,000	1	33,000			
23,000	4	34,000			
24,000	2	35,000			
25,000	1				
26,000	0				
27,000					

TABLE B-30
SPECTRUM BS1B.FL3 (NO. 30)

DESCRIPTION: FLIGHT 1B – 4.0 HOUR DURATION

FLIGHT HOURS = 2,500	FLIGHTS = 625	LANDINGS	= 625
TOTAL CYCLES = 18,245	AVERAGE NO. OF CYCLES PER:	FLIGHT	= 29.2
RANGE TRUNCATION (PSI) = 4,000		FLIGHT HOUR	= 7.3
HIGHEST PEAK (PSI) = 24,478		SMALLEST VALLEY (PSI)	= −16,534

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
~~-12,000~~				-1.5	0
-~~11,000~~				-1.2	335
-~~10,000~~		1,000		-1.0	35
~~-9,000~~	7	2,000		-.9	1
-8,000	0	3,000	0	-.8	141
-7,000	606	4,000	10,711	-.7	9
-6,000	36	5,000	3,319	-.6	0
-5,000	3	6,000	1,767	-.5	0
-4,000	95	7,000	909	-.4	0
-3,000	3	8,000	524	-.3	0
-2,000	0	9,000	331	-.2	1
-1,000		10,000	84	-.1	3
0		11,000	42	0	9
1,000		12,000	16	.1	22
2,000		13,000	10	.2	118
3,000		14,000	5	.3	232
4,000		15,000	0	.4	662
5,000		16,000	1	.5	3,458
6,000		17,000	1	.6	11,687
7,000	0	18,000	0	.7	678
8,000	1	19,000		.8	0
9,000	0	20,000		.9	0
10,000	0	21,000		1.0	750
11,000	2	22,000			
12,000	4,559	23,000	0		
13,000	3,483	24,000	105		
14,000	6,426	25,000	35		
15,000	2,055	26,000	6		
16,000	550	27,000	34		
17,000	259	28,000	41		
18,000	87	29,000	20		
19,000	43	30,000	22		
20,000	2	31,000	1		
21,000	17	32,000	1		
22,000	7	33,000	0		
23,000	3	34,000			
24,000	1	35,000			
25,000	0				
26,000					
27,000					

TABLE B-31
SPECTRUM BS6.FS1 (NO. 31)

DESCRIPTION: SPECTRUM NO. 6 WITHOUT LANDING IMPACT CYCLES

FLIGHT HOURS = 2,500
TOTAL CYCLES = 180,851
RANGE TRUNCATION (PSI) = 4,000
HIGHEST PEAK (PSI) = 23,923

FLIGHTS = 2,422
AVERAGE NO. OF CYCLES PER: LANDINGS = 3,843
FLIGHT = 74.7
FLIGHT HOUR = 72.3
SMALLEST VALLEY (PSI) = −17,878

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000				-1.5	194
-11,000				-1.2	635
-10,000	0	1,000		-1.0	548
-9,000	11	2,000		-.9	648
-8,000	0	3,000		-.8	476
-7,000	208	4,000		-.7	622
-6,000	908	5,000	74,840	-.6	274
-5,000	1,351	6,000	66,176	-.5	190
-4,000	3,112	7,000	24,483	-.4	56
-3,000	7,027	8,000	7,846	-.3	0
-2,000	734	9,000	2,333	-.2	1
-1,000	51	10,000	1,022	-.1	3
0	2	11,000	210	0	10
1,000	0	12,000	59	.1	41
2,000		13,000	29	.2	142
3,000		14,000	6	.3	679
4,000		15,000	4	.4	3,112
5,000		16,000	0	.5	16,318
6,000	0	17,000	0	.6	52,467
7,000	3	18,000	24	.7	89,957
8,000	233	19,000	96	.8	828
9,000	4,226	20,000	121	.9	0
10,000	17,152	21,000	424	1.0	0
11,000	34,417	22,000	1,133		13,450
12,000	31,849	23,000	927		
13,000	36,116	24,000	389		
14,000	9,006	25,000	110		
15,000	26,320	26,000	391		
16,000	6,039	27,000	26		
17,000	1,567	28,000	159		
18,000	186	29,000	25		
19,000	197	30,000	7		
20,000	63	31,000	0		
21,000	16	32,000	1		
22,000	4	33,000	0		
23,000	6	34,000			
24,000	1	35,000			
25,000					
26,000					
27,000					

TABLE B-32
SPECTRUM BS6.FS2 (NO. 32)

DESCRIPTION: SPECTRUM NO. 6 WITH SIMPLIFIED FLAPS-UP CLIMB AND DESCENT GUST SEGMENTS

FLIGHT HOURS = 2,500
TOTAL CYCLES = 180,493
RANGE TRUNCATION (PSI) = 4,000
HIGHEST PEAK (PSI) = 23,923

FLIGHTS = 2,422
AVERAGE NO. OF CYCLES PER: LANDINGS = 3,843
FLIGHT = 74.5
FLIGHT HOUR = 72.2
SMALLEST VALLEY (PSI) = −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	290
-11,000	53			-1.2	692
-10,000	0	1,000		-1.0	555
-9,000	13	2,000		-.9	875
-8,000	0	3,000		-.8	488
-7,000	209	4,000	0	-.7	659
-6,000	917	5,000	74,280	-.6	310
-5,000	1,382	6,000	66,210	-.5	205
-4,000	3,073	7,000	24,428	-.4	98
-3,000	7,027	8,000	7,836	-.3	58
-2,000	737	9,000	2,339	-.2	50
-1,000	54	10,000	1,063	-.1	66
0	2	11,000	274	0	84
1,000	0	12,000	79	.1	124
2,000	0	13,000	46	.2	278
3,000	0	14,000	17	.3	853
4,000	0	15,000	16	.4	3,391
5,000	384	16,000	11	.5	16,400
6,000	359	17,000	11	.6	52,076
7,000	120	18,000	33	.7	88,604
8,000	477	19,000	91	.8	870
9,000	4,654	20,000	121	.9	0
10,000	17,396	21,000	455	1.0	0
11,000	34,343	22,000	1,123		13,467
12,000	31,582	23,000	954		
13,000	35,320	24,000	397		
14,000	8,106	25,000	105		
15,000	26,203	26,000	380		
16,000	6,046	27,000	26		
17,000	1,568	28,000	164		
18,000	182	29,000	28		
19,000	197	30,000	5		
20,000	62	31,000	0		
21,000	16	32,000	1		
22,000	4	33,000	0		
23,000	6	34,000			
24,000	1	35,000			
25,000	0				
26,000					
27,000					

TABLE B-33
SPECTRUM BS1.FS3 (NO. 33)

DESCRIPTION: SPECTRUM NO. 1 WITH SIMPLIFIED FLAPS-UP CLIMB AND DESCENT GUST SEGMENTS

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	= 2,528
TOTAL CYCLES	= 39,832	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 15.8
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 15.9
HIGHEST PEAK (PSI)	= 24,415			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	0
-4,000	5,149
-3,000	6,386
-2,000	113
-1,000	17
0	0
1,000	0
2,000	0
3,000	0
4,000	0
5,000	0
6,000	499
7,000	0
8,000	125
9,000	1,406
10,000	4,085
11,000	2,423
12,000	1,069
13,000	4,582
14,000	8,932
15,000	3,185
16,000	1,481
17,000	215
18,000	113
19,000	27
20,000	14
21,000	7
22,000	1
23,000	0
24,000	2
25,000	1
26,000	0
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	17,703
6,000	4,131
7,000	9,293
8,000	4,372
9,000	1,301
10,000	326
11,000	55
12,000	50
13,000	7
14,000	17
15,000	6
16,000	14
17,000	7
18,000	0
19,000	21
20,000	206
21,000	106
22,000	295
23,000	1,347
24,000	455
25,000	101
26,000	13
27,000	1
28,000	3
29,000	0
30,000	2
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	69
-1.2	1,092
-1.0	25
-.9	51
-.8	101
-.7	781
-.6	236
-.5	310
-.4	43
-.3	53
-.2	3
-.1	47
0	6
.1	89
.2	27
.3	220
.4	395
.5	2,983
.6	10,771
.7	9,610
.8	1,255
.9	0
1.0	0
	11,665

TABLE B-34
SPECTRUM BS1.FS4 (NO. 34)

DESCRIPTION: SPECTRUM NO. 1 WITH FLAPS-UP CLIMB AND DESCENT STRESS TRANSFER FUNCTIONS SAME AS FOR CRUISE

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	= 2,528
TOTAL CYCLES	= 45,403	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 18.0
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 18.2
HIGHEST PEAK (PSI)	= 22,032			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	0
-4,000	5,151
-3,000	6,386
-2,000	110
-1,000	18
0	0
1,000	0
2,000	0
3,000	0
4,000	0
5,000	0
6,000	499
7,000	0
8,000	0
9,000	525
10,000	7,452
11,000	1,683
12,000	790
13,000	6,332
14,000	11,042
15,000	3,498
16,000	1,530
17,000	215
18,000	122
19,000	28
20,000	14
21,000	6
22,000	0
23,000	2
24,000	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	21,848
6,000	4,042
7,000	10,400
8,000	4,692
9,000	1,407
10,000	322
11,000	43
12,000	52
13,000	9
14,000	19
15,000	0
16,000	12
17,000	7
18,000	0
19,000	19
20,000	199
21,000	101
22,000	298
23,000	1,372
24,000	469
25,000	77
26,000	11
27,000	0
28,000	2
29,000	0
30,000	2
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	71
-1.2	1,085
-1.0	31
-.9	51
-.8	98
-.7	791
-.6	231
-.5	303
-.4	47
-.3	52
-.2	0
-.1	48
0	4
.1	91
.2	36
.3	258
.4	624
.5	4,244
.6	14,777
.7	9,688
.8	1,208
.9	0
1.0	0
	11,665

TABLE B-35
SPECTRUM BS1.FS5 (NO. 35)

DESCRIPTION: SPECTRUM NO. 1 CLIMB AND DESCENT STRESS TRANSFER FUNCTION SAME AS FOR CRUISE

FLIGHT HOURS = 2,500
TOTAL CYCLES = 43,575
RANGE TRUNCATION (PSI) = 4,000
HIGHEST PEAK (PSI) = 22,032

FLIGHTS = 2,528
AVERAGE NO. OF CYCLES PER: FLIGHT = 17.2; FLIGHT HOUR = 17.4
LANDINGS = 2,528
SMALLEST VALLEY (PSI) = -24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
	0
-5,000	
	5,151
-4,000	
	6,386
-3,000	
	110
-2,000	
	18
-1,000	
	0
0	
	0
1,000	
	0
2,000	
	0
3,000	
	0
4,000	
	0
5,000	
	499
6,000	
	15
7,000	
	0
8,000	
	960
9,000	
	7,813
10,000	
	1,011
11,000	
	306
12,000	
	6,697
13,000	
	11,563
14,000	
	2,451
15,000	
	455
16,000	
	2
17,000	
	95
18,000	
	27
19,000	
	10
20,000	
	4
21,000	
	0
22,000	
	2
23,000	
	0
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
	0
4,000	
	22,155
5,000	
	2,445
6,000	
	10,033
7,000	
	4,629
8,000	
	1,315
9,000	
	307
10,000	
	43
11,000	
	51
12,000	
	9
13,000	
	19
14,000	
	0
15,000	
	12
16,000	
	7
17,000	
	13
18,000	
	5
19,000	
	263
20,000	
	514
21,000	
	1,230
22,000	
	446
23,000	
	34
24,000	
	35
25,000	
	6
26,000	
	1
27,000	
	1
28,000	
	0
29,000	
	2
30,000	
	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	617
-1.5	
	564
-1.2	
	13
-1.0	
	95
-.9	
	44
-.8	
	960
-.7	
	67
-.6	
	300
-.5	
	48
-.4	
	52
-.3	
	0
-.2	
	48
-.1	
	4
0	
	91
.1	
	35
.2	
	249
.3	
	597
.4	
	3,851
.5	
	14,312
.6	
	9,421
.7	
	542
.8	
	0
.9	
	0
1.0	
	11,665

TABLE B-36
SPECTRUM BS6.ES1 (NO. 36)

DESCRIPTION: SPECTRUM NO. 6 WITH THE NUMBER OF GUST AND MANEUVER CYCLES INCREASED BY 15 PERCENT.

FLIGHT HOURS = 2,500
TOTAL CYCLES = 206,201
RANGE TRUNCATION (PSI) = 4,000
HIGHEST PEAK (PSI) = 23,923

FLIGHTS = 2,422
AVERAGE NO. OF CYCLES PER: FLIGHT = 85.1; FLIGHT HOUR = 82.5
LANDINGS = 3,843
SMALLEST VALLEY (PSI) = -24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
	0
-10,000	
	11
-9,000	
	0
-8,000	
	213
-7,000	
	911
-6,000	
	1,371
-5,000	
	3,082
-4,000	
	7,007
-3,000	
	753
-2,000	
	56
-1,000	
	2
0	
	0
1,000	
	0
2,000	
	0
3,000	
	0
4,000	
	384
5,000	
	358
6,000	
	97
7,000	
	238
8,000	
	4,793
9,000	
	19,845
10,000	
	39,316
11,000	
	36,510
12,000	
	41,465
13,000	
	10,319
14,000	
	30,199
15,000	
	6,869
16,000	
	1,806
17,000	
	211
18,000	
	226
19,000	
	69
20,000	
	18
21,000	
	4
22,000	
	4
23,000	
	1
24,000	
	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
	0
4,000	
	86,395
5,000	
	75,307
6,000	
	27,820
7,000	
	8,655
8,000	
	2,481
9,000	
	1,186
10,000	
	275
11,000	
	96
12,000	
	46
13,000	
	19
14,000	
	16
15,000	
	11
16,000	
	11
17,000	
	22
18,000	
	106
19,000	
	109
20,000	
	400
21,000	
	1,140
22,000	
	952
23,000	
	429
24,000	
	116
25,000	
	392
26,000	
	29
27,000	
	154
28,000	
	30
29,000	
	4
30,000	
	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	272
-1.5	
	673
-1.2	
	562
-1.0	
	896
-.9	
	470
-.8	
	665
-.7	
	331
-.6	
	208
-.5	
	94
-.4	
	56
-.3	
	49
-.2	
	61
-.1	
	78
0	
	124
.1	
	272
.2	
	869
.3	
	3,566
.4	
	18,370
.5	
	60,642
.6	
	103,552
.7	
	942
.8	
	0
.9	
	0
1.0	
	13,449

TABLE B-37
SPECTRUM BS6.ES2 (NO. 37)

DESCRIPTION: SPECTRUM NO. 6 WITH THE NUMBER OF GUST AND MANEUVER CYCLES DECREASED BY 15 PERCENT.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 157,494	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 65.0
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 63.0
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	51
-10,000	0
-9,000	19
-8,000	0
-7,000	210
-6,000	936
-5,000	1,380
-4,000	3,060
-3,000	7,040
-2,000	733
-1,000	50
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	358
7,000	96
8,000	206
9,000	3,657
10,000	14,497
11,000	29,780
12,000	27,117
13,000	30,738
14,000	7,810
15,000	22,439
16,000	5,200
17,000	1,336
18,000	156
19,000	165
20,000	51
21,000	15
22,000	4
23,000	3
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	64,121
6,000	56,952
7,000	22,004
8,000	7,011
9,000	2,241
10,000	879
11,000	241
12,000	66
13,000	44
14,000	15
15,000	16
16,000	10
17,000	11
18,000	30
19,000	105
20,000	124
21,000	473
22,000	1,091
23,000	990
24,000	376
25,000	97
26,000	391
27,000	26
28,000	145
29,000	27
30,000	5
31,000	2
32,000	1
33,000	0
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	274
-1.2	679
-1.0	582
-.9	907
-.8	476
-.7	647
-.6	299
-.5	204
-.4	101
-.3	58
-.2	49
-.1	62
0	74
.1	112
.2	218
.3	683
.4	2,573
.5	14,103
.6	44,774
.7	76,426
.8	712
.9	0
1.0	0
	13,481

TABLE B-38
SPECTRUM BS6.ES3 (NO. 38)

DESCRIPTION: SPECTRUM NO. 6 WITH THE SLOPE OF GUST AND MANEUVER EXCEEDANCES SPECTRA INCREASED 15 PERCENT.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 256,217	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 105.8
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 102.5
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	50
-10,000	0
-9,000	14
-8,000	0
-7,000	200
-6,000	895
-5,000	1,388
-4,000	3,084
-3,000	6,998
-2,000	759
-1,000	56
0	1
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	358
7,000	105
8,000	364
9,000	6,856
10,000	24,992
11,000	46,133
12,000	42,552
13,000	53,517
14,000	13,842
15,000	38,920
16,000	10,484
17,000	3,144
18,000	380
19,000	521
20,000	162
21,000	41
22,000	6
23,000	10
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	99,407
6,000	91,930
7,000	39,703
8,000	13,988
9,000	3,659
10,000	2,504
11,000	735
12,000	249
13,000	94
14,000	21
15,000	21
16,000	11
17,000	12
18,000	18
19,000	103
20,000	102
21,000	351
22,000	1,115
23,000	960
24,000	483
25,000	140
26,000	370
27,000	28
28,000	178
29,000	28
30,000	7
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	248
-1.2	685
-1.0	583
-.9	832
-.8	498
-.7	687
-.6	338
-.5	196
-.4	101
-.3	59
-.2	49
-.1	69
0	101
.1	190
.2	526
.3	1,798
.4	6,623
.5	28,113
.6	81,617
.7	118,318
.8	1,141
.9	0
1.0	0
	13,445

TABLE B-39
SPECTRUM BS6.ES4 (NO. 39)

DESCRIPTION: SPECTRUM NO. 6 WITH THE SLOPE OF GUST AND MANEUVER EXCEEDANCES SPECTRA DECREASED 15 PERCENT.

FLIGHT HOURS	= 2,500	FLIGHTS =	2,422	LANDINGS	= 3,843
TOTAL CYCLES	= 117,516	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 48.5
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 47.0
HIGHEST PEAK (PSI)	= 22,694			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	42
-10,000	0
-9,000	14
-8,000	0
-7,000	207
-6,000	926
-5,000	1,369
-4,000	3,081
-3,000	7,017
-2,000	758
-1,000	50
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	358
7,000	96
8,000	143
9,000	2,225
10,000	10,636
11,000	23,458
12,000	21,282
13,000	21,093
14,000	5,255
15,000	15,340
16,000	2,988
17,000	639
18,000	72
19,000	55
20,000	18
21,000	5
22,000	2
23,000	1
24,000	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	51,158
6,000	41,805
7,000	14,090
8,000	4,245
9,000	1,726
10,000	387
11,000	112
12,000	39
13,000	25
14,000	12
15,000	13
16,000	10
17,000	11
18,000	26
19,000	111
20,000	128
21,000	477
22,000	1,186
23,000	969
24,000	325
25,000	77
26,000	393
27,000	19
28,000	143
29,000	22
30,000	7
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	297
-1.2	693
-1.0	575
-.9	923
-.8	408
-.7	698
-.6	282
-.5	208
-.4	83
-.3	60
-.2	49
-.1	60
0	69
.1	86
.2	137
.3	296
.4	1,153
.5	8,005
.6	29,421
.7	60,021
.8	526
.9	0
1.0	0
	13,466

TABLE B-40
SPECTRUM BS1.DSL1 (NO. 40)

DESCRIPTION: SPECTRUM NO. 1 STRESSES INCREASED 15 PERCENT.

FLIGHT HOURS	= 2,500	FLIGHTS =	2,528	LANDINGS	= 2,528
TOTAL CYCLES	= 45,807	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 18.1
RANGE TRUNCATION (PSI)	= 4,000 (1.15)			FLIGHT HOUR	= 18.3
HIGHEST PEAK (PSI)	= 25,431			SMALLEST VALLEY (PSI)	= −27,943

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	0
-5,000	5,151
-4,000	5,477
-3,000	909
-2,000	110
-1,000	18
0	0
1,000	
2,000	
3,000	
4,000	
5,000	0
6,000	499
7,000	0
8,000	0
9,000	0
10,000	582
11,000	4,126
12,000	3,679
13,000	1,243
14,000	1,193
15,000	6,315
16,000	10,121
17,000	4,456
18,000	1,131
19,000	509
20,000	201
21,000	37
22,000	28
23,000	14
24,000	4
25,000	2
26,000	2
27,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	3,899
6,000	19,431
7,000	3,281
8,000	10,210
9,000	1,388
10,000	3,547
11,000	1,061
12,000	301
13,000	59
14,000	33
15,000	9
16,000	19
17,000	0
18,000	12
19,000	0
20,000	7
21,000	14
22,000	5
23,000	199
24,000	101
25,000	290
26,000	1,264
27,000	388
28,000	241
29,000	33
30,000	11
31,000	0
32,000	2
33,000	0
34,000	2
35,000	0

R DISTRIBUTION

R	n
-1.5	71
-1.2	1,088
-1.0	28
-.9	51
-.8	98
-.7	791
-.6	231
-.5	303
-.4	47
-.3	52
-.2	0
-.1	47
0	4
.1	89
.2	30
.3	233
.4	500
.5	3,897
.6	13,076
.7	12,294
.8	1,210
.9	0
1.0	0
	11,665

TABLE B-41
SPECTRUM BS3.DSL1 (NO. 41)

DESCRIPTION: SPECTRUM NO. 3 STRESSES INCREASED 15 PERCENT.

FLIGHT HOURS = 2,500	FLIGHTS = 5,112	LANDINGS	= 5,112
TOTAL CYCLES = 649,353	AVERAGE NO. OF CYCLES PER:	FLIGHT	= 127.0
RANGE TRUNCATION (PSI) = 4,000 (1.15)		FLIGHT HOUR	= 259.7
HIGHEST PEAK (PSI) = 28,297		SMALLEST VALLEY (PSI)	= −18,046

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	50
-10,000	4
-9,000	0
-8,000	0
-7,000	3,104
-6,000	4,878
-5,000	6,754
-4,000	9,171
-3,000	1,539
-2,000	45
-1,000	3
0	0
1,000	
2,000	
3,000	
4,000	
5,000	
6,000	0
7,000	480
8,000	0
9,000	29
10,000	2
11,000	0
12,000	144,802
13,000	147,691
14,000	158,999
15,000	13,959
16,000	122,325
17,000	27,107
18,000	1,643
19,000	5,368
20,000	1,127
21,000	33
22,000	186
23,000	36
24,000	2
25,000	13
26,000	2
27,000	0
28,000	1
29,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	214,964
5,000	287,444
6,000	16,293
7,000	91,055
8,000	25,266
9,000	3,533
10,000	4,182
11,000	1,076
12,000	4
13,000	268
14,000	85
15,000	13
16,000	26
17,000	11
18,000	0
19,000	7
20,000	5
21,000	0
22,000	3
23,000	225
24,000	1,227
25,000	792
26,000	229
27,000	218
28,000	27
29,000	1,914
30,000	83
31,000	347
32,000	43
33,000	2
34,000	10
35,000	1
36,000	0
37,000	

R DISTRIBUTION

R	n
	21
-1.5	17
-1.2	150
-1.0	1,963
-.9	760
-.8	1,920
-.7	334
-.6	43
-.5	0
-.4	39
-.3	2
-.2	86
-.1	16
0	115
.1	359
.2	1,797
.3	7,276
.4	29,081
.5	166,302
.6	411,674
.7	1,850
.8	0
.9	0
1.0	25,548

TABLE B-42
SPECTRUM BS4.DSL1 (NO. 42)

DESCRIPTION: SPECTRUM 4 STRESSES INCREASED 15 PERCENT.

FLIGHT HOURS = 2,500	FLIGHTS = 3,111	LANDINGS	= 15,872
TOTAL CYCLES = 199,036	AVERAGE NO. OF CYCLES PER:	FLIGHT	= 64.0
RANGE TRUNCATION (PSI) = 4,000 (1.15)		FLIGHT HOUR	= 79.6
HIGHEST PEAK (PSI) = 33,167		SMALLEST VALLEY (PSI)	= −32,180

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	0
-6,000	9,839
-5,000	20,166
-4,000	11,835
-3,000	481
-2,000	55
-1,000	0
0	
1,000	
2,000	
3,000	
4,000	0
5,000	4,345
6,000	1,236
7,000	0
8,000	235
9,000	3,890
10,000	15,877
11,000	29,881
12,000	24,448
13,000	12,044
14,000	17,777
15,000	24,241
16,000	8,433
17,000	9,638
18,000	1,681
19,000	1,808
20,000	527
21,000	247
22,000	136
23,000	88
24,000	59
25,000	14
26,000	24
27,000	13
28,000	6
29,000	12

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	14,761
5,000	83,167
6,000	31,346
7,000	26,844
8,000	12,628
9,000	9,497
10,000	2,496
11,000	870
12,000	544
13,000	102
14,000	228
15,000	98
16,000	108
17,000	35
18,000	58
19,000	71
20,000	35
21,000	55
22,000	492
23,000	2,874
24,000	3,532
25,000	4,761
26,000	3,069
27,000	880
28,000	332
29,000	67
30,000	34
31,000	11
32,000	14
33,000	6
34,000	3
35,000	6
	4
	8
	0

R DISTRIBUTION

R	n
	762
-1.5	2,176
-1.2	4,165
-1.0	4,124
-.9	2,767
-.8	1,221
-.7	1,762
-.6	617
-.5	693
-.4	341
-.3	439
-.2	308
-.1	623
0	502
.1	889
.2	733
.3	3,240
.4	25,574
.5	59,546
.6	44,815
.7	1,363
.8	0
.9	0
1.0	42,376

TABLE B-43
SPECTRUM BS6.DSL1 (NO. 43)

DESCRIPTION: SPECTRUM NO. 6 STRESSES INCREASED 15 PERCENT.

FLIGHT HOURS = 2,500	FLIGHTS = 2,422	LANDINGS = 3,843	
TOTAL CYCLES = 181,644	AVERAGE NO. OF CYCLES PER:	FLIGHT = 75.0	
RANGE TRUNCATION (PSI) = 4,000 (1.15)		FLIGHT HOUR = 72.7	
HIGHEST PEAK (PSI) = 27,512		SMALLEST VALLEY (PSI) = −27,943	

PEAK DISTRIBUTION

Peak (psi)	n
-13,000	47
-12,000	0
-11,000	2
-10,000	7
-9,000	2
-8,000	199
-7,000	302
-6,000	631
-5,000	3,771
-4,000	4,995
-3,000	3,098
-2,000	371
-1,000	20
0	1
1,000	0
2,000	↕
3,000	
4,000	
5,000	0
6,000	606
7,000	136
8,000	94
9,000	109
10,000	3,569
11,000	11,091
12,000	8,709
13,000	33,240
14,000	31,527
15,000	35,667
16,000	8,272
17,000	26,169
18,000	6,667
19,000	633
20,000	1,305
21,000	284
22,000	36
23,000	55
24,000	14
25,000	6
26,000	4
27,000	2
28,000	1
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	55397
6,000	76,076
7,000	10,122
8,000	24,394
9,000	6,948
10,000	2,819
11,000	1,360
12,000	386
13,000	76
14,000	79
15,000	49
16,000	20
17,000	14
18,000	8
19,000	5
20,000	15
21,000	59
22,000	50
23,000	117
24,000	429
25,000	787
26,000	1,043
27,000	496
28,000	258
29,000	53
30,000	364
31,000	22
32,000	162
33,000	9
34,000	21
35,000	5
36,000	1
	0

R DISTRIBUTION

R	n
-1.5	277
-1.2	698
-1.0	559
-.9	869
-.8	490
-.7	654
-.6	333
-.5	197
-.4	92
-.3	58
-.2	49
-.1	63
0	79
.1	119
.2	243
.3	793
.4	3,155
.5	16,125
.6	52,775
.7	89,731
.8	839
.9	0
1.0	0
	13,446

TABLE B-44
SPECTRUM BS1.DSL2 (NO. 44)

DESCRIPTION: SPECTRUM NO. 1 STRESSES DECREASED 10 PERCENT.

FLIGHT HOURS = 2,500	FLIGHTS = 2,528	LANDINGS = 2,528	
TOTAL CYCLES = 45,807	AVERAGE NO. OF CYCLES PER:	FLIGHT = 18.1	
RANGE TRUNCATION (PSI) = 4,000 (0.9)		FLIGHT HOUR = 18.3	
HIGHEST PEAK (PSI) = 19,902		SMALLEST VALLEY (PSI) = −21,868	

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	0
-4,000	5,151
-3,000	5,477
-2,000	1,008
-1,000	27
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	499
6,000	0
7,000	0
8,000	2,124
9,000	4,795
10,000	2,676
11,000	4,240
12,000	3,873
13,000	11,831
14,000	3,307
15,000	509
16,000	219
17,000	47
18,000	14
19,000	6
20,000	2
21,000	0
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	4,653
5,000	21,295
6,000	9,423
7,000	2,794
8,000	4,613
9,000	335
10,000	63
11,000	34
12,000	9
13,000	19
14,000	12
15,000	0
16,000	7
17,000	19
18,000	199
19,000	158
20,000	241
21,000	1,644
22,000	241
23,000	37
24,000	7
25,000	2
26,000	0
27,000	2
28,000	0
29,000	
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	71
-1.2	1,088
-1.0	28
-.9	51
-.8	98
-.7	791
-.6	231
-.5	303
-.4	47
-.3	52
-.2	0
-.1	47
0	4
.1	89
.2	30
.3	235
.4	500
.5	3,897
.6	13,076
.7	12,294
.8	1,210
.9	0
1.0	0
	11,665

TABLE B-45
SPECTRUM BS3.DSL2 (NO. 45)

DESCRIPTION: SPECTRUM NO. 3 STRESSES DECREASED 10 PERCENT.

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112		LANDINGS	= 5,112
TOTAL CYCLES	= 649,353	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 127.0
RANGE TRUNCATION (PSI)	= 4,000 (0.9)			FLIGHT HOUR	= 259.7
HIGHEST PEAK (PSI)	= 22,130			SMALLEST VALLEY (PSI)	= −14,123

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	0
-8,000	50
-7,000	4
-6,000	0
-5,000	3,104
-4,000	4,878
-3,000	6,754
-2,000	10,547
-1,000	206
0	0
1,000	
2,000	
3,000	
4,000	
5,000	0
6,000	480
7,000	0
8,000	29
9,000	2
10,000	144,802
11,000	147,691
12,000	162,108
13,000	129,621
14,000	30,661
15,000	2,633
16,000	4,487
17,000	1,020
18,000	217
19,000	38
20,000	13
21,000	2
22,000	0
23,000	1
24,000	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	217,281
5,000	291,308
6,000	101,056
7,000	25,377
8,000	3,558
9,000	4,184
10,000	1,052
11,000	269
12,000	85
13,000	33
14,000	17
15,000	0
16,000	7
17,000	5
18,000	3
19,000	225
20,000	1,231
21,000	1,017
22,000	218
23,000	52
24,000	1,891
25,000	428
26,000	43
27,000	12
28,000	1
29,000	0
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	21
-1.2	17
-1.0	150
-.9	1,963
-.8	760
-.7	1,920
-.6	334
-.5	43
-.4	0
-.3	39
-.2	2
-.1	86
0	16
.1	115
.2	359
.3	1,797
.4	7,276
.5	29,081
.6	166,302
.7	411,674
.8	1,850
.9	0
1.0	0
	25,548

TABLE B-46
SPECTRUM BS4.DSL2 (NO. 46)

DESCRIPTION: SPECTRUM NO. 4 STRESSES DECREASED 10 PERCENT.

FLIGHT HOURS	= 2,500	FLIGHTS = 3,111		LANDINGS	= 15,872
TOTAL CYCLES	= 199,036	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 64.0
RANGE TRUNCATION (PSI)	= 4,000 (0.9)			FLIGHT HOUR	= 79.6
HIGHEST PEAK (PSI)	= 25,957			SMALLEST VALLEY (PSI)	= −25,185

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	0
-4,000	6,568
-3,000	31,639
-2,000	3,912
-1,000	248
0	9
1,000	0
2,000	0
3,000	0
4,000	869
5,000	4,712
6,000	0
7,000	235
8,000	6,382
9,000	33,778
10,000	31,598
11,000	14,942
12,000	19,720
13,000	29,398
14,000	9,176
15,000	3,570
16,000	1,443
17,000	401
18,000	220
19,000	108
20,000	52
21,000	24
22,000	14
23,000	9
24,000	5
25,000	2
26,000	2
27,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	34,335
5,000	78,197
6,000	41,421
7,000	14,772
8,000	9,848
9,000	2,925
10,000	613
11,000	152
12,000	221
13,000	125
14,000	115
15,000	80
16,000	61
17,000	76
18,000	492
19,000	3,788
20,000	5,968
21,000	4,133
22,000	1,390
23,000	188
24,000	73
25,000	20
26,000	14
27,000	7
28,000	8
29,000	4
30,000	8
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	762
-1.2	2,176
-1.0	4,165
-.9	4,124
-.8	2,767
-.7	1,221
-.6	1,762
-.5	617
-.4	693
-.3	341
-.2	439
-.1	308
0	623
.1	502
.2	889
.3	733
.4	3,240
.5	25,574
.6	59,546
.7	44,815
.8	1,363
.9	0
1.0	0
	42,376

TABLE B-47
SPECTRUM BS6.DSL2 (NO. 47)

DESCRIPTION: SPECTRUM NO. 6 STRESSES DECREASED 10 PERCENT.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,644	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.0
RANGE TRUNCATION (PSI)	= 4,000 (0.9)			FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 21,531			SMALLEST VALLEY (PSI)	= −21,868

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000				-1.5	277
-11,000	0			-1.2	698
-10,000	47	1,000		-1.0	559
-9,000	0	2,000		-.9	869
-8,000	9	3,000	0	-.8	490
-7,000	2	4,000	58,161	-.7	654
-6,000	199	5,000	77,727	-.6	333
-5,000	915	6,000	29,067	-.5	197
-4,000	3,414	7,000	7,966	-.4	92
-3,000	6,283	8,000	3,109	-.3	58
-2,000	2,498	9,000	1,258	-.2	49
-1,000	77	10,000	286	-.1	63
0	2	11,000	84	0	79
1,000	0	12,000	48	.1	119
2,000	0	13,000	26	.2	243
3,000	0	14,000	16	.3	793
4,000	96	15,000	7	.4	3,155
5,000	646	16,000	37	.5	16,125
6,000	94	17,000	77	.6	52,775
7,000	109	18,000	125	.7	89,731
8,000	4,183	19,000	544	.8	839
9,000	17,372	20,000	1,035	.9	0
10,000	34,783	21,000	1,131	1.0	0
11,000	33,149	22,000	326		13,446
12,000	35,381	23,000	34		
13,000	31,984	24,000	364		
14,000	7,910	25,000	180		
15,000	1,051	26,000	28		
16,000	1,092	27,000	7		
17,000	250	28,000	1		
18,000	71	29,000	0		
19,000	16	30,000			
20,000	8	31,000			
21,000	2	32,000			
22,000	1	33,000			
23,000	0	34,000			
24,000		35,000			
25,000					
26,000					
27,000					

TABLE B-48
SPECTRUM BS6.DSL3 (NO. 48)

DESCRIPTION: SPECTRUM NO. 6 STRESSES DECREASED 26 PERCENT.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,644	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.0
RANGE TRUNCATION (PSI)	= 4,000 (0.74)			FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 17,703			SMALLEST VALLEY (PSI)	= −17,981

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000				-1.5	277
-11,000				-1.2	698
-10,000		1,000		-1.0	559
-9,000	0	2,000	0	-.9	869
-8,000	47	3,000	1,317	-.8	490
-7,000	2	4,000	132,811	-.7	654
-6,000	7	5,000	31,364	-.6	333
-5,000	201	6,000	9,388	-.5	197
-4,000	915	7,000	2,295	-.4	92
-3,000	4,348	8,000	445	-.3	58
-2,000	7,533	9,000	97	-.2	49
-1,000	391	10,000	60	-.1	63
0	2	11,000	23	0	79
1,000	0	12,000	12	.1	119
2,000	0	13,000	40	.2	243
3,000	0	14,000	77	.3	793
4,000	742	15,000	248	.4	3,155
5,000	94	16,000	979	.5	16,125
6,000	247	17,000	1,417	.6	52,775
7,000	13,447	18,000	494	.7	89,731
8,000	41,590	19,000	58	.8	839
9,000	22,768	20,000	381	.9	0
10,000	28,618	21,000	171	1.0	0
11,000	32,082	22,000	22		13,446
12,000	6,697	23,000	5		
13,000	1,510	24,000	0		
14,000	312	25,000			
15,000	68	26,000			
16,000	14	27,000			
17,000	8	28,000			
18,000	1	29,000			
19,000	0	30,000			
20,000		31,000			
21,000		32,000			
22,000		33,000			
23,000		34,000			
24,000		35,000			
25,000					
26,000					
27,000					

TABLE B-49
SPECTRUM BS6.DSL4 (NO. 49)

DESCRIPTION: SPECTRUM NO. 6 STRESSES INCREASED 35 PERCENT.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422	LANDINGS = 3,843
TOTAL CYCLES	= 181,644	AVERAGE NO. OF CYCLES PER: FLIGHT	= 75.0
RANGE TRUNCATION (PSI)	= 4,000 (1.35)	FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 32,297	SMALLEST VALLEY (PSI)	= −32,802

PEAK DISTRIBUTION

Peak (psi)	n
	56
-12,000	0
-11,000	201
-10,000	0
-9,000	914
-8,000	20
-7,000	3,395
-6,000	3,378
-5,000	4,690
-4,000	713
-3,000	72
-2,000	7
-1,000	0
0	
1,000	
2,000	
3,000	
4,000	0
5,000	96
6,000	510
7,000	136
8,000	94
9,000	5
10,000	251
11,000	4,036
12,000	10,997
13,000	7,459
14,000	33,699
15,000	31,128
16,000	4,712
17,000	32,690
18,000	8,083
19,000	25,691
20,000	6,120
21,000	722
22,000	1,296
23,000	25
24,000	246
25,000	30
26,000	45
27,000	26
32,000	1
33,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	58,161
6,000	73,166
7,000	9,656
8,000	23,972
9,000	4,877
10,000	5,002
11,000	1,196
12,000	1,129
13,000	339
14,000	76
15,000	79
16,000	27
17,000	26
18,000	22
19,000	12
20,000	8
21,000	4
22,000	9
23,000	31
24,000	35
25,000	89
26,000	78
27,000	272
28,000	502
29,000	805
30,000	940
31,000	363
32,000	154
33,000	30
34,000	362
35,000	6
36,000	83
37,000	102
38,000	23
39,000	8
42,000	0

R DISTRIBUTION

R	n
	277
-1.5	698
-1.2	559
-1.0	869
-.9	490
-.8	654
-.7	333
-.6	197
-.5	92
-.4	58
-.3	49
-.2	63
-.1	79
0	119
.1	243
.2	793
.3	3,155
.4	16,125
.5	52,775
.6	89,731
.7	839
.8	0
.9	0
1.0	13,446

TABLE B-50
SPECTRUM BS1.VPC1 (NO. 50)

DESCRIPTION: SPECTRUM NO. 1 WITH DIFFERENT VALLEY/PEAK COUPLING

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528	LANDINGS = 2,528
TOTAL CYCLES	= 42,463	AVERAGE NO. OF CYCLES PER: FLIGHT	= 16.8
RANGE TRUNCATION (PSI)	= 4,000	FLIGHT HOUR	= 17.0
HIGHEST PEAK (PSI)	= 22,114	SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	0
-5,000	5,639
-4,000	6,320
-3,000	112
-2,000	17
-1,000	0
0	
1,000	
2,000	
3,000	
4,000	0
5,000	499
6,000	0
7,000	0
8,000	2,748
9,000	5,775
10,000	2,683
11,000	1,135
12,000	1,330
13,000	10,964
14,000	3,339
15,000	1,515
16,000	214
17,000	123
18,000	28
19,000	14
20,000	6
21,000	1
22,000	1
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	15,989
5,000	3,399
6,000	13,010
7,000	4,939
8,000	1,422
9,000	682
10,000	25
11,000	321
12,000	5
13,000	73
14,000	2
15,000	26
16,000	10
17,000	32
18,000	258
19,000	81
20,000	314
21,000	1,356
22,000	418
23,000	83
24,000	14
25,000	0
26,000	2
27,000	0
28,000	2
29,000	0
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	69
-1.5	1,089
-1.2	29
-1.0	48
-.9	55
-.8	789
-.7	212
-.6	369
-.5	48
-.4	52
-.3	0
-.2	44
-.1	7
0	93
.1	76
.2	385
.3	794
.4	2,503
.5	16,470
.6	6,071
.7	1,172
.8	0
.9	0
1.0	12,088

TABLE B-51
SPECTRUM BS2.VPC1 (NO. 51)

DESCRIPTION: SPECTRUM NO. 2 WITH DIFFERENT VALLEY/PEAK COUPLING

FLIGHT HOURS = 2.500	FLIGHTS = 437	LANDINGS = 437	
TOTAL CYCLES = 8.842	AVERAGE NO. OF CYCLES PER:	FLIGHT = 20.2	
RANGE TRUNCATION (PSI) = 4.000		FLIGHT HOUR = 3.5	
HIGHEST PEAK (PSI) = 17.915		SMALLEST VALLEY (PSI) = −17.878	

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	0
-8,000	584
-7,000	24
-6,000	2
-5,000	0
-4,000	913
-3,000	2
-2,000	0
-1,000	
0	
1,000	
2,000	
3,000	
4,000	
5,000	
6,000	
7,000	
8,000	0
9,000	1,187
10,000	685
11,000	1,609
12,000	2,490
13,000	1,078
14,000	213
15,000	39
16,000	13
17,000	3
18,000	0
19,000	
20,000	
21,000	
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	4,184
5,000	2,643
6,000	369
7,000	253
8,000	808
9,000	42
10,000	71
11,000	8
12,000	15
13,000	2
14,000	5
15,000	0
16,000	3
17,000	1
18,000	1
19,000	0
20,000	0
21,000	0
22,000	0
23,000	111
24,000	20
25,000	1
26,000	0
27,000	237
28,000	57
29,000	9
30,000	0
31,000	1
32,000	1
33,000	0
34,000	
35,000	

R DISTRIBUTION

R	n
	1
-1.5	250
-1.2	53
-1.0	112
-.9	21
-.8	0
-.7	
-.6	
-.5	
-.4	
-.3	0
-.2	1
-.1	2
0	13
.1	31
.2	103
.3	294
.4	456
.5	3,975
.6	1,940
.7	65
.8	0
.9	0
1.0	1,525

TABLE B-52
SPECTRUM BS3.VPC1 (NO. 52)

DESCRIPTION: SPECTRUM NO. 3 WITH DIFFERENT VALLEY/PEAK COUPLING

FLIGHT HOURS = 2.500	FLIGHTS = 5.112	LANDINGS = 5.112	
TOTAL CYCLES = 388.719	AVERAGE NO. OF CYCLES PER:	FLIGHT = 76.0	
RANGE TRUNCATION (PSI) = 4.000		FLIGHT HOUR = 155.5	
HIGHEST PEAK (PSI) = 24.588		SMALLEST VALLEY (PSI) = −15.692	

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	0
-7,000	4,277
-6,000	6,601
-5,000	298
-4,000	14,668
-3,000	2,382
-2,000	208
-1,000	6
0	0
1,000	
2,000	
3,000	
4,000	
5,000	0
6,000	480
7,000	0
8,000	29
9,000	0
10,000	142
11,000	146,227
12,000	42,292
13,000	13,779
14,000	124,480
15,000	25,367
16,000	6,076
17,000	353
18,000	814
19,000	186
20,000	38
21,000	1
22,000	12
23,000	2
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	4,408
5,000	170,828
6,000	125,000
7,000	41,250
8,000	543
9,000	32,587
10,000	44
11,000	6,927
12,000	13
13,000	736
14,000	782
15,000	205
16,000	151
17,000	53
18,000	5
19,000	44
20,000	148
21,000	1,312
22,000	1,211
23,000	272
24,000	22
25,000	1,727
26,000	67
27,000	334
28,000	39
29,000	9
30,000	2
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	21
-1.5	17
-1.2	97
-1.0	1,775
-.9	642
-.8	2,208
-.7	406
-.6	42
-.5	0
-.4	38
-.3	0
-.2	81
-.1	24
0	334
.1	939
.2	3,620
.3	14,568
.4	61,173
.5	265,518
.6	6,835
.7	1,941
.8	0
.9	0
1.0	28,440

TABLE B-53
SPECTRUM BS4.VPC1 (NO. 53)

DESCRIPTION: SPECTRUM NO. 4 WITH DIFFERENT VALLEY/PEAK COUPLING

FLIGHT HOURS	= 2,500	FLIGHTS = 3,111		LANDINGS	= 15,872
TOTAL CYCLES	= 199,348	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 64.1
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 79.7
HIGHEST PEAK (PSI)	= 28,841			SMALLEST VALLEY (PSI)	= −27,983

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	0
-5,000	15,700
-4,000	24,902
-3,000	2,350
-2,000	79
-1,000	5
0	0
1,000	0
2,000	0
3,000	0
4,000	3,476
5,000	2,105
6,000	0
7,000	0
8,000	3,704
9,000	51,815
10,000	30,483
11,000	15,281
12,000	4,358
13,000	27,280
14,000	8,054
15,000	5,379
16,000	2,841
17,000	793
18,000	316
19,000	211
20,000	106
21,000	42
22,000	33
23,000	11
24,000	8
25,000	8
26,000	5
27,000	2
28,000	1
29,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	86,356
5,000	25,520
6,000	43,066
7,000	12,227
8,000	11,758
9,000	2,027
10,000	614
11,000	742
12,000	253
13,000	244
14,000	112
15,000	77
16,000	120
17,000	27
18,000	99
19,000	571
20,000	3,161
21,000	6,296
22,000	3,399
23,000	1,810
24,000	681
25,000	95
26,000	44
27,000	11
28,000	12
29,000	6
30,000	8
31,000	4
32,000	8
33,000	0
34,000	
35,000	

R DISTRIBUTION

R	n
	767
-1.5	2,182
-1.2	4,097
-1.0	4,233
-.9	2,730
-.8	1,185
-.7	1,639
-.6	605
-.5	830
-.4	360
-.3	438
-.2	304
-.1	628
0	519
.1	925
.2	857
.3	2,821
.4	19,951
.5	89,726
.6	19,778
.7	1,737
.8	0
.9	0
1.0	43,036

TABLE B-54
SPECTRUM BS5.VPC1 (NO. 54)

DESCRIPTION: SPECTRUM NO. 5 WITH DIFFERENT VALLEY/PEAK COUPLING

FLIGHT HOURS	= 2,500	FLIGHTS = 3,205		LANDINGS	= 3,205
TOTAL CYCLES	= 228,996	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 71.5
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 91.6
HIGHEST PEAK (PSI)	= 20,664			SMALLEST VALLEY (PSI)	= −14,897

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	0
-7,000	4,264
-6,000	6,597
-5,000	297
-4,000	13
-3,000	0
-2,000	
-1,000	
0	
1,000	
2,000	
3,000	
4,000	0
5,000	29
6,000	2
7,000	838
8,000	10,908
9,000	181,199
10,000	18,604
11,000	4,272
12,000	1,270
13,000	417
14,000	191
15,000	48
16,000	22
17,000	16
18,000	4
19,000	3
20,000	2
21,000	0
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	156,950
5,000	48,335
6,000	6,482
7,000	10,091
8,000	425
9,000	2,510
10,000	709
11,000	18
12,000	186
13,000	10
14,000	47
15,000	16
16,000	1
17,000	239
18,000	660
19,000	60
20,000	579
21,000	1,112
22,000	424
23,000	131
24,000	7
25,000	3
26,000	1
27,000	0
28,000	
29,000	
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	1,734
-1.5	724
-1.2	681
-1.0	57
-.9	8
-.8	1
-.7	2
-.6	0
-.5	2
-.4	0
-.3	3
-.2	13
-.1	82
0	195
.1	793
.2	2,913
.3	12,310
.4	44,654
.5	152,835
.6	818
.7	0
.8	0
.9	0
1.0	11,171

TABLE B-55
SPECTRUM BS6.VPC1 (NO. 55)

DESCRIPTION: SPECTRUM NO. 6 WITH DIFFERENT VALLEY/PEAK COUPLING

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 133,037	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 54.9
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 53.2
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	0
-7,000	206
-6,000	1,230
-5,000	1,904
-4,000	3,245
-3,000	7,569
-2,000	773
-1,000	54
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	358
7,000	94
8,000	79
9,000	2,086
10,000	24,383
11,000	6,127
12,000	31,436
13,000	10,068
14,000	8,874
15,000	26,148
16,000	5,981
17,000	1,563
18,000	186
19,000	197
20,000	63
21,000	16
22,000	4
23,000	6
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	30,422
6,000	42,507
7,000	33,250
8,000	11,669
9,000	2,084
10,000	7,008
11,000	173
12,000	1,513
13,000	50
14,000	185
15,000	170
16,000	52
17,000	43
18,000	47
19,000	124
20,000	155
21,000	452
22,000	1,087
23,000	959
24,000	416
25,000	108
26,000	366
27,000	19
28,000	148
29,000	23
30,000	7
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	261
-1.2	685
-1.0	562
-.9	888
-.8	427
-.7	686
-.6	307
-.5	238
-.4	115
-.3	58
-.2	49
-.1	61
0	81
.1	164
.2	384
.3	1,200
.4	4,603
.5	19,039
.6	81,598
.7	5,787
.8	861
.9	0
1.0	0
	14,983

TABLE B-56
SPECTRUM BS1.LLT1 (NO. 56)

DESCRIPTION: SPECTRUM NO. 1 WITH 4,500 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	= 2,528
TOTAL CYCLES	= 39,298	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 15.6
RANGE TRUNCATION (PSI)	= 4,500			FLIGHT HOUR	= 15.7
HIGHEST PEAK (PSI)	= 22,114			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	0
-4,000	5,151
-3,000	6,386
-2,000	110
-1,000	18
0	0
1,000	
2,000	
3,000	
4,000	
5,000	0
6,000	354
7,000	0
8,000	12
9,000	266
10,000	2,294
11,000	1,955
12,000	1,067
13,000	6,253
14,000	10,356
15,000	3,177
16,000	1,515
17,000	211
18,000	123
19,000	28
20,000	14
21,000	6
22,000	1
23,000	1
24,000	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	14,338
6,000	4,693
7,000	10,841
8,000	4,922
9,000	1,468
10,000	332
11,000	52
12,000	55
13,000	9
14,000	19
15,000	0
16,000	12
17,000	7
18,000	0
19,000	17
20,000	192
21,000	96
22,000	267
23,000	1,375
24,000	482
25,000	105
26,000	12
27,000	0
28,000	2
29,000	0
30,000	2
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	67
-1.2	1,085
-1.0	34
-.9	52
-.8	93
-.7	773
-.6	252
-.5	290
-.4	62
-.3	52
-.2	0
-.1	47
0	4
.1	89
.2	32
.3	115
.4	910
.5	4,508
.6	7,389
.7	11,771
.8	8
.9	0
1.0	0
	11,665

TABLE B-57
SPECTRUM BS3.LLT1 (NO. 57)

DESCRIPTION: SPECTRUM NO. 3 WITH 4,500 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112		LANDINGS	= 5,112
TOTAL CYCLES	= 465,207	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 91.0
RANGE TRUNCATION (PSI)	= 4,500			FLIGHT HOUR	= 186.1
HIGHEST PEAK (PSI)	= 24,588			SMALLEST VALLEY (PSI)	= −15,692

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000		1,000		-1.5	21
-11,000		2,000		-1.2	17
-10,000	0	3,000		-1.0	170
-9,000	1	4,000	0	-.9	1,909
-8,000	0	5,000	417	-.8	676
-7,000	0	6,000	314,805	-.7	1,973
-6,000	3,085	7,000	105,385	-.6	393
-5,000	4,836	8,000	28,937	-.5	49
-4,000	249	9,000	4,524	-.4	0
-3,000	14,649	10,000	4,431	-.3	39
-2,000	2,401	11,000	1,137	-.2	2
-1,000	206	12,000	294	-.1	86
0	5	13,000	89	0	16
1,000	0	14,000	17	.1	115
2,000		15,000	26	.2	362
3,000		16,000	12	.3	2,484
4,000		17,000	7	.4	8,956
5,000		18,000	0	.5	38,891
6,000	0	19,000	5	.6	188,647
7,000	403	20,000	3	.7	194,777
8,000	0	21,000	169	.8	192
9,000	14	22,000	1,215	.9	0
10,000	1	23,000	1,048	1.0	0
11,000	26,607	24,000	247		25,432
12,000	83,594	25,000	19		
13,000	159,146	26,000	1,889		
14,000	13,873	27,000	103		
15,000	123,188	28,000	353		
16,000	25,434	29,000	57		
17,000	6,108	30,000	17		
18,000	353	31,000	1		
19,000	814	32,000	0		
20,000	186	33,000			
21,000	38	34,000			
22,000	1	35,000			
23,000	12				
24,000	2				
25,000	1				
26,000					
27,000					

TABLE B-58
SPECTRUM BS4.LLT1 (NO. 58)

DESCRIPTION: SPECTRUM NO. 4 WITH 4,500 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS = 3,111		LANDINGS	= 15,872
TOTAL CYCLES	= 161,624	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 52.0
RANGE TRUNCATION (PSI)	= 4,500			FLIGHT HOUR	= 64.6
HIGHEST PEAK (PSI)	= 28,841			SMALLEST VALLEY (PSI)	= −27,983

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000		1,000		-1.5	762
-11,000		2,000		-1.2	2,140
-10,000		3,000		-1.0	4,019
-9,000		4,000	0	-.9	4,088
-8,000		5,000	48,417	-.8	2,878
-7,000		6,000	34,437	-.7	1,304
-6,000		7,000	34,508	-.6	1,793
-5,000	0	8,000	14,985	-.5	729
-4,000	15,272	9,000	10,544	-.4	571
-3,000	24,239	10,000	1,172	-.3	344
-2,000	2,360	11,000	523	-.2	439
-1,000	83	12,000	216	-.1	305
0	5	13,000	268	0	375
1,000	0	14,000	99	.1	252
2,000	0	15,000	108	.2	251
3,000	0	16,000	60	.3	556
4,000	0	17,000	88	.4	4,617
5,000	2,472	18,000	28	.5	27,741
6,000	1,719	19,000	76	.6	24,983
7,000	0	20,000	359	.7	41,469
8,000	19	21,000	2,754	.8	49
9,000	1,492	22,000	6,350	.9	0
10,000	11,852	23,000	3,686	1.0	0
11,000	23,882	24,000	2,019		41,959
12,000	14,051	25,000	714		
13,000	18,340	26,000	120		
14,000	27,950	27,000	41		
15,000	8,319	28,000	12		
16,000	5,299	29,000	13		
17,000	2,734	30,000	7		
18,000	793	31,000	8		
19,000	316	32,000	4		
20,000	211	33,000	8		
21,000	106	34,000	0		
22,000	42	35,000			
23,000	33				
24,000	11				
25,000	8				
26,000	8				
27,000	5				
28,000	2				
29,000	1				
	0				

TABLE B-59
SPECTRUM BS6.LLT1 (NO. 59)

DESCRIPTION: SPECTRUM NO. 6 WITH 4,500 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS =	2,422	LANDINGS	= 3,843
TOTAL CYCLES	= 130,687	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 54.0
RANGE TRUNCATION (PSI)	= 4,500			FLIGHT HOUR	= 52.3
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
	0
-8,000	
	145
-7,000	
	910
-6,000	
	1,362
-5,000	
	3,084
-4,000	
	6,768
-3,000	
	735
-2,000	
	54
-1,000	
	2
0	
	0
1,000	
	0
2,000	
	0
3,000	
	0
4,000	
	272
5,000	
	278
6,000	
	80
7,000	
	121
8,000	
	979
9,000	
	8,166
10,000	
	10,258
11,000	
	19,099
12,000	
	35,735
13,000	
	8,680
14,000	
	25,995
15,000	
	5,940
16,000	
	1,549
17,000	
	186
18,000	
	197
19,000	
	63
20,000	
	16
21,000	
	4
22,000	
	6
23,000	
	1
24,000	
	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
	0
4,000	
	15,100
5,000	
	69,936
6,000	
	28,573
7,000	
	8,950
8,000	
	2,648
9,000	
	1,103
10,000	
	289
11,000	
	95
12,000	
	54
13,000	
	21
14,000	
	14
15,000	
	10
16,000	
	11
17,000	
	26
18,000	
	87
19,000	
	96
20,000	
	408
21,000	
	1,087
22,000	
	1,004
23,000	
	441
24,000	
	140
25,000	
	364
26,000	
	27
27,000	
	163
28,000	
	30
29,000	
	7
30,000	
	1
31,000	
	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	275
-1.5	
	691
-1.2	
	557
-1.0	
	849
-.9	
	495
-.8	
	662
-.7	
	344
-.6	
	211
-.5	
	84
-.4	
	59
-.3	
	49
-.2	
	63
-.1	
	51
0	
	91
.1	
	172
.2	
	883
.3	
	3,947
.4	
	18,451
.5	
	43,296
.6	
	46,350
.7	
	45
.8	
	0
.9	
	0
1.0	
	13,062

TABLE B-60
SPECTRUM BS1.LLT2 (NO. 60)

DESCRIPTION: SPECTRUM NO. 1 WITH 3,500 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS =	2,528	LANDINGS	= 2,528
TOTAL CYCLES	= 82,385	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 32.6
RANGE TRUNCATION (PSI)	= 3,500			FLIGHT HOUR	= 33.0
HIGHEST PEAK (PSI)	= 22,114			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
	0
-5,000	
	5,151
-4,000	
	8,367
-3,000	
	110
-2,000	
	18
-1,000	
	0
0	
1,000	
2,000	
3,000	
4,000	
	0
5,000	
	499
6,000	
	0
7,000	
	243
8,000	
	4,509
9,000	
	8,327
10,000	
	3,193
11,000	
	1,225
12,000	
	31,228
13,000	
	12,183
14,000	
	5,417
15,000	
	1,528
16,000	
	214
17,000	
	123
18,000	
	28
19,000	
	14
20,000	
	6
21,000	
	1
22,000	
	1
23,000	
	0
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
	0
3,000	
	37,910
4,000	
	23,185
5,000	
	3,355
6,000	
	9,230
7,000	
	4,403
8,000	
	1,307
9,000	
	308
10,000	
	41
11,000	
	49
12,000	
	9
13,000	
	19
14,000	
	0
15,000	
	12
16,000	
	7
17,000	
	0
18,000	
	50
19,000	
	173
20,000	
	191
21,000	
	231
22,000	
	1,348
23,000	
	466
24,000	
	77
25,000	
	10
26,000	
	0
27,000	
	2
28,000	
	0
29,000	
	2
30,000	
	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	71
-1.5	
	1,089
-1.2	
	27
-1.0	
	60
-.9	
	185
-.8	
	695
-.7	
	262
-.6	
	272
-.5	
	47
-.4	
	52
-.3	
	0
-.2	
	47
-.1	
	4
0	
	89
.1	
	30
.2	
	227
.3	
	436
.4	
	3,198
.5	
	14,076
.6	
	32,084
.7	
	15,788
.8	
	0
.9	
	0
1.0	
	13,646

TABLE B-61
SPECTRUM BS3.LLT2 (NO. 61)

DESCRIPTION: SPECTRUM NO. 3 WITH 3,500 PSI RANGE TRUNCATION

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112		LANDINGS	= 5,112
TOTAL CYCLES	= 1,169,011	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 228.7
RANGE TRUNCATION (PSI)	= 3,500			FLIGHT HOUR	= 467.6
HIGHEST PEAK (PSI)	= 24,588			SMALLEST VALLEY (PSI)	= −15,692

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000				-1.5	21
-11,000				-1.2	19
-10,000	0	1,000		-1.0	397
-9,000	50	2,000		-.9	1,717
-8,000	0	3,000	0	-.8	842
-7,000	71	4,000	521,178	-.7	1,844
-6,000	3,110	5,000	218,003	-.6	325
-5,000	4,906	6,000	300,515	-.5	43
-4,000	300	7,000	90,398	-.4	0
-3,000	14,651	8,000	24,756	-.3	39
-2,000	2,401	9,000	3,416	-.2	2
-1,000	206	10,000	4,165	-.1	86
0	5	11,000	1,047	0	16
1,000	0	12,000	265	.1	114
2,000		13,000	83	.2	359
3,000		14,000	12	.3	1,798
4,000		15,000	26	.4	7,266
5,000		16,000	11	.5	29,117
6,000	0	17,000	7	.6	165,191
7,000	614	18,000	0	.7	411,605
8,000	0	19,000	5	.8	522,510
9,000	29	20,000	3	.9	0
10,000	13	21,000	310	1.0	0
11,000	144,871	22,000	1,234		25,700
12,000	147,421	23,000	912		
13,000	671,653	24,000	479		
14,000	15,437	25,000	28		
15,000	126,665	26,000	1,684		
16,000	29,080	27,000	73		
17,000	6,121	28,000	350		
18,000	353	29,000	35		
19,000	814	30,000	12		
20,000	186	31,000	1		
21,000	38	32,000	0		
22,000	1	33,000			
23,000	12	34,000			
24,000	2	35,000			
25,000	1				
26,000	0				
27,000					

TABLE B-62
SPECTRUM BS4.LLT2 (NO. 62)

DESCRIPTION: SPECTRUM NO. 4 WITH 3,500 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS = 3,111		LANDINGS	= 15,872
TOTAL CYCLES	= 349,938	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 112.5
RANGE TRUNCATION (PSI)	= 3,500			FLIGHT HOUR	= 140.0
HIGHEST PEAK (PSI)	= 28,841			SMALLEST VALLEY (PSI)	= −27,983

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000				-1.5	765
-11,000				-1.2	2,253
-10,000		1,000		-1.0	4,233
-9,000		2,000		-.9	4,456
-8,000		3,000	0	-.8	2,507
-7,000		4,000	157,826	-.7	1,047
-6,000		5,000	94,471	-.6	1,719
-5,000	0	6,000	28,914	-.5	618
-4,000	15,273	7,000	27,357	-.4	689
-3,000	26,291	8,000	12,777	-.3	341
-2,000	2,360	9,000	10,030	-.2	439
-1,000	83	10,000	1,067	-.1	310
0	5	11,000	505	0	621
1,000	0	12,000	186	.1	502
2,000	0	13,000	263	.2	889
3,000	0	14,000	95	.3	971
4,000	0	15,000	104	.4	3,188
5,000	3,476	16,000	57	.5	21,805
6,000	2,607	17,000	88	.6	73,810
7,000	1	18,000	40	.7	78,734
8,000	261	19,000	94	.8	106,028
9,000	28,333	20,000	575	.9	0
10,000	52,303	21,000	3,439	1.0	0
11,000	34,279	22,000	6,115		44,013
12,000	16,451	23,000	3,472		
13,000	112,531	24,000	1,735		
14,000	30,828	25,000	537		
15,000	14,909	26,000	99		
16,000	5,569	27,000	40		
17,000	2,841	28,000	12		
18,000	793	29,000	13		
19,000	316	30,000	7		
20,000	211	31,000	8		
21,000	106	32,000	4		
22,000	42	33,000	8		
23,000	33	34,000	0		
24,000	11	35,000			
25,000	8				
26,000	8				
27,000	5				
28,000	2				
29,000	1				
	0				

TABLE B-63
SPECTRUM BS6.LLT2 (NO. 63)

DESCRIPTION: SPECTRUM NO. 6 WITH 3,500 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	=	3,843
TOTAL CYCLES	= 311,256	AVERAGE NO. OF CYCLES PER:		FLIGHT	=	128.5
RANGE TRUNCATION (PSI)	= 3,500			FLIGHT HOUR	=	124.5
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	=	−24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	47
-10,000	0
-9,000	9
-8,000	0
-7,000	223
-6,000	943
-5,000	1,384
-4,000	3,098
-3,000	7,719
-2,000	739
-1,000	54
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	414
7,000	157
8,000	581
9,000	7,973
10,000	20,915
11,000	35,000
12,000	32,142
13,000	152,967
14,000	9,847
15,000	27,936
16,000	6,683
17,000	1,566
18,000	186
19,000	197
20,000	63
21,000	16
22,000	4
23,000	6
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	131,244
5,000	75,585
6,000	65,170
7,000	24,008
8,000	7,584
9,000	2,282
10,000	1,037
11,000	266
12,000	89
13,000	53
14,000	20
15,000	14
16,000	10
17,000	11
18,000	39
19,000	88
20,000	115
21,000	556
22,000	1,036
23,000	940
24,000	463
25,000	106
26,000	336
27,000	20
28,000	153
29,000	24
30,000	6
31,000	1
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	293
-1.5	691
-1.2	615
-1.0	863
-.9	487
-.8	601
-.7	337
-.6	191
-.5	91
-.4	58
-.3	49
-.2	63
-.1	79
0	119
.1	243
.2	815
.3	3,044
.4	15,638
.5	55,312
.6	99,259
.7	118,190
.8	0
.9	0
1.0	14,218

TABLE B-64
SPECTRUM BS1.LLT3 (NO. 64)

DESCRIPTION: SPECTRUM NO. 1 WITH 3,000 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	=	2,528
TOTAL CYCLES	= 95,954	AVERAGE NO. OF CYCLES PER:		FLIGHT	=	38.0
RANGE TRUNCATION (PSI)	= 3,000			FLIGHT HOUR	=	38.4
HIGHEST PEAK (PSI)	= 22,114			SMALLEST VALLEY (PSI)	=	−24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	0
-7,000	20
-6,000	0
-5,000	1
-4,000	5,153
-3,000	8,383
-2,000	112
-1,000	18
0	0
1,000	
2,000	
3,000	
4,000	
5,000	0
6,000	666
7,000	0
8,000	2,504
9,000	7,866
10,000	8,676
11,000	3,477
12,000	1,250
13,000	35,876
14,000	14,284
15,000	5,629
16,000	1,652
17,000	214
18,000	123
19,000	28
20,000	14
21,000	6
22,000	1
23,000	1
24,000	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	57,062
5,000	19,349
6,000	2,430
7,000	8,581
8,000	4,255
9,000	1,288
10,000	305
11,000	41
12,000	46
13,000	9
14,000	19
15,000	0
16,000	12
17,000	7
18,000	0
19,000	59
20,000	211
21,000	177
22,000	260
23,000	1,368
24,000	392
25,000	70
26,000	9
27,000	0
28,000	2
29,000	0
30,000	2
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	74
-1.5	1,086
-1.2	27
-1.0	60
-.9	202
-.8	710
-.7	239
-.6	263
-.5	47
-.4	52
-.3	0
-.2	47
-.1	4
0	89
.1	30
.2	224
.3	574
.4	2,689
.5	14,998
.6	35,458
.7	25,106
.8	288
.9	0
1.0	13,687

TABLE B-65
SPECTRUM BS3.LLT3 (NO. 65)

DESCRIPTION: SPECTRUM NO. 3 WITH 3,000 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112		LANDINGS	= 5,112
TOTAL CYCLES	= 1,578,809	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 308.8
RANGE TRUNCATION (PSI)	= 3,000			FLIGHT HOUR	= 631.5
HIGHEST PEAK (PSI)	= 24,588			SMALLEST VALLEY (PSI)	= −15,692

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	0
-10,000	972
-9,000	0
-8,000	77
-7,000	4,273
-6,000	4,906
-5,000	300
-4,000	14,651
-3,000	2,401
-2,000	206
-1,000	5
0	0
1,000	
2,000	
3,000	
4,000	
5,000	0
6,000	863
7,000	0
8,000	160
9,000	55
10,000	542,919
11,000	131,941
12,000	675,271
13,000	15,661
14,000	127,145
15,000	29,366
16,000	6,230
17,000	353
18,000	814
19,000	186
20,000	38
21,000	1
22,000	12
23,000	2
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	0
3,000	934,147
4,000	217,891
5,000	248,149
6,000	90,012
7,000	24,503
8,000	3,377
9,000	4,151
10,000	1,046
11,000	268
12,000	83
13,000	12
14,000	26
15,000	11
16,000	7
17,000	0
18,000	5
19,000	3
20,000	469
21,000	1,100
22,000	920
23,000	446
24,000	28
25,000	1,799
26,000	74
27,000	234
28,000	35
29,000	12
30,000	1
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	21
-1.5	19
-1.2	399
-1.0	1,855
-.9	839
-.8	1,740
-.7	292
-.6	43
-.5	0
-.4	39
-.3	2
-.2	86
-.1	16
0	114
.1	359
.2	1,794
.3	7,243
.4	28,955
.5	164,599
.6	409,556
.7	932,612
.8	435
.9	0
1.0	27,791

TABLE B-66
SPECTRUM BS4.LLT3 (NO. 66)

DESCRIPTION: SPECTRUM NO. 4 WITH 3,000 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS = 3,111		LANDINGS	= 15,872
TOTAL CYCLES	= 418,814	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 134.6
RANGE TRUNCATION (PSI)	= 3,000			FLIGHT HOUR	= 167.5
HIGHEST PEAK (PSI)	= 28,841			SMALLEST VALLEY (PSI)	= −27,983

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	0
-7,000	1
-6,000	1
-5,000	15,273
-4,000	26,292
-3,000	2,361
-2,000	83
-1,000	5
0	0
1,000	0
2,000	0
3,000	0
4,000	4,636
5,000	3,187
6,000	3
7,000	2,998
8,000	54,443
9,000	71,688
10,000	38,892
11,000	17,539
12,000	119,014
13,000	33,613
14,000	17,253
15,000	7,155
16,000	2,641
17,000	793
18,000	316
19,000	211
20,000	106
21,000	42
22,000	33
23,000	11
24,000	8
25,000	8
26,000	5
27,000	2
28,000	1
29,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	0
3,000	243,696
4,000	84,759
5,000	24,198
6,000	25,226
7,000	12,440
8,000	9,960
9,000	1,045
10,000	502
11,000	183
12,000	263
13,000	95
14,000	104
15,000	57
16,000	88
17,000	40
18,000	94
19,000	687
20,000	3,584
21,000	6,802
22,000	2,975
23,000	1,345
24,000	485
25,000	94
26,000	40
27,000	12
28,000	13
29,000	7
30,000	8
31,000	4
32,000	8
33,000	0
34,000	
35,000	

R DISTRIBUTION

R	n
	769
-1.5	2,342
-1.2	4,317
-1.0	4,500
-.9	2,420
-.8	920
-.7	1,821
-.6	544
-.5	654
-.4	341
-.3	439
-.2	312
-.1	619
0	502
.1	886
.2	1,526
.3	3,611
.4	17,485
.5	92,485
.6	108,447
.7	128,277
.8	1,581
.9	0
1.0	44,016

TABLE B-67
SPECTRUM BS6.LLT3 (NO. 67)

DESCRIPTION: SPECTRUM NO. 6 WITH 3,000 PSI RANGE TRUNCATION

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 425,270	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 175.6
RANGE TRUNCATION (PSI)	= 3,000			FLIGHT HOUR	= 170.1
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	47
-10,000	0
-9,000	288
-8,000	0
-7,000	227
-6,000	1,272
-5,000	1,426
-4,000	3,102
-3,000	7,753
-2,000	750
-1,000	54
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	512
6,000	531
7,000	565
8,000	2,804
9,000	22,577
10,000	29,402
11,000	115,051
12,000	34,611
13,000	156,189
14,000	10,749
15,000	28,337
16,000	6,961
17,000	1,587
18,000	186
19,000	197
20,000	63
21,000	16
22,000	4
23,000	6
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	252,444
5,000	70,990
6,000	63,489
7,000	23,300
8,000	7,426
9,000	2,253
10,000	1,025
11,000	264
12,000	88
13,000	53
14,000	20
15,000	14
16,000	10
17,000	11
18,000	47
19,000	82
20,000	136
21,000	608
22,000	1,103
23,000	892
24,000	379
25,000	96
26,000	359
27,000	22
28,000	128
29,000	24
30,000	6
31,000	1
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	304
-1.2	693
-1.0	624
-.9	899
-.8	463
-.7	586
-.6	335
-.5	179
-.4	77
-.3	58
-.2	49
-.1	64
0	78
.1	119
.2	239
.3	868
.4	3,078
.5	13,634
.6	65,728
.7	117,968
.8	203,958
.9	339
1.0	0
	14,921

TABLE B-68
SPECTRUM BS6.LLT4 (NO. 68)

DESCRIPTION: SPECTRUM NO. 6 WITH ONLY ONE TAXI CYCLE PER LANDING.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 168,583	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 69.6
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 67.4
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	0
-6,000	3
-5,000	0
-4,000	26
-3,000	24
-2,000	80
-1,000	4
0	1
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	358
7,000	96
8,000	235
9,000	4,220
10,000	17,249
11,000	34,481
12,000	31,850
13,000	36,089
14,000	9,057
15,000	26,344
16,000	6,043
17,000	1,566
18,000	186
19,000	197
20,000	63
21,000	16
22,000	4
23,000	6
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	74,358
6,000	61,357
7,000	20,751
8,000	5,855
9,000	1,012
10,000	949
11,000	242
12,000	80
13,000	42
14,000	16
15,000	17
16,000	12
17,000	13
18,000	200
19,000	332
20,000	173
21,000	259
22,000	625
23,000	790
24,000	471
25,000	226
26,000	489
27,000	51
28,000	207
29,000	45
30,000	11
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	356
-1.2	746
-1.0	432
-.9	750
-.8	437
-.7	489
-.6	495
-.5	334
-.4	127
-.3	61
-.2	50
-.1	62
0	79
.1	118
.2	244
.3	767
.4	3,108
.5	16,317
.6	52,657
.7	89,984
.8	832
.9	0
1.0	0
	138

TABLE B-69
SPECTRUM BS6.LLT5 (NO. 69)

DESCRIPTION: SPECTRUM NO. 6 WITH AN AVERAGE OF 25.9 TAXI CYCLES PER LANDING.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 267,999	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 110.7
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 107.2
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	12
-10,000	0
-9,000	5
-8,000	3,896
-7,000	7,791
-6,000	17,639
-5,000	22,248
-4,000	27,300
-3,000	9,823
-2,000	842
-1,000	59
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	358
7,000	97
8,000	235
9,000	4,252
10,000	17,258
11,000	34,408
12,000	31,829
13,000	36,126
14,000	9,003
15,000	26,353
16,000	6,039
17,000	1,567
18,000	186
19,000	197
20,000	63
21,000	16
22,000	4
23,000	6
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	130,295
6,000	86,003
7,000	36,391
8,000	8,377
9,000	1,629
10,000	983
11,000	261
12,000	82
13,000	41
14,000	18
15,000	14
16,000	11
17,000	11
18,000	5
19,000	25
20,000	312
21,000	814
22,000	1,298
23,000	499
24,000	136
25,000	486
26,000	52
27,000	207
28,000	43
29,000	4
30,000	2
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	188
-1.2	598
-1.0	597
-.9	386
-.8	994
-.7	457
-.6	754
-.5	149
-.4	48
-.3	56
-.2	50
-.1	63
0	78
.1	116
.2	255
.3	777
.4	3,130
.5	16,159
.6	52,745
.7	89,955
.8	827
.9	0
1.0	0
	99,617

TABLE B-70
SPECTRUM BS3.LLT4 (NO. 70)

DESCRIPTION: SPECTRUM NO. 3 WITH 5,000 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112		LANDINGS	= 5,112
TOTAL CYCLES	= 464,790	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 90.9
RANGE TRUNCATION (PSI)	= 5,000			FLIGHT HOUR	= 185.9
HIGHEST PEAK (PSI)	= 24,588			SMALLEST VALLEY (PSI)	= −15,692

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	0
-9,000	1
-8,000	0
-7,000	0
-6,000	3,085
-5,000	4,836
-4,000	249
-3,000	14,649
-2,000	2,401
-1,000	206
0	5
1,000	0
2,000	
3,000	
4,000	
5,000	
6,000	0
7,000	403
8,000	0
9,000	14
10,000	0
11,000	26,598
12,000	83,566
13,000	158,907
14,000	13,855
15,000	123,127
16,000	25,394
17,000	6,087
18,000	353
19,000	814
20,000	186
21,000	38
22,000	1
23,000	12
24,000	2
25,000	1
26,000	0
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	
5,000	0
6,000	314,633
7,000	105,263
8,000	29,018
9,000	4,599
10,000	4,462
11,000	1,143
12,000	295
13,000	89
14,000	17
15,000	26
16,000	12
17,000	7
18,000	0
19,000	5
20,000	3
21,000	167
22,000	1,213
23,000	1,044
24,000	248
25,000	21
26,000	1,892
27,000	105
28,000	353
29,000	57
30,000	17
31,000	1
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	21
-1.2	17
-1.0	168
-.9	1,909
-.8	673
-.7	1,970
-.6	401
-.5	49
-.4	0
-.3	39
-.2	2
-.1	86
0	16
.1	115
.2	362
.3	2,485
.4	8,972
.5	38,942
.6	188,701
.7	194,425
.8	5
.9	0
1.0	0
	25,432

TABLE B-71
SPECTRUM BS6.LLT6 (NO. 71)

DESCRIPTION: SPECTRUM NO. 6 WITH 5,000 PSI RANGE TRUNCATION.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 117,493	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 48.5
RANGE TRUNCATION (PSI)	= 5,000			FLIGHT HOUR	= 47.0
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	236
-11,000	2			-1.2	695
-10,000	0	1,000		-1.0	584
-9,000	0	2,000		-.9	846
-8,000	0	3,000		-.8	485
-7,000	145	4,000		-.7	730
-6,000	910	5,000	0	-.6	331
-5,000	1,267	6,000	69,539	-.5	182
-4,000	2,742	7,000	29,863	-.4	78
-3,000	6,665	8,000	9,654	-.3	60
-2,000	735	9,000	2,859	-.2	49
-1,000	54	10,000	1,181	-.1	63
0	2	11,000	301	0	51
1,000	0	12,000	100	.1	58
2,000	0	13,000	56	.2	162
3,000	0	14,000	21	.3	938
4,000	0	15,000	15	.4	4,491
5,000	272	16,000	10	.5	14,372
6,000	229	17,000	11	.6	41,648
7,000	79	18,000	13	.7	38,910
8,000	42	19,000	94	.8	2
9,000	329	20,000	34	.9	0
10,000	3,685	21,000	375	1.0	0
11,000	9,765	22,000	990		12,522
12,000	18,749	23,000	1,119		
13,000	32,720	24,000	501		
14,000	5,611	25,000	158		
15,000	25,771	26,000	369		
16,000	5,709	27,000	27		
17,000	1,537	28,000	151		
18,000	186	29,000	43		
19,000	197	30,000	8		
20,000	63	31,000	1		
21,000	16	32,000	0		
22,000	4	33,000			
23,000	6	34,000			
24,000	1	35,000			
25,000	0				
26,000					
27,000					

TABLE B-72
SPECTRUM BS1.HIL1 (NO. 72)

DESCRIPTION: SPECTRUM NO. 1 WITH THE NUMBER OF 10 HIGHEST PEAKS INCREASED TO 100.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	= 2,528
TOTAL CYCLES	= 45,928	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 18.2
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 18.4
HIGHEST PEAK (PSI)	= 22,114			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000				-1.5	71
-11,000				-1.2	1,088
-10,000		1,000		-1.0	28
-9,000		2,000		-.9	51
-8,000		3,000		-.8	99
-7,000		4,000	0	-.7	790
-6,000		5,000	22,083	-.6	231
-5,000	0	6,000	4,482	-.5	303
-4,000	5,151	7,000	10,236	-.4	47
-3,000	6,386	8,000	4,619	-.3	52
-2,000	110	9,000	1,362	-.2	0
-1,000	18	10,000	232	-.1	54
0	0	11,000	48	0	24
1,000		12,000	79	.1	105
2,000		13,000	57	.2	41
3,000		14,000	53	.3	238
4,000		15,000	7	.4	517
5,000	0	16,000	13	.5	3,939
6,000	499	17,000	7	.6	13,087
7,000	0	18,000	0	.7	12,289
8,000	212	19,000	19	.8	1,209
9,000	1,912	20,000	199	.9	0
10,000	4,795	21,000	102	1.0	0
11,000	2,677	22,000	297		11,665
12,000	1,111	23,000	1,372		
13,000	6,458	24,000	469		
14,000	11,103	25,000	77		
15,000	3,492	26,000	11		
16,000	1,527	27,000	0		
17,000	214	28,000	2		
18,000	123	29,000	0		
19,000	28	30,000	2		
20,000	32	31,000	0		
21,000	60	32,000			
22,000	10	33,000			
23,000	10	34,000			
24,000	0	35,000			
25,000					
26,000					
27,000					

TABLE B-73
SPECTRUM BS1.HIL2 (NO. 73)

DESCRIPTION: SPECTRUM NO. 1 WITH THE NUMBER OF 10 HIGHEST PEAKS INCREASED TO 200

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	= 2,528
TOTAL CYCLES	= 46,059	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 18.2
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 18.4
HIGHEST PEAK (PSI)	= 22,114			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	0
-5,000	5,151
-4,000	6,386
-3,000	110
-2,000	18
-1,000	0
0	
1,000	
2,000	
3,000	
4,000	0
5,000	499
6,000	0
7,000	212
8,000	1,912
9,000	4,795
10,000	2,677
11,000	1,111
12,000	6,497
13,000	11,100
14,000	3,488
15,000	1,526
16,000	214
17,000	123
18,000	28
19,000	52
20,000	120
21,000	20
22,000	20
23,000	0
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	22,071
5,000	4,475
6,000	10,227
7,000	4,623
8,000	1,362
9,000	347
10,000	67
11,000	106
12,000	106
13,000	91
14,000	11
15,000	15
16,000	7
17,000	1
18,000	19
19,000	199
20,000	102
21,000	297
22,000	1,372
23,000	469
24,000	77
25,000	11
26,000	0
27,000	2
28,000	0
29,000	2
30,000	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	71
-1.5	1,088
-1.2	28
-1.0	51
-.9	99
-.8	790
-.7	231
-.6	303
-.5	47
-.4	52
-.3	0
-.2	62
-.1	46
0	124
.1	52
.2	238
.3	545
.4	3,982
.5	13,102
.6	12,275
.7	1,208
.8	0
.9	0
1.0	11,665

TABLE B-74
SPECTRUM BS1.HIL3 (NO. 74)

DESCRIPTION: SPECTRUM NO. 1 WITH THE 10 HIGHEST PEAKS = 33,056 PSI

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	= 2,528
TOTAL CYCLES	= 45,804	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 18.1
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 18.3
HIGHEST PEAK (PSI)	= 33,056			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	0
-5,000	5,151
-4,000	6,386
-3,000	110
-2,000	18
-1,000	0
0	
1,000	
2,000	
3,000	
4,000	0
5,000	499
6,000	0
7,000	212
8,000	1,912
9,000	4,795
10,000	2,676
11,000	1,111
12,000	6,423
13,000	11,100
14,000	3,496
15,000	1,528
16,000	214
17,000	123
18,000	28
19,000	12
20,000	0
21,000	
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	0
33,000	10
34,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	22,090
5,000	4,487
6,000	10,241
7,000	4,614
8,000	1,360
9,000	317
10,000	43
11,000	49
12,000	7
13,000	16
14,000	1
15,000	12
16,000	7
17,000	0
18,000	19
19,000	199
20,000	102
21,000	298
22,000	1,273
23,000	469
24,000	85
25,000	11
26,000	0
27,000	2
28,000	0
29,000	2
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	71
-1.5	1,088
-1.2	28
-1.0	51
-.9	98
-.8	791
-.7	231
-.6	303
-.5	47
-.4	52
-.3	0
-.2	46
-.1	5
0	89
.1	30
.2	243
.3	500
.4	3,888
.5	13,075
.6	12,291
.7	1,212
.8	0
.9	0
1.0	11,665

TABLE B-75
SPECTRUM BS1.HIL4 (NO. 75)

DESCRIPTION: SPECTRUM NO. 1 WITH THE 10 HIGHEST PEAKS = 27,750 PSI

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528	LANDINGS	= 2,528
TOTAL CYCLES	= 45,804	AVERAGE NO. OF CYCLES PER:	FLIGHT	= 18.1
RANGE TRUNCATION (PSI)	= 4,000		FLIGHT HOUR	= 18.3
HIGHEST PEAK (PSI)	= 27,750		SMALLEST VALLEY (PSI)	= −24.298

PEAK DISTRIBUTION Peak (psi)	n	RANGE DISTRIBUTION Range (psi)	n	R DISTRIBUTION R	n
					71
-12,000				-1.5	1,088
-11,000				-1.2	28
-10,000		1,000		-1.0	51
-9,000		2,000		-.9	98
-8,000		3,000	0	-.8	791
-7,000		4,000	22,090	-.7	231
-6,000	0	5,000	4,487	-.6	303
-5,000	5,151	6,000	10,241	-.5	47
-4,000	6,386	7,000	4,614	-.4	52
-3,000	110	8,000	1,360	-.3	0
-2,000	18	9,000	317	-.2	46
-1,000	0	10,000	43	-.1	5
0		11,000	49	0	89
1,000		12,000	7	.1	30
2,000		13,000	16	.2	235
3,000		14,000	1	.3	507
4,000	0	15,000	13	.4	3,889
5,000	499	16,000	7	.5	13,075
6,000	0	17,000	1	.6	12,291
7,000	212	18,000	19	.7	1,212
8,000	1,912	19,000	207	.8	0
9,000	4,795	20,000	101	.9	0
10,000	2,676	21,000	298	1.0	11,665
11,000	1,111	22,000	1,372		
12,000	6,423	23,000	469		
13,000	11,100	24,000	77		
14,000	3,496	25,000	11		
15,000	1,528	26,000	0		
16,000	214	27,000	2		
17,000	123	28,000	0		
18,000	28	29,000	2		
19,000	12	30,000	0		
20,000	0	31,000			
21,000		32,000			
22,000		33,000			
23,000		34,000			
24,000		35,000			
25,000					
26,000	0				
27,000	10				
28,000	0				

TABLE B-76
SPECTRUM BS3. HIL1 (NO. 76)

DESCRIPTION: SPECTRUM NO. 3 WITH THE NUMBER OF 10 HIGHEST PEAKS INCREASED TO 100.

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112	LANDINGS	= 5,112
TOTAL CYCLES	= 649,521	AVERAGE NO. OF CYCLES PER:	FLIGHT	= 127.1
RANGE TRUNCATION (PSI)	= 4,000		FLIGHT HOUR	= 259.8
HIGHEST PEAK (PSI)	= 24,588		SMALLEST VALLEY (PSI)	= −15.692

PEAK DISTRIBUTION Peak (psi)	n	RANGE DISTRIBUTION Range (psi)	n	R DISTRIBUTION R	n
					21
-12,000				-1.5	17
-11,000	0			-1.2	150
-10,000	50	1,000		-1.0	1,963
-9,000	0	2,000		-.9	760
-8,000	4	3,000	0	-.8	1,920
-7,000	3,104	4,000	217,957	-.7	324
-6,000	4,878	5,000	200,727	-.6	43
-5,000	249	6,000	91,061	-.5	0
-4,000	14,651	7,000	25,320	-.4	48
-3,000	2,401	8,000	3,504	-.3	2
-2,000	206	9,000	4,183	-.2	95
-1,000	5	10,000	1,051	-.1	34
0	0	11,000	270	0	169
1,000		12,000	184	.1	359
2,000		13,000	14	.2	1,800
3,000		14,000	83	.3	7,317
4,000		15,000	29	.4	29,126
5,000	0	16,000	12	.5	166,297
6,000	480	17,000	0	.6	411,666
7,000	0	18,000	5	.7	1,852
8,000	29	19,000	3	.8	0
9,000	2	20,000	225	.9	0
10,000	144,797	21,000	1,227	1.0	25,548
11,000	146,857	22,000	995		
12,000	159,918	23,000	239		
13,000	13,959	24,000	18		
14,000	124,572	25,000	1,928		
15,000	25,754	26,000	83		
16,000	6,108	27,000	355		
17,000	353	28,000	35		
18,000	814	29,000	12		
19,000	186	30,000	1		
20,000	38	31,000	0		
21,000	1	32,000			
22,000	75	33,000			
23,000	20	34,000			
24,000	10	35,000			
25,000	0				
26,000					
27,000					

TABLE B-77

SPECTRUM BS3.HIL2 (NO. 77)

DESCRIPTION : SPECTRUM NO. 3 WITH THE NUMBER OF 10 HIGHEST PEAKS INCREASED TO 200.

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112		LANDINGS	= 5,112
TOTAL CYCLES	= 649,703	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 127.1
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 259.9
HIGHEST PEAK (PSI)	= 24,588			SMALLEST VALLEY (PSI)	= −15,692

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	0
-9,000	50
-8,000	0
-7,000	4
-6,000	3,104
-5,000	4,878
-4,000	249
-3,000	14,651
-2,000	2,401
-1,000	206
0	5
1,000	0
2,000	
3,000	
4,000	
5,000	0
6,000	480
7,000	0
8,000	29
9,000	2
10,000	144,806
11,000	146,853
12,000	159,993
13,000	13,959
14,000	124,574
15,000	25,754
16,000	6,108
17,000	353
18,000	814
19,000	186
20,000	38
21,000	1
22,000	145
23,000	40
24,000	20
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	217,954
6,000	300,718
7,000	91,057
8,000	25,316
9,000	3,504
10,000	4,183
11,000	1,052
12,000	270
13,000	265
14,000	14
15,000	149
16,000	56
17,000	16
18,000	0
19,000	6
20,000	3
21,000	225
22,000	1,227
23,000	995
24,000	239
25,000	18
26,000	1,928
27,000	83
28,000	355
29,000	35
30,000	12
31,000	1
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	21
-1.2	17
-1.0	150
-.9	1,963
-.8	760
-.7	1,920
-.6	334
-.5	43
-.4	0
-.3	58
-.2	2
-.1	105
0	54
.1	229
.2	359
.3	1,810
.4	7,360
.5	29,169
.6	166,290
.7	411,660
.8	1,851
.9	0
	0
1.0	25,548

TABLE B-78

SPECTRUM BS3.HIL3 (NO. 78)

DESCRIPTION: SPECTRUM NO. 3 WITH THE 10 HIGHEST PEAKS = 33,056 PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112		LANDINGS	= 5,112
TOTAL CYCLES	= 649,353	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 127.0
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 259.7
HIGHEST PEAK (PSI)	= 33,056			SMALLEST VALLEY (PSI)	= −15,692

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	0
-9,000	50
-8,000	0
-7,000	4
-6,000	3,104
-5,000	4,878
-4,000	249
-3,000	14,651
-2,000	2,401
-1,000	206
0	5
1,000	0
2,000	
3,000	
4,000	
5,000	0
6,000	480
7,000	0
8,000	29
9,000	2
10,000	144,789
11,000	146,858
12,000	159,845
13,000	13,959
14,000	124,574
15,000	25,754
16,000	6,108
17,000	353
18,000	814
19,000	186
20,000	38
21,000	1
22,000	5
23,000	0
24,000	
25,000	
26,000	
27,000	0
33,000	10
34,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	217,954
6,000	300,745
7,000	91,052
8,000	25,323
9,000	3,504
10,000	4,187
11,000	1,051
12,000	269
13,000	79
14,000	14
15,000	22
16,000	10
17,000	7
18,000	0
19,000	5
20,000	3
21,000	225
22,000	1,227
23,000	995
24,000	248
25,000	18
26,000	1,929
27,000	83
28,000	355
29,000	35
30,000	12
31,000	1
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	21
-1.2	17
-1.0	150
-.9	1,963
-.8	760
-.7	1,920
-.6	334
-.5	43
-.4	0
-.3	39
-.2	2
-.1	86
0	16
.1	115
.2	259
.3	1,808
.4	7,270
.5	29,076
.6	166,296
.7	411,680
.8	1,850
.9	0
	0
1.0	25,548

TABLE B-79
SPECTRUM BS3.HIL4 (NO. 79)

DESCRIPTION: SPECTRUM NO. 3 WITH THE 10 HIGHEST PEAKS = 27,750 PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112	LANDINGS	= 5,112
TOTAL CYCLES	= 649,353	AVERAGE NO. OF CYCLES PER:	FLIGHT	= 127.0
RANGE TRUNCATION (PSI)	= 4,000		FLIGHT HOUR	= 259.7
HIGHEST PEAK (PSI)	= 27,750		SMALLEST VALLEY (PSI)	= −15,692

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
					21
-12,000				-1.5	17
-11,000	0			-1.2	150
-10,000	50	1,000		-1.0	1,963
-9,000	0	2,000		-.9	760
-8,000	4	3,000	0	-.8	1,920
-7,000	3,104	4,000	217,954	-.7	334
-6,000	4,878	5,000	300,745	-.6	43
-5,000	249	6,000	91,052	-.5	0
-4,000	14,651	7,000	25,323	-.4	39
-3,000	2,401	8,000	2,504	-.3	2
-2,000	206	9,000	4,187	-.2	86
-1,000	5	10,000	1,051	-.1	16
0	0	11,000	269	0	115
1,000		12,000	79	.1	359
2,000		13,000	14	.2	1,799
3,000		14,000	22	.3	7,279
4,000		15,000	10	.4	29,076
5,000	0	16,000	7	.5	166,296
6,000	480	17,000	0	.6	411,680
7,000	0	18,000	11	.7	1,850
8,000	29	19,000	3	.8	0
9,000	2	20,000	226	.9	0
10,000	144,789	21,000	1,227	1.0	25,548
11,000	146,858	22,000	995		
12,000	159,845	23,000	239		
13,000	13,959	24,000	18		
14,000	124,574	25,000	1,928		
15,000	25,754	26,000	83		
16,000	6,108	27,000	355		
17,000	353	28,000	35		
18,000	814	29,000	[illegible]		
19,000	186	30,000	1		
20,000	38	31,000	0		
21,000	1	32,000			
22,000	5	33,000			
23,000	0	34,000			
24,000		35,000			
25,000					
26,000					
27,000	10				
28,000	0				

TABLE B-80
SPECTRUM BS6.HIL1 (NO. 80)

DESCRIPTION: SPECTRUM NO. 6 WITH THE NUMBER OF 10 HIGHEST PEAKS INCREASED TO 100.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422	LANDINGS	= 3,843
TOTAL CYCLES	= 181,747	AVERAGE NO. OF CYCLES PER:	FLIGHT	= 75.0
RANGE TRUNCATION (PSI)	= 4,000		FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 23,923		SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
	0				277
-12,000	47			-1.5	698
-11,000	0			-1.2	559
-10,000	9	1,000		-1.0	869
-9,000	0	2,000		-.9	490
-8,000	201	3,000	0	-.8	654
-7,000	914	4,000	74,958	-.7	333
-6,000	1,373	5,000	66,136	-.6	197
-5,000	3,084	6,000	24,923	-.5	92
-4,000	7,026	7,000	7,863	-.4	58
-3,000	736	8,000	2,346	-.3	49
-2,000	54	9,000	1,063	-.2	63
-1,000	2	10,000	283	-.1	88
0	0	11,000	107	0	137
1,000	0	12,000	92	.1	243
2,000	0	13,000	49	.2	793
3,000	0	14,000	22	.3	3,174
4,000	384	15,000	10	.4	16,169
5,000	358	16,000	12	.5	52,796
6,000	95	17,000	31	.6	89,721
7,000	246	18,000	85	.7	841
8,000	4,197	19,000	117	.8	0
9,000	17,220	20,000	435	.9	0
10,000	34,344	21,000	1,113	1.0	13,446
11,000	31,833	22,000	971		
12,000	36,080	23,000	427		
13,000	9,014	24,000	117		
14,000	26,379	25,000	367		
15,000	6,023	26,000	22		
16,000	1,565	27,000	167		
17,000	186	28,000	24		
18,000	197	29,000	6		
19,000	63	30,000	1		
20,000	16	31,000	0		
21,000	31	32,000			
22,000	60	33,000			
23,000	10	34,000			
24,000	0	35,000			
25,000					
26,000					
27,000					

TABLE B-81
SPECTRUM BS6.HIL2 (NO. 81)

DESCRIPTION: SPECTRUM NO. 6 WITH THE NUMBER OF 10 HIGHEST PEAKS INCREASED TO 200.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,858	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.1
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	47
-10,000	0
-9,000	9
-8,000	0
-7,000	201
-6,000	914
-5,000	1,373
-4,000	3,084
-3,000	7,026
-2,000	736
-1,000	54
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	358
7,000	95
8,000	246
9,000	4,197
10,000	17,220
11,000	34,344
12,000	31,833
13,000	36,098
14,000	9,012
15,000	26,380
16,000	6,017
17,000	1,565
18,000	186
19,000	197
20,000	63
21,000	16
22,000	61
23,000	120
24,000	20
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	74,961
6,000	66,123
7,000	24,917
8,000	7863
9,000	2,344
10,000	1,073
11,000	295
12,000	132
13,000	132
14,000	76
15,000	34
16,000	12
17,000	12
18,000	31
19,000	96
20,000	117
21,000	435
22,000	1,113
23,000	971
24,000	427
25,000	117
26,000	367
27,000	22
28,000	167
29,000	24
30,000	6
31,000	1
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	277
-1.2	698
-1.0	559
-.9	869
-.8	490
-.7	654
-.6	333
-.5	197
-.4	92
-.3	58
-.2	49
-.1	63
0	98
.1	157
.2	243
.3	795
.4	3,195
.5	16,218
.6	52,816
.7	89,707
.8	844
.9	0
1.0	0
	13,446

TABLE B-82
SPECTRUM BS6.HIL3 (NO. 82)

DESCRIPTION: SPECTRUM NO. 6 WITH THE 10 HIGHEST PEAKS = 33,056 PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,641	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.0
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 33,056			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	47
-10,000	0
-9,000	9
-8,000	0
-7,000	201
-6,000	914
-5,000	1,373
-4,000	3,084
-3,000	7,026
-2,000	736
-1,000	54
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	358
7,000	95
8,000	246
9,000	4,197
10,000	17,220
11,000	34,344
12,000	31,833
13,000	36,059
14,000	9,015
15,000	26,378
16,000	6,028
17,000	1,565
18,000	186
19,000	197
20,000	63
21,000	16
22,000	1
23,000	0
24,000	
25,000	
26,000	
27,000	
33,000	0
34,000	10
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	74,957
6,000	66,143
7,000	24,928
8,000	7,865
9,000	2,346
10,000	1,045
11,000	271
12,000	93
13,000	47
14,000	18
15,000	14
16,000	10
17,000	11
18,000	31
19,000	85
20,000	117
21,000	440
22,000	1113
23,000	972
24,000	429
25,000	119
26,000	367
27,000	22
28,000	167
29,000	24
30,000	6
31,000	1
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	277
-1.2	698
-1.0	559
-.9	869
-.8	490
-.7	654
-.6	333
-.5	197
-.4	92
-.3	58
-.2	49
-.1	63
0	79
.1	117
.2	243
.3	797
.4	3,159
.5	16,122
.6	52,769
.7	89,731
.8	839
.9	0
1.0	0
	13,446

TABLE B-83
SPECTRUM BS6.HIL4 (NO. 83)

DESCRIPTION: SPECTRUM NO. 6 WITH THE 10 HIGHEST PEAKS = 27,750 PSI.

FLIGHT HOURS	= 2,500	FLIGHTS =	2,422		LANDINGS	=	3,843
TOTAL CYCLES	= 181,642	AVERAGE NO. OF CYCLES PER:			FLIGHT	=	75.0
RANGE TRUNCATION (PSI)	= 4,000				FLIGHT HOUR	=	72.7
HIGHEST PEAK (PSI)	= 27,750				SMALLEST VALLEY (PSI)	=	−24,298

PEAK DISTRIBUTION

Peak (psi)	n
	0
-12,000	47
-11,000	0
-10,000	9
-9,000	0
-8,000	201
-7,000	914
-6,000	1,373
-5,000	3,084
-4,000	7,026
-3,000	736
-2,000	54
-1,000	2
0	0
1,000	0
2,000	0
3,000	0
4,000	384
5,000	358
6,000	95
7,000	246
8,000	4,197
9,000	17,220
10,000	34,344
11,000	31,833
12,000	36,059
13,000	9,015
14,000	26,379
15,000	6,028
16,000	1,565
17,000	186
18,000	197
19,000	63
20,000	16
21,000	1
22,000	0
23,000	
24,000	
25,000	
26,000	0
27,000	10
28,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	74,957
5,000	66,142
6,000	24,928
7,000	7,865
8,000	2,346
9,000	1,045
10,000	271
11,000	93
12,000	48
13,000	18
14,000	15
15,000	15
16,000	11
17,000	32
18,000	87
19,000	119
20,000	435
21,000	1,113
22,000	971
23,000	427
24,000	117
25,000	367
26,000	22
27,000	167
28,000	24
29,000	6
30,000	1
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	277
-1.5	698
-1.2	559
-1.0	869
-.9	490
-.8	654
-.7	333
-.6	197
-.5	92
-.4	58
-.3	49
-.2	63
-.1	79
0	119
.1	243
.2	793
.3	3,158
.4	16,127
.5	52,769
.6	89,730
.7	839
.8	0
.9	0
1.0	13,446

TABLE B-84
SPECTRUM BS1.HIL5 (NO. 84)

DESCRIPTION: SPECTRUM NO. 1 WITH THE 10 HIGHEST PEAKS = 33,056 PSI. AND THEIR NUMBER INCREASED TO 200.

FLIGHT HOURS	= 2,500	FLIGHTS =	2,528		LANDINGS	=	2,528
TOTAL CYCLES	= 46,056	AVERAGE NO. OF CYCLES PER:			FLIGHT	=	18.2
RANGE TRUNCATION (PSI)	= 4,000				FLIGHT HOUR	=	18.4
HIGHEST PEAK (PSI)	= 33,056				SMALLEST VALLEY (PSI)	=	−24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	0
-5,000	5,151
-4,000	6,386
-3,000	110
-2,000	18
-1,000	0
0	
1,000	
2,000	
3,000	
4,000	0
5,000	499
6,000	0
7,000	212
8,000	1,912
9,000	4,795
10,000	2,677
11,000	1,111
12,000	6,498
13,000	11,096
14,000	3,488
15,000	1,526
16,000	214
17,000	123
18,000	28
19,000	12
20,000	0
21,000	
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	0
33,000	200
34,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	22,070
5,000	4,473
6,000	10,227
7,000	4,610
8,000	1,360
9,000	317
10,000	43
11,000	71
12,000	47
13,000	58
14,000	10
15,000	12
16,000	7
17,000	1
18,000	19
19,000	199
20,000	116
21,000	297
22,000	1,433
23,000	469
24,000	190
25,000	20
26,000	2
27,000	2
28,000	1
29,000	2
30,000	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	71
-1.5	1,088
-1.2	28
-1.0	51
-.9	99
-.8	790
-.7	231
-.6	303
-.5	47
-.4	52
-.3	0
-.2	62
-.1	46
0	124
.1	55
.2	357
.3	573
.4	3,885
.5	13,060
.6	12,259
.7	1,210
.8	0
.9	0
1.0	11,665

TABLE B-85
SPECTRUM BS1.HIL6 (NO. 85)

DESCRIPTION: SPECTRUM NO. 1 WITH THE 10 HIGHEST PEAKS = 27,750 PSI, AND THEIR NUMBER INCREASED TO 200.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	= 2,528
TOTAL CYCLES	= 46,056	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 18.2
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 18.4
HIGHEST PEAK (PSI)	= 27,750			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
	0
-5,000	
	5,151
-4,000	
	6,386
-3,000	
	110
-2,000	
	18
-1,000	
	0
0	
1,000	
2,000	
3,000	
4,000	
	0
5,000	
	499
6,000	
	0
7,000	
	212
8,000	
	1,912
9,000	
	4,795
10,000	
	2,677
11,000	
	1,111
12,000	
	6,498
13,000	
	11,096
14,000	
	3,488
15,000	
	1,526
16,000	
	187
17,000	
	0
18,000	
19,000	
20,000	
21,000	
22,000	
23,000	
24,000	
25,000	
26,000	
	0
27,000	
	200
28,000	
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
	0
4,000	
	22,070
5,000	
	4,473
6,000	
	10,227
7,000	
	4,610
8,000	
	1,360
9,000	
	317
10,000	
	43
11,000	
	71
12,000	
	47
13,000	
	58
14,000	
	10
15,000	
	26
16,000	
	7
17,000	
	62
18,000	
	21
19,000	
	310
20,000	
	111
21,000	
	299
22,000	
	1,373
23,000	
	469
24,000	
	77
25,000	
	11
26,000	
	0
27,000	
	2
28,000	
	0
29,000	
	2
30,000	
	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	71
-1.5	
	1,088
-1.2	
	28
-1.0	
	51
-.9	
	99
-.8	
	790
-.7	
	231
-.6	
	303
-.5	
	47
-.4	
	52
-.3	
	0
-.2	
	62
-.1	
	46
0	
	124
.1	
	53
.2	
	246
.3	
	672
.4	
	3,899
.5	
	1,3060
.6	
	12,259
.7	
	1,210
.8	
	0
.9	
	0
1.0	
	11,665

TABLE B-86
SPECTRUM BS3.HIL5 (NO. 86)

DESCRIPTION: SPECTRUM NO. 3 WITH THE 10 HIGHEST PEAKS = 33,056 PSI, AND THEIR NUMBER INCREASED TO 200.

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112		LANDINGS	= 5,112
TOTAL CYCLES	= 649,850	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 127.1
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 259.9
HIGHEST PEAK (PSI)	= 33,056			SMALLEST VALLEY (PSI)	= −15,692

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
	0
-10,000	
	50
-9,000	
	0
-8,000	
	4
-7,000	
	3,104
-6,000	
	4,878
-5,000	
	249
-4,000	
	14,651
-3,000	
	2,401
-2,000	
	206
-1,000	
	5
0	
	0
1,000	
2,000	
3,000	
4,000	
5,000	
	0
6,000	
	480
7,000	
	0
8,000	
	29
9,000	
	2
10,000	
	144,805
11,000	
	146,853
12,000	
	160,043
13,000	
	13,959
14,000	
	124,577
15,000	
	25,754
16,000	
	6,108
17,000	
	353
18,000	
	814
19,000	
	186
20,000	
	38
21,000	
	1
22,000	
	100
23,000	
	0
24,000	
25,000	
26,000	
27,000	
	0
33,000	
	200
34,000	
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
	0
4,000	
	217,953
5,000	
	300,700
6,000	
	91,031
7,000	
	25,317
8,000	
	3,504
9,000	
	4,187
10,000	
	1,051
11,000	
	269
12,000	
	323
13,000	
	14
14,000	
	128
15,000	
	36
16,000	
	11
17,000	
	0
18,000	
	5
19,000	
	3
20,000	
	225
21,000	
	1,227
22,000	
	997
23,000	
	388
24,000	
	18
25,000	
	1,965
26,000	
	89
27,000	
	361
28,000	
	35
29,000	
	12
30,000	
	1
31,000	
	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	21
-1.5	
	17
-1.2	
	150
-1.0	
	1,963
-.9	
	760
-.8	
	1,920
-.7	
	334
-.6	
	43
-.5	
	0
-.4	
	58
-.3	
	2
-.2	
	105
-.1	
	54
0	
	324
.1	
	371
.2	
	1,988
.3	
	7,292
.4	
	29,143
.5	
	166,265
.6	
	411,641
.7	
	1,851
.8	
	0
.9	
	0
1.0	
	25,548

TABLE B-87
SPECTRUM BS3.HIL6 (NO. 87)

DESCRIPTION: SPECTRUM NO. 3 WITH THE 10 HIGHEST PEAKS = 27,750 PSI, AND THEIR NUMBER INCREASED TO 200.

FLIGHT HOURS	= 2,500	FLIGHTS = 5,112		LANDINGS	= 5,112
TOTAL CYCLES	= 649,361	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 127.0
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 259.7
HIGHEST PEAK (PSI)	= 27,750			SMALLEST VALLEY (PSI)	= −15,692

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	0
-10,000	50
-9,000	0
-8,000	4
-7,000	3,104
-6,000	4,878
-5,000	249
-4,000	14,651
-3,000	2,401
-2,000	206
-1,000	5
0	0
1,000	
2,000	
3,000	
4,000	
5,000	0
6,000	480
7,000	0
8,000	29
9,000	2
10,000	144,805
11,000	146,858
12,000	159,832
13,000	13,959
14,000	124,574
15,000	25,754
16,000	6,108
17,000	353
18,000	814
19,000	186
20,000	38
21,000	1
22,000	0
23,000	0
24,000	0
25,000	0
26,000	0
27,000	200
28,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	217,954
5,000	300,742
6,000	91,053
7,000	25,323
8,000	3,504
9,000	4,187
10,000	1,051
11,000	269
12,000	66
13,000	14
14,000	36
15,000	9
16,000	7
17,000	0
18,000	5
19,000	3
20,000	242
21,000	1,227
22,000	998
23,000	239
24,000	18
25,000	1,928
26,000	83
27,000	355
28,000	35
29,000	12
30,000	1
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	21
-1.5	17
-1.2	150
-1.0	1,963
-.9	760
-.8	1,920
-.7	334
-.6	43
-.5	0
-.4	58
-.3	2
-.2	85
-.1	14
0	104
.1	362
.2	1,815
.3	7,268
.4	29,073
.5	166,294
.6	411,680
.7	1,850
.8	0
.9	0
1.0	25,548

TABLE B-88
SPECTRUM BS6.HIL5 (NO. 88)

DESCRIPTION: SPECTRUM NO. 6 WITH THE 10 HIGHEST PEAKS = 33,056 PSI, AND THEIR NUMBER INCREASED TO 200.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,824	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.0
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 33,056			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
	0
-12,000	47
-11,000	0
-10,000	9
-9,000	0
-8,000	201
-7,000	914
-6,000	1,373
-5,000	3,084
-4,000	7,026
-3,000	736
-2,000	54
-1,000	2
0	0
1,000	0
2,000	0
3,000	0
4,000	384
5,000	358
6,000	95
7,000	246
8,000	4,197
9,000	17,220
10,000	34,344
11,000	31,833
12,000	36,065
13,000	9,011
14,000	26,380
15,000	6,017
16,000	1,565
17,000	186
18,000	197
19,000	63
20,000	16
21,000	1
22,000	0
23,000	
24,000	
25,000	
26,000	
27,000	0
33,000	200
34,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	74,960
5,000	66,131
6,000	24,915
7,000	7,864
8,000	2,344
9,000	1,045
10,000	270
11,000	93
12,000	47
13,000	33
14,000	16
15,000	10
16,000	12
17,000	31
18,000	86
19,000	117
20,000	494
21,000	1,113
22,000	1,033
23,000	460
24,000	151
25,000	377
26,000	24
27,000	167
28,000	24
29,000	6
30,000	1
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	277
-1.5	698
-1.2	559
-1.0	869
-.9	490
-.8	654
-.7	333
-.6	197
-.5	92
-.4	58
-.3	49
-.2	63
-.1	98
0	117
.1	245
.2	870
.3	3,274
.4	16,121
.5	52,756
.6	89,714
.7	844
.8	0
.9	0
1.0	13,446

TABLE B-89
SPECTRUM BS6.HIL6 (NO. 89)

DESCRIPTION: SPECTRUM NO. 6 WITH THE 10 HIGHEST PEAKS = 27,750 PSI, AND THEIR NUMBER INCREASED TO 200.

FLIGHT HOURS = 2,500 FLIGHTS = 2,422 LANDINGS = 3,843
TOTAL CYCLES = 181,856 AVERAGE NO. OF CYCLES PER: FLIGHT = 75.0
RANGE TRUNCATION (PSI) = 4,000 FLIGHT HOUR = 72.7
HIGHEST PEAK (PSI) = 27,750 SMALLEST VALLEY (PSI) = −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	277
-11,000	47			-1.2	698
-10,000	0	1,000		-1.0	559
-9,000	9	2,000		-.9	869
-8,000	0	3,000		-.8	490
-7,000	201	4,000	0	-.7	654
-6,000	914	5,000	74,960	-.6	333
-5,000	1,373	6,000	66,123	-.5	197
-4,000	3,084	7,000	24,915	-.4	92
-3,000	7,026	8,000	7,864	-.3	58
-2,000	736	9,000	2,344	-.2	49
-1,000	54	10,000	1,045	-.1	63
0	2	11,000	270	0	98
1,000	0	12,000	93	.1	157
2,000	0	13,000	79	.2	243
3,000	0	14,000	33	.3	805
4,000	0	15,000	24	.4	3,282
5,000	384	16,000	69	.5	16,180
6,000	358	17,000	12	.6	52,756
7,000	95	18,000	93	.7	89,706
8,000	246	19,000	119	.8	844
9,000	4,197	20,000	156	.9	0
10,000	17,220	21,000	440	1.0	0
11,000	34,344	22,000	1,115		13,446
12,000	31,833	23,000	971		
13,000	36,097	24,000	427		
14,000	9,011	25,000	117		
15,000	26,380	26,000	367		
16,000	6,017	27,000	22		
17,000	1,565	28,000	167		
18,000	186	29,000	24		
19,000	197	30,000	6		
20,000	63	31,000	1		
21,000	16	32,000	0		
22,000	1	33,000			
23,000	0	34,000			
24,000	0	35,000			
25,000	0				
26,000	0				
27,000	0				
28,000	200				
	0				

TABLE B-90
SPECTRUM BS6.CLP1 (NO. 90)

DESCRIPTION: SPECTRUM NO. 6 WITH $P_{CLIP} \geq 21,531$ PSI.

FLIGHT HOURS = 2,500 FLIGHTS = 2,422 LANDINGS = 3,843
TOTAL CYCLES = 181,644 AVERAGE NO. OF CYCLES PER: FLIGHT = 75.0
RANGE TRUNCATION (PSI) = 4,000 FLIGHT HOUR = 72.7
HIGHEST PEAK (PSI) = 21,531 SMALLEST VALLEY (PSI) = −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	277
-11,000	47			-1.2	698
-10,000	0	1,000		-1.0	559
-9,000	9	2,000		-.9	869
-8,000	0	3,000		-.8	490
-7,000	201	4,000	0	-.7	654
-6,000	914	5,000	74,958	-.6	333
-5,000	1,373	6,000	66,142	-.5	197
-4,000	3,084	7,000	24,930	-.4	92
-3,000	7,026	8,000	7,864	-.3	58
-2,000	736	9,000	2,346	-.2	49
-1,000	54	10,000	1,050	-.1	63
0	2	11,000	272	0	79
1,000	0	12,000	92	.1	119
2,000	0	13,000	55	.2	243
3,000	0	14,000	17	.3	793
4,000	0	15,000	14	.4	3,153
5,000	384	16,000	10	.5	16,127
6,000	358	17,000	11	.6	52,775
7,000	95	18,000	31	.7	89,731
8,000	246	19,000	85	.8	839
9,000	4,197	20,000	117	.9	0
10,000	17,220	21,000	435	1.0	0
11,000	34,344	22,000	1,113		13,399
12,000	31,833	23,000	971		
13,000	36,061	24,000	427		
14,000	9,016	25,000	117		
15,000	26,378	26,000	367		
16,000	6,028	27,000	22		
17,000	1,565	28,000	167		
18,000	186	29,000	24		
19,000	197	30,000	6		
20,000	63	31,000	1		
21,000	16	32,000	0		
22,000	11	33,000			
23,000	0	34,000			
24,000		35,000			
25,000					
26,000					
27,000					

TABLE B-91
SPECTRUM BS6.CLP2 (NO. 91)

DESCRIPTION: SPECTRUM NO. 6 WITH $P_{CLIP} \geqslant$ 17,942 PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,644	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.0
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 17,942			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	47
-10,000	0
-9,000	9
-8,000	0
-7,000	201
-6,000	914
-5,000	1,373
-4,000	3,084
-3,000	7,026
-2,000	736
-1,000	54
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	358
7,000	95
8,000	246
9,000	4,197
10,000	17,220
11,000	34,344
12,000	31,833
13,000	36,061
14,000	9,016
15,000	26,378
16,000	6,028
17,000	1,565
18,000	473
19,000	0
20,000	
21,000	
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	74,963
5,000	66,155
6,000	24,926
7,000	7,870
8,000	2,489
9,000	928
10,000	257
11,000	82
12,000	41
13,000	15
14,000	14
15,000	10
16,000	11
17,000	31
18,000	85
19,000	117
20,000	435
21,000	1,113
22,000	971
23,000	427
24,000	117
25,000	369
26,000	20
27,000	167
28,000	24
29,000	6
30,000	1
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	277
-1.2	698
-1.0	559
-.9	869
-.8	490
-.7	655
-.6	332
-.5	197
-.4	92
-.3	58
-.2	49
-.1	63
0	79
.1	119
.2	243
.3	793
.4	3,146
.5	16,100
.6	52,799
.7	89,735
.8	845
.9	0
1.0	0
	13,446

TABLE B-92
SPECTRUM BS6.CLP3 (NO. 92)

DESCRIPTION: SPECTRUM NO. 6 WITH $P_{CLIP} \leqslant$ 0 PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 168,198	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 69.5
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 67.3
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= 0

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	
-4,000	
-3,000	
-2,000	
-1,000	
0	
1,000	
2,000	
3,000	
4,000	0
5,000	384
6,000	358
7,000	95
8,000	246
9,000	4,197
10,000	17,220
11,000	34,344
12,000	31,833
13,000	36,061
14,000	9,016
15,000	26,378
16,000	6,028
17,000	1,565
18,000	186
19,000	197
20,000	63
21,000	16
22,000	4
23,000	6
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	74,308
6,000	61,428
7,000	20,740
8,000	5,804
9,000	1,117
10,000	1,266
11,000	1,075
12,000	598
13,000	788
14,000	783
15,000	250
16,000	33
17,000	5
18,000	0
19,000	3
20,000	0
21,000	
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	
28,000	
29,000	
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	
-1.2	
-1.0	
-.9	
-.8	
-.7	
-.6	
-.5	
-.4	
-.3	
-.2	
-.1	C
0	4,418
.1	119
.2	243
.3	793
.4	3,155
.5	16,125
.6	52,775
.7	89,731
.8	839
.9	0
1.0	0
	0

TABLE B-93
SPECTRUM BS6.CLP4 (NO. 93)

DESCRIPTION: SPECTRUM NO. 6 WITH $P_{CLIP} \leq -5{,}000$ PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 177,893	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 73.5
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 71.2
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= -5,000

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
	0
-5,000	
	2,982
-4,000	
	6,039
-3,000	
	627
-2,000	
	45
-1,000	
	2
0	
	0
1,000	
	0
2,000	
	0
3,000	
	0
4,000	
	384
5,000	
	358
6,000	
	95
7,000	
	246
8,000	
	4,197
9,000	
	17,220
10,000	
	34,344
11,000	
	31,833
12,000	
	36,061
13,000	
	9,016
14,000	
	26,378
15,000	
	6,028
16,000	
	1,565
17,000	
	186
18,000	
	197
19,000	
	63
20,000	
	16
21,000	
	4
22,000	
	6
23,000	
	1
24,000	
	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
0	
	2,982 *
1,000	
	6,039 *
2,000	
	627 *
3,000	
	45 *
4,000	
	74,038
5,000	
	61,298
6,000	
	20,794
7,000	
	5,601
8,000	
	996
9,000	
	1,038
10,000	
	270
11,000	
	84
12,000	
	108
13,000	
	183
14,000	
	365
15,000	
	869
16,000	
	529
17,000	
	761
18,000	
	776
19,000	
	249
20,000	
	33
21,000	
	5
22,000	
	0
23,000	
	3
24,000	
	0
25,000	
26,000	
27,000	
28,000	
29,000	
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	
	0
-1.2	
	102
-1.0	
	82
-.9	
	17
-.8	
	28
-.7	
	125
-.6	
	555
-.5	
	1,972
-.4	
	1,340
-.3	
	55
-.2	
	63
-.1	
	79
0	
	119
.1	
	243
.2	
	793
.3	
	3,155
.4	
	16,125
.5	
	52,775
.6	
	89,731
.7	
	839
.8	
	0
.9	
	0
1.0	
	9,695

* CYCLES WITH RANGE < 4,000 PRODUCED BY CLIPPING AFTER THE RANGE TRUNCATION.

TABLE B-94
SPECTRUM BS6.MISC1 (NO.94)

DESCRIPTION: SPECTRUM NO. 6 WITH FLIGHT INCREMENTAL LOADS AVERAGING INTERVAL Δg = 0.05.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 180,832	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 74.7
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 72.3
HIGHEST PEAK (PSI)	= 22,387			SMALLEST VALLEY (PSI)	= -24,298

PEAK DISTRIBUTION

Peak (psi)	n
	0
-12,000	
	9
-11,000	
	0
-10,000	
	6
-9,000	
	74
-8,000	
	159
-7,000	
	768
-6,000	
	2,346
-5,000	
	2,801
-4,000	
	6,135
-3,000	
	1,116
-2,000	
	27
-1,000	
	0
0	
	0
1,000	
	0
2,000	
	0
3,000	
	0
4,000	
	364
5,000	
	331
6,000	
	93
7,000	
	151
8,000	
	5,605
9,000	
	11,256
10,000	
	26,721
11,000	
	28,906
12,000	
	27,035
13,000	
	48,858
14,000	
	9,804
15,000	
	6,308
16,000	
	1,207
17,000	
	526
18,000	
	123
19,000	
	47
20,000	
	16
21,000	
	7
22,000	
	3
23,000	
	0
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
	0
4,000	
	92,253
5,000	
	56,115
6,000	
	16,918
7,000	
	8,205
8,000	
	2,279
9,000	
	806
10,000	
	207
11,000	
	77
12,000	
	46
13,000	
	22
14,000	
	12
15,000	
	12
16,000	
	10
17,000	
	36
18,000	
	95
19,000	
	128
20,000	
	472
21,000	
	1,163
22,000	
	943
23,000	
	347
24,000	
	101
25,000	
	337
26,000	
	106
27,000	
	107
28,000	
	33
29,000	
	2
30,000	
	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	236
-1.5	
	636
-1.2	
	589
-1.0	
	843
-.9	
	573
-.8	
	680
-.7	
	325
-.6	
	201
-.5	
	89
-.4	
	44
-.3	
	47
-.2	
	65
-.1	
	94
0	
	144
.1	
	232
.2	
	662
.3	
	3,223
.4	
	16,028
.5	
	57,926
.6	
	83,948
.7	
	786
.8	
	0
.9	
	0
1.0	
	13,461

TABLE B-95
SPECTRUM BS6.MISC2 (NO. 95)

DESCRIPTION: SPECTRUM NO. 6 WITH FLIGHT INCREMENTAL LOADS AVERAGING INTERVAL Δg = 0.20.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 375,893	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 155.2
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR =	150.4
HIGHEST PEAK (PSI)	= 24,790			SMALLEST VALLEY (PSI) =	−24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	42
-11,000	0
-10,000	0
-9,000	166
-8,000	1
-7,000	227
-6,000	940
-5,000	4,169
-4,000	6,864
-3,000	1,681
-2,000	102
-1,000	4
0	0
1,000	0
2,000	0
3,000	0
4,000	280
5,000	299
6,000	120
7,000	96
8,000	5,341
9,000	3,108
10,000	9,208
11,000	142,165
12,000	25,419
13,000	162,135
14,000	3,045
15,000	4,493
16,000	5,302
17,000	363
18,000	263
19,000	30
20,000	14
21,000	7
22,000	7
23,000	0
24,000	2
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	172,162
5,000	153,714
6,000	25,654
7,000	14,614
8,000	4,451
9,000	433
10,000	817
11,000	12
12,000	93
13,000	22
14,000	9
15,000	6
16,000	14
17,000	86
18,000	48
19,000	70
20,000	423
21,000	763
22,000	924
23,000	810
24,000	201
25,000	21
26,000	422
27,000	3
28,000	112
29,000	7
30,000	0
31,000	2
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	318
-1.5	611
-1.2	589
-1.0	1,100
-.9	290
-.8	573
-.7	353
-.6	134
-.5	108
-.4	79
-.3	41
-.2	77
-.1	58
0	133
.1	89
.2	1,242
.3	2,164
.4	23,780
.5	25,610
.6	303,853
.7	395
.8	0
.9	0
1.0	14,196

TABLE B-96
SPECTRUM BS6.MISC3 (NO. 96)

DESCRIPTION: SPECTRUM NO. 6 250 FLIGHT HOUR SEQUENCE

FLIGHT HOURS	= 250	FLIGHTS = 243		LANDINGS	= 388
TOTAL CYCLES	= 18,210	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 71.9
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR =	72.8
HIGHEST PEAK (PSI)	= 20,710			SMALLEST VALLEY (PSI) =	−16,724

PEAK DISTRIBUTION

Peak (psi)	n
	0
-12,000	5
-11,000	0
-10,000	1
-9,000	0
-8,000	20
-7,000	92
-6,000	146
-5,000	315
-4,000	740
-3,000	78
-2,000	3
-1,000	0
0	
1,000	
2,000	
3,000	0
4,000	40
5,000	36
6,000	7
7,000	20
8,000	413
9,000	1,777
10,000	3,439
11,000	2,154
12,000	3,603
13,000	892
14,000	2,638
15,000	601
16,000	153
17,000	15
18,000	17
19,000	4
20,000	1
21,000	0
22,000	
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	7,506
5,000	6,683
6,000	2,466
7,000	782
8,000	224
9,000	109
10,000	25
11,000	5
12,000	1
13,000	0
14,000	1
15,000	0
16,000	0
17,000	4
18,000	4
19,000	11
20,000	41
21,000	116
22,000	97
23,000	42
24,000	12
25,000	40
26,000	2
27,000	7
28,000	2
29,000	0
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	21
-1.5	66
-1.2	59
-1.0	94
-.9	46
-.8	71
-.7	27
-.6	13
-.5	8
-.4	6
-.3	6
-.2	6
-.1	8
0	12
.1	26
.2	76
.3	215
.4	1,619
.5	5,254
.6	8,995
.7	72
.8	0
.9	0
1.0	1,400

TABLE B-97
SPECTRUM BS6.MISC4 (NO. 97)

DESCRIPTION: SPECTRUM NO. 6 500 FLIGHT HOUR SEQUENCE.

FLIGHT HOURS	= 500	FLIGHTS = 484		LANDINGS	= 768
TOTAL CYCLES	= 36,303	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.0
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 72.6
HIGHEST PEAK (PSI)	= 20,710			SMALLEST VALLEY (PSI)	= −16,724

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	12
-10,000	0
-9,000	1
-8,000	32
-7,000	38
-6,000	183
-5,000	268
-4,000	596
-3,000	1,414
-2,000	155
-1,000	10
0	0
1,000	
2,000	
3,000	
4,000	0
5,000	76
6,000	69
7,000	18
8,000	47
9,000	836
10,000	3,457
11,000	6,874
12,000	6,382
13,000	7,185
14,000	1,819
15,000	5,241
16,000	1,199
17,000	308
18,000	34
19,000	36
20,000	11
21,000	2
22,000	0
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	15,085
5,000	13,221
6,000	4,930
7,000	1,542
8,000	451
9,000	217
10,000	55
11,000	18
12,000	9
13,000	3
14,000	3
15,000	1
16,000	0
17,000	6
18,000	19
19,000	30
20,000	97
21,000	206
22,000	191
23,000	77
24,000	16
25,000	87
26,000	2
27,000	26
28,000	10
29,000	1
30,000	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	41
-1.2	122
-1.0	121
-.9	186
-.8	91
-.7	148
-.6	71
-.5	29
-.4	17
-.3	12
-.2	10
-.1	12
0	16
.1	22
.2	49
.3	150
.4	598
.5	3,251
.6	10,579
.7	17,910
.8	159
.9	0
1.0	0
	2,709

TABLE B-98
SPECTRUM BS6.MISC5 (NO. 98)

DESCRIPTION: SPECTRUM NO. 6 1,250 FLIGHT HOUR SEQUENCE

FLIGHT HOURS	= 1,250	FLIGHTS = 1,213		LANDINGS	= 1,927
TOTAL CYCLES	= 90,995	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.0
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 72.8
HIGHEST PEAK (PSI)	= 22,694			SMALLEST VALLEY (PSI)	= −17,170

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	21
-10,000	0
-9,000	5
-8,000	14
-7,000	104
-6,000	466
-5,000	691
-4,000	1,510
-3,000	3,613
-2,000	386
-1,000	26
0	0
1,000	0
2,000	0
3,000	0
4,000	0
5,000	180
6,000	172
7,000	46
8,000	103
9,000	2,139
10,000	8,614
11,000	17,180
12,000	15,924
13,000	18,072
14,000	4,577
15,000	13,130
16,000	3,015
17,000	782
18,000	86
19,000	99
20,000	28
21,000	8
22,000	2
23,000	2
24,000	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	37,573
5,000	33,383
6,000	12,316
7,000	3,851
8,000	1,191
9,000	528
10,000	129
11,000	45
12,000	18
13,000	8
14,000	6
15,000	6
16,000	7
17,000	11
18,000	47
19,000	68
20,000	210
21,000	592
22,000	478
23,000	181
24,000	55
25,000	190
26,000	8
27,000	80
28,000	10
29,000	4
30,000	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	127
-1.2	312
-1.0	296
-.9	457
-.8	229
-.7	362
-.6	165
-.5	75
-.4	46
-.3	28
-.2	24
-.1	31
0	38
.1	57
.2	129
.3	391
.4	1,564
.5	8,162
.6	26,300
.7	44,988
.8	378
.9	0
1.0	0
	6,836

TABLE B-99
SPECTRUM BS6.MISC6 (NO. 99)

DESCRIPTION: A SIMPLIFIED SPECTRUM NO. 6

FLIGHT HOURS	= 2,500	**FLIGHTS =** 2,422		**LANDINGS**	= 3,843
TOTAL CYCLES	= 176,778	**AVERAGE NO. OF CYCLES PER:**		**FLIGHT**	= 73.0
RANGE TRUNCATION (PSI)	= 4,000			**FLIGHT HOUR**	= 70.7
HIGHEST PEAK (PSI)	= 23,923			**SMALLEST VALLEY (PSI)**	= −11,253

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	0
-5,000	11,529
-4,000	0
-3,000	
-2,000	
-1,000	
0	
1,000	
2,000	
3,000	
4,000	
5,000	
6,000	
7,000	
8,000	
9,000	0
10,000	57,645
11,000	65,331
12,000	0
13,000	0
14,000	38,430
15,000	0
16,000	3,818
17,000	0
18,000	0
19,000	0
20,000	14
21,000	4
22,000	6
23,000	1
24,000	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	103,761
5,000	42,273
6,000	23,058
7,000	3,818
8,000	0
9,000	14
10,000	4
11,000	0
12,000	6
13,000	1
14,000	0
15,000	
16,000	
17,000	
18,000	
19,000	
20,000	
21,000	0
22,000	3,843
23,000	0
24,000	
25,000	
26,000	
27,000	
28,000	
29,000	
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	
-1.2	0
-1.0	3,843
-.9	0
-.8	
-.7	
-.6	
-.5	
-.4	
-.3	
-.2	
-.1	
0	
.1	
.2	
.3	0
.4	15,379
.5	57,638
.6	88,389
.7	0
.8	0
.9	0
1.0	11,529

TABLE B-100
SPECTRUM BS1.MISC7 (NO. 100)

DESCRIPTION: SPECTRUM NO. 1 FLIGHT 1.0g STRESSES INCREASED AND AMPLITUDES DECREASED.

FLIGHT HOURS	= 2,500	**FLIGHTS =** 2,528		**LANDINGS**	= 2,528
TOTAL CYCLES	= 42,258	**AVERAGE NO. OF CYCLES PER:**		**FLIGHT**	= 16.7
RANGE TRUNCATION (PSI)	= 4,000			**FLIGHT HOUR**	= 16.9
HIGHEST PEAK (PSI)	= 22,663			**SMALLEST VALLEY (PSI)**	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	5,151
-4,000	6,386
-3,000	110
-2,000	18
-1,000	0
0	
1,000	
2,000	
3,000	
4,000	0
5,000	499
6,000	0
7,000	0
8,000	17
9,000	969
10,000	3,663
11,000	2,665
12,000	1,281
13,000	5,472
14,000	10,504
15,000	3,626
16,000	1,361
17,000	364
18,000	103
19,000	47
20,000	15
21,000	5
22,000	2
23,000	0
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	20,573
5,000	6,402
6,000	7,191
7,000	3,954
8,000	1,161
9,000	288
10,000	62
11,000	38
12,000	6
13,000	14
14,000	0
15,000	12
16,000	7
17,000	0
18,000	5
19,000	12
20,000	54
21,000	185
22,000	165
23,000	1,423
24,000	609
25,000	83
26,000	7
27,000	4
28,000	1
29,000	2
30,000	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	55
-1.5	210
-1.2	919
-1.0	49
-.9	5
-.8	253
-.7	823
-.6	95
-.5	299
-.4	52
-.3	0
-.2	44
-.1	0
0	82
.1	7
.2	170
.3	88
.4	810
.5	5,952
.6	19,644
.7	1,036
.8	0
.9	0
1.0	11,665

TABLE B-101
SPECTRUM BS3.MISC8 (NO. 101)

DESCRIPTION: SPECTRUM NO. 3 600 FLIGHT SEQUENCE.

FLIGHT HOURS	= 293.4	FLIGHTS = 600		LANDINGS	= 600
TOTAL CYCLES	= 74,887	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 124.8
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 255.2
HIGHEST PEAK (PSI)	= 22,003			SMALLEST VALLEY (PSI)	= -14,451

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	0
-10,000	4
-9,000	0
-8,000	0
-7,000	379
-6,000	588
-5,000	35
-4,000	1,635
-3,000	263
-2,000	21
-1,000	0
0	
1,000	
2,000	
3,000	
4,000	
5,000	0
6,000	36
7,000	0
8,000	1
9,000	1
10,000	16,141
11,000	16,409
12,000	18,793
13,000	1,642
14,000	15,024
15,000	3,049
16,000	700
17,000	33
18,000	106
19,000	19
20,000	4
21,000	0
22,000	4
23,000	0
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	24,286
5,000	35,407
6,000	10,597
7,000	2,927
8,000	404
9,000	463
10,000	129
11,000	38
12,000	11
13,000	1
14,000	2
15,000	1
16,000	0
17,000	0
18,000	1
19,000	0
20,000	23
21,000	141
22,000	115
23,000	31
24,000	3
25,000	229
26,000	10
27,000	39
28,000	7
29,000	2
30,000	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	1
-1.5	1
-1.2	23
-1.0	230
-.9	81
-.8	231
-.7	33
-.6	6
-.5	0
-.4	2
-.3	0
-.2	5
-.1	1
0	13
.1	50
.2	204
.3	792
.4	3,405
.5	18,990
.6	47,673
.7	221
.8	0
.9	0
1.0	2,925

TABLE B-102
SPECTRUM BS1.MISC9 (NO. 102)

DESCRIPTION: SPECTRUM NO. 1 WITH DIFFERENT SEQUENCE OF CYCLES WITHIN A FLIGHT.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,528		LANDINGS	= 2,528
TOTAL CYCLES	= 56,697	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 22.4
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 22.7
HIGHEST PEAK (PSI)	= 22,114			SMALLEST VALLEY (PSI)	= -24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	0
-5,000	5,147
-4,000	6,392
-3,000	112
-2,000	17
-1,000	0
0	
1,000	
2,000	
3,000	
4,000	0
5,000	499
6,000	0
7,000	142
8,000	2,769
9,000	7,449
10,000	5,742
11,000	1,297
12,000	5,777
13,000	11,733
14,000	7,584
15,000	1,650
16,000	214
17,000	123
18,000	28
19,000	14
20,000	6
21,000	1
22,000	1
23,000	0
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	22,916
5,000	13,444
6,000	10,972
7,000	4,700
8,000	1,543
9,000	396
10,000	77
11,000	52
12,000	8
13,000	20
14,000	0
15,000	12
16,000	7
17,000	0
18,000	6
19,000	184
20,000	165
21,000	1,089
22,000	477
23,000	492
24,000	69
25,000	19
26,000	3
27,000	2
28,000	0
29,000	3
30,000	1
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	260
-1.5	887
-1.2	38
-1.0	47
-.9	38
-.8	775
-.7	280
-.6	309
-.5	74
-.4	52
-.3	0
-.2	47
-.1	4
0	89
.1	29
.2	259
.3	686
.4	5,266
.5	21,882
.6	13,080
.7	927
.8	0
.9	0
1.0	11,668

TABLE B-103
SPECTRUM BS6.MISC10 (NO. 103)

DESCRIPTION: SPECTRUM NO. 6 WITHOUT TAXI, LOADING IMPACT OR GAG CYCLES.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 164,228	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 67.8
RANGE TRUNCATION (PSI)	= 4,000			FLIGHT HOUR	= 65.7
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −1,805

PEAK DISTRIBUTION Peak (psi)	n	RANGE DISTRIBUTION Range (psi)	n	R DISTRIBUTION R	n
-12,000				-1.5	
-11,000				-1.2	
-10,000		1,000		-1.0	
-9,000		2,000		-.9	
-8,000		3,000		-.8	
-7,000		4,000	0	-.7	
-6,000		5,000	74,141	-.6	
-5,000		6,000	61,139	-.5	
-4,000		7,000	20,804	-.4	
-3,000		8,000	5,891	-.3	0
-2,000		9,000	1,031	-.2	1
-1,000		10,000	904	-.1	2
0		11,000	223	0	11
1,000		12,000	65	.1	40
2,000		13,000	20	.2	149
3,000		14,000	7	.3	704
4,000		15,000	3	.4	3,192
5,000		16,000	0	.5	16,380
6,000	0	17,000		.6	52,589
7,000	9	18,000		.7	90,046
8,000	149	19,000		.8	814
9,000	4,005	20,000		.9	0
10,000	16,984	21,000		1.0	
11,000	33,227	22,000			
12,000	31,451	23,000			
13,000	35,479	24,000			
14,000	8,611	25,000			
15,000	26,237	26,000			
16,000	6,041	27,000			
17,000	1,562	28,000			
18,000	186	29,000			
19,000	197	30,000			
20,000	63	31,000			
21,000	16	32,000			
22,000	4	33,000			
23,000	6	34,000			
24,000	1	35,000			
25,000	0				
26,000					
27,000					

TABLE B-104
SPECTRUM BS6.COMB1 (NO. 104)

DESCRIPTION: SPECTRUM NO. 6 WITH DIFFERENT VALLEY/PEAK COUPLING AND RANGE TRUNCATION = 3,500 PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 285,380	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 117.8
RANGE TRUNCATION (PSI)	= 3,500			FLIGHT HOUR	= 114.2
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION Peak (psi)	n	RANGE DISTRIBUTION Range (psi)	n	R DISTRIBUTION R	n
-12,000				-1.5	271
-11,000				-1.2	692
-10,000		1,000		-1.0	618
-9,000		2,000		-.9	840
-8,000	0	3,000	0	-.8	451
-7,000	206	4,000	153,097	-.7	642
-6,000	1,230	5,000	31,471	-.6	319
-5,000	1,904	6,000	41,859	-.5	223
-4,000	3,245	7,000	32,501	-.4	113
-3,000	8,531	8,000	11,337	-.3	58
-2,000	773	9,000	2,032	-.2	49
-1,000	54	10,000	6,993	-.1	61
0	2	11,000	173	0	81
1,000	0	12,000	1,508	.1	164
2,000	0	13,000	46	.2	384
3,000	0	14,000	185	.3	1,225
4,000	0	15,000	170	.4	4,554
5,000	384	16,000	52	.5	19,096
6,000	414	17,000	43	.6	81,558
7,000	121	18,000	58	.7	12,422
8,000	610	19,000	133	.8	145,614
9,000	2,425	20,000	141	.9	0
10,000	26,359	21,000	521	1.0	0
11,000	6,494	22,000	1,060		15,945
12,000	31,674	23,000	950		
13,000	154,027	24,000	456		
14,000	9,991	25,000	92		
15,000	28,107	26,000	314		
16,000	6,790	27,000	17		
17,000	1,566	28,000	139		
18,000	186	29,000	23		
19,000	197	30,000	7		
20,000	63	31,000	0		
21,000	16	32,000			
22,000	4	33,000			
23,000	6	34,000			
24,000	1	35,000			
25,000	0				
26,000					
27,000					

TABLE B-105
SPECTRUM BS6.COMB2 (NO. 105)

DESCRIPTION : SPECTRUM NO. 6 WITH DIFFERENT VALLEY/PEAK COUPLING AND RANGE TRUNCATION = 3,000 PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 407,806	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 168.4
RANGE TRUNCATION (PSI)	= 3,000			FLIGHT HOUR	= 163.1
HIGHEST PEAK (PSI)	= 23,923			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	0
-7,000	206
-6,000	1,230
-5,000	1,904
-4,000	3,245
-3,000	8,531
-2,000	773
-1,000	54
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	512
6,000	531
7,000	170
8,000	1,302
9,000	4,500
10,000	28,926
11,000	114,911
12,000	34,645
13,000	157,616
14,000	10,960
15,000	28,647
16,000	7,081
17,000	1,587
18,000	186
19,000	197
20,000	63
21,000	16
22,000	4
23,000	6
24,000	1
25,000	0
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	278,980
5,000	29,178
6,000	40,566
7,000	32,287
8,000	11,278
9,000	2,016
10,000	6,989
11,000	172
12,000	1,508
13,000	48
14,000	185
15,000	170
16,000	52
17,000	43
18,000	72
19,000	123
20,000	159
21,000	584
22,000	1,090
23,000	901
24,000	393
25,000	90
26,000	331
27,000	17
28,000	121
29,000	23
30,000	7
31,000	0
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	281
-1.2	687
-1.0	636
-.9	866
-.8	469
-.7	592
-.6	316
-.5	214
-.4	108
-.3	58
-.2	49
-.1	61
0	81
.1	164
.2	284
.3	1,288
.4	4,676
.5	18,801
.6	82,258
.7	18,382
.8	261,058
.9	432
1.0	0
	15,945

TABLE B-106
SPECTRUM BS6.COMB3 (NO. 106)

DESCRIPTION : SPECTRUM NO. 6 WITH 15 PERCENT HIGHER STRESSES AND RANGE TRUNCATIONS = 3,500 (1.15) PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 311,256	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 128.5
RANGE TRUNCATION (PSI)	= 3,500 (1.15)			FLIGHT HOUR	= 124.5
HIGHEST PEAK (PSI)	= 27,512			SMALLEST VALLEY (PSI)	= −27,943

PEAK DISTRIBUTION

Peak (psi)	n
-14,000	0
-12,000	47
-11,000	2
-10,000	7
-9,000	16
-8,000	207
-7,000	331
-6,000	633
-5,000	3,780
-4,000	5,697
-3,000	3,105
-2,000	372
-1,000	20
0	1
1,000	0
2,000	
3,000	
4,000	
5,000	0
6,000	606
7,000	192
8,000	121
9,000	447
10,000	4,552
11,000	14,996
12,000	11,536
13,000	33,776
14,000	32,280
15,000	152,037
16,000	8,869
17,000	27,605
18,000	7,678
19,000	634
20,000	1,305
21,000	284
22,000	38
23,000	55
24,000	14
25,000	6
26,000	4
27,000	2
28,000	1
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	187,481
6,000	75,816
7,000	9,138
8,000	23,529
9,000	6,670
10,000	2,764
11,000	1,350
12,000	369
13,000	73
14,000	79
15,000	49
16,000	20
17,000	14
18,000	8
19,000	5
20,000	16
21,000	68
22,000	51
23,000	115
24,000	550
25,000	702
26,000	1,017
27,000	498
28,000	293
29,000	44
30,000	333
31,000	20
32,000	149
33,000	8
34,000	21
35,000	5
36,000	1
	0

R DISTRIBUTION

R	n
-1.5	293
-1.2	691
-1.0	615
-.9	863
-.8	487
-.7	601
-.6	337
-.5	191
-.4	91
-.3	58
-.2	49
-.1	63
0	79
.1	119
.2	243
.3	815
.4	3,044
.5	15,638
.6	55,312
.7	99,259
.8	118,190
.9	0
1.0	0
	14,218

TABLE B-107
SPECTRUM BS6.COMB4 (NO. 107)

DESCRIPTION: SPECTRUM NO. 6 WITH 15 PERCENT HIGHER STRESSES AND RANGE TRUNCATION = 3,000 (1.15) PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422	LANDINGS	=	3,843
TOTAL CYCLES	= 425,270	AVERAGE NO. OF CYCLES PER:	FLIGHT	=	175.6
RANGE TRUNCATION (PSI)	= 3,000 (1.15)		FLIGHT HOUR	=	170.1
HIGHEST PEAK (PSI)	= 27,512		SMALLEST VALLEY (PSI)	=	−27,943

PEAK DISTRIBUTION

Peak (psi)	n
	0
-14,000	
	47
-12,000	
	87
-11,000	
	201
-10,000	
	16
-9,000	
	211
-8,000	
	437
-7,000	
	896
-6,000	
	3,786
-5,000	
	5,703
-4,000	
	3,133
-3,000	
	383
-2,000	
	20
-1,000	
	1
0	
	0
1,000	
2,000	
3,000	
4,000	
	0
5,000	
	819
6,000	
	224
7,000	
	172
8,000	
	2,422
9,000	
	18,278
10,000	
	24,130
11,000	
	12,652
12,000	
	115,141
13,000	
	33,427
14,000	
	154,987
15,000	
	9,680
16,000	
	28,052
17,000	
	8,001
18,000	
	643
19,000	
	1,317
20,000	
	284
21,000	
	38
22,000	
	55
23,000	
	14
24,000	
	6
25,000	
	4
26,000	
	2
27,000	
	1
28,000	
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
	0
3,000	
	114,895
4,000	
	192,533
5,000	
	71,952
6,000	
	7,910
7,000	
	22,898
8,000	
	6,511
9,000	
	2,732
10,000	
	1,339
11,000	
	364
12,000	
	70
13,000	
	79
14,000	
	49
15,000	
	20
16,000	
	14
17,000	
	8
18,000	
	5
19,000	
	21
20,000	
	71
21,000	
	45
22,000	
	136
23,000	
	607
24,000	
	719
25,000	
	1,079
26,000	
	384
27,000	
	250
28,000	
	42
29,000	
	356
30,000	
	22
31,000	
	126
32,000	
	6
33,000	
	21
34,000	
	5
35,000	
	1
36,000	
	0

R DISTRIBUTION

R	n
	304
-1.5	
	693
-1.2	
	624
-1.0	
	899
-.9	
	463
-.8	
	586
-.7	
	335
-.6	
	179
-.5	
	86
-.4	
	56
-.3	
	49
-.2	
	64
-.1	
	78
0	
	119
.1	
	239
.2	
	868
.3	
	3,078
.4	
	13,624
.5	
	65,728
.6	
	117,968
.7	
	203,958
.8	
	339
.9	
	0
1.0	
	14,921

TABLE B-108
SPECTRUM BS6.COMB5 (NO. 108)

DESCRIPTION: SPECTRUM NO. 6 WITH 10 PERCENT LOWER STRESSES AND RANGE TRUNCATION = 4,500 (0.9) PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422	LANDINGS	=	3,843
TOTAL CYCLES	= 130,687	AVERAGE NO. OF CYCLES PER:	FLIGHT	=	54.0
RANGE TRUNCATION (PSI)	= 4,500 (0.9)		FLIGHT HOUR	=	52.3
HIGHEST PEAK (PSI)	= 21,531		SMALLEST VALLEY (PSI)	=	−21,868

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
	0
-11,000	
	2
-10,000	
	0
-9,000	
	0
-8,000	
	0
-7,000	
	145
-6,000	
	911
-5,000	
	3,403
-4,000	
	6,025
-3,000	
	2,497
-2,000	
	77
-1,000	
	2
0	
	0
1,000	
	0
2,000	
	0
3,000	
	68
4,000	
	482
5,000	
	79
6,000	
	41
7,000	
	912
8,000	
	8,314
9,000	
	10,683
10,000	
	20,341
11,000	
	35,107
12,000	
	31,601
13,000	
	7,529
14,000	
	1,034
15,000	
	1,086
16,000	
	250
17,000	
	71
18,000	
	16
19,000	
	8
20,000	
	2
21,000	
	1
22,000	
	0
23,000	
24,000	
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
	0
3,000	
	78,941
4,000	
	33,329
5,000	
	9,290
6,000	
	3,434
7,000	
	1,316
8,000	
	301
9,000	
	89
10,000	
	48
11,000	
	27
12,000	
	16
13,000	
	7
14,000	
	32
15,000	
	79
16,000	
	106
17,000	
	511
18,000	
	1,020
19,000	
	1,162
20,000	
	356
21,000	
	41
22,000	
	358
23,000	
	180
24,000	
	33
25,000	
	10
26,000	
	1
27,000	
	0
28,000	
29,000	
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	275
-1.5	
	691
-1.2	
	557
-1.0	
	849
-.9	
	495
-.8	
	662
-.7	
	344
-.6	
	211
-.5	
	84
-.4	
	59
-.3	
	49
-.2	
	63
-.1	
	51
0	
	91
.1	
	172
.2	
	883
.3	
	3,947
.4	
	18,451
.5	
	43,296
.6	
	46,350
.7	
	45
.8	
	0
.9	
	0
1.0	
	13,062

TABLE B-109
SPECTRUM BS6.COMB6 (NO. 109)

DESCRIPTION: SPECTRUM NO. 6 WITH 10 PERCENT LOWER STRESSES AND RANGE TRUNCATION = 3,500 (0.9) PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 311,256	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 128.5
RANGE TRUNCATION (PSI)	= 3,500 (0.9)			FLIGHT HOUR	= 124.5
HIGHEST PEAK (PSI)	= 21,531			SMALLEST VALLEY (PSI)	= −21,868

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	293
-11,000	47			-1.2	691
-10,000	0	1,000		-1.0	615
-9,000	9	2,000		-.9	863
-8,000	23	3,000	0	-.8	487
-7,000	200	4,000	190,001	-.7	601
-6,000	946	5,000	77,184	-.6	337
-5,000	3,423	6,000	27,776	-.5	191
-4,000	6,986	7,000	7,659	-.4	91
-3,000	2,505	8,000	3,048	-.3	58
-2,000	77	9,000	1,242	-.2	49
-1,000	2	10,000	276	-.1	63
0	0	11,000	84	0	79
1,000	0	12,000	48	.1	119
2,000	0	13,000	26	.2	243
3,000	96	14,000	16	.3	815
4,000	702	15,000	7	.4	3,044
5,000	120	16,000	43	.5	15,638
6,000	448	17,000	82	.6	55,312
7,000	6,793	18,000	123	.7	99,259
8,000	22,265	19,000	666	.8	118,190
9,000	35,500	20,000	954	.9	0
10,000	36,974	21,000	1,102	1.0	0
11,000	149,255	22,000	353		14,218
12,000	33,472	23,000	30		
13,000	8,921	24,000	336		
14,000	1,052	25,000	165		
15,000	1,092	26,000	27		
16,000	250	27,000	7		
17,000	71	28,000	1		
18,000	16	29,000	0		
19,000	8	30,000			
20,000	2	31,000			
21,000	1	32,000			
22,000	0	33,000			
23,000		34,000			
24,000		35,000			
25,000					
26,000					
27,000					

TABLE B-110
SPECTRUM BS6.COMB7 (NO. 110)

DESCRIPTION: SPECTRUM NO. 88 WITH RANGE TRUNCATION = 3,500 PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 311,433	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 128.6
RANGE TRUNCATION (PSI)	= 3,500			FLIGHT HOUR	= 124.6
HIGHEST PEAK (PSI)	= 33,056			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	293
-11,000	47			-1.2	691
-10,000	0	1,000		-1.0	615
-9,000	9	2,000		-.9	863
-8,000	0	3,000	0	-.8	487
-7,000	223	4,000	131,244	-.7	601
-6,000	943	5,000	75,565	-.6	337
-5,000	1,384	6,000	65,167	-.5	191
-4,000	3,098	7,000	24,001	-.4	91
-3,000	7,719	8,000	7,584	-.3	58
-2,000	739	9,000	2,283	-.2	49
-1,000	54	10,000	1,033	-.1	63
0	2	11,000	264	0	98
1,000	0	12,000	90	.1	117
2,000	0	13,000	47	.2	245
3,000	0	14,000	33	.3	879
4,000	0	15,000	16	.4	3,176
5,000	384	16,000	10	.5	15,634
6,000	414	17,000	12	.6	55,302
7,000	157	18,000	39	.7	99,235
8,000	581	19,000	89	.8	118,190
9,000	7,973	20,000	115	.9	0
10,000	20,915	21,000	652	1.0	0
11,000	35,000	22,000	1,036		14,218
12,000	32,140	23,000	978		
13,000	152,977	24,000	496		
14,000	9,841	25,000	127		
15,000	27,932	26,000	346		
16,000	6,672	27,000	22		
17,000	1,566	28,000	153		
18,000	186	29,000	24		
19,000	197	30,000	6		
20,000	63	31,000	1		
21,000	16	32,000	0		
22,000	1	33,000			
23,000	0	34,000			
24,000		35,000			
25,000					
26,000					
27,000	0				
33,000	200				
34,000	0				

TABLE B-111
SPECTRUM BS6.COMB8 (NO. 111)

DESCRIPTION: SPECTRUM NO. 89 WITH RANGE TRUNCATION = 3,500 PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,856	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.1
RANGE TRUNCATION (PSI)	= 3,500			FLIGHT HOUR =	72.7
HIGHEST PEAK (PSI)	= 27,750			SMALLEST VALLEY (PSI) =	−24,298

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	0
-11,000	47
-10,000	0
-9,000	9
-8,000	0
-7,000	223
-6,000	943
-5,000	1,384
-4,000	3,098
-3,000	7,719
-2,000	739
-1,000	54
0	2
1,000	0
2,000	0
3,000	0
4,000	0
5,000	384
6,000	414
7,000	157
8,000	581
9,000	7,973
10,000	20,915
11,000	35,000
12,000	32,141
13,000	153,016
14,000	9,841
15,000	27,932
16,000	6,672
17,000	1,566
18,000	186
19,000	197
20,000	63
21,000	16
22,000	1
23,000	0
24,000	0
25,000	0
26,000	0
27,000	0
28,000	200
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	0
4,000	131,252
5,000	75,565
6,000	65,139
7,000	24,001
8,000	7,584
9,000	2,283
10,000	1,033
11,000	265
12,000	90
13,000	78
14,000	33
15,000	24
16,000	106
17,000	12
18,000	77
19,000	122
20,000	141
21,000	561
22,000	1,038
23,000	940
24,000	463
25,000	106
26,000	336
27,000	20
28,000	153
29,000	24
30,000	6
31,000	1
32,000	0
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
-1.5	293
-1.2	691
-1.0	615
-.9	883
-.8	487
-.7	601
-.6	337
-.5	191
-.4	91
-.3	58
-.2	49
-.1	63
0	98
.1	157
.2	243
.3	827
.4	3,134
.5	15,730
.6	55,302
.7	99,227
.8	118,198
.9	0
1.0	0
	14,218

TABLE B-112
SPECTRUM BS6.COMB9 (NO. 112)

DESCRIPTION: SPECTRUM NO. 6 WITH 15 PERCENT HIGHER STRESSES AND THE 10 HIGHEST PEAKS = 27,750 PSI AND THEIR NUMBER INCREASED TO 200.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,856	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.1
RANGE TRUNCATION (PSI)	= 4,000 (1.15)			FLIGHT HOUR =	72.7
HIGHEST PEAK (PSI)	= 27,750			SMALLEST VALLEY (PSI) =	−27,943

PEAK DISTRIBUTION

Peak (psi)	n
-14,000	0
-12,000	47
-11,000	2
-10,000	7
-9,000	2
-8,000	199
-7,000	302
-6,000	631
-5,000	3,771
-4,000	4,995
-3,000	3,098
-2,000	371
-1,000	20
0	1
1,000	0
2,000	↓
3,000	↓
4,000	↓
5,000	0
6,000	606
7,000	136
8,000	94
9,000	109
10,000	3,569
11,000	11,091
12,000	8,709
13,000	33,240
14,000	31,527
15,000	35,703
16,000	8,267
17,000	26,171
18,000	6,656
19,000	633
20,000	1,305
21,000	284
22,000	38
23,000	55
24,000	14
25,000	3
26,000	0
27,000	0
28,000	200
	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	0
5,000	55,402
6,000	76,056
7,000	10,119
8,000	24,380
9,000	6,948
10,000	2,817
11,000	1,357
12,000	385
13,000	75
14,000	138
15,000	75
16,000	95
17,000	22
18,000	77
19,000	11
20,000	20
21,000	61
22,000	51
23,000	117
24,000	429
25,000	787
26,000	1,043
27,000	496
28,000	258
29,000	53
30,000	364
31,000	22
32,000	162
33,000	9
34,000	21
35,000	5
36,000	1
	0

R DISTRIBUTION

R	n
-1.5	277
-1.2	698
-1.0	559
-.9	869
-.8	490
-.7	654
-.6	333
-.5	197
-.4	92
-.3	58
-.2	49
-.1	63
0	98
.1	157
.2	243
.3	795
.4	3,230
.5	16,183
.6	52,815
.7	89,706
.8	844
.9	0
1.0	0
	13,446

TABLE B-113
SPECTRUM BS6.COMB10 (NO. 113)

DESCRIPTION: SPECTRUM NO. 6 WITH 26 PERCENT LOWER STRESSES AND THE 10 HIGHEST PEAKS = 27,750 PSI AND THEIR NUMBER INCREASED TO 200.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 181,856	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 75.1
RANGE TRUNCATION (PSI)	= 4,000 (0.74)			FLIGHT HOUR	= 72.7
HIGHEST PEAK (PSI)	= 27,750			SMALLEST VALLEY (PSI)	= −17,981

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	0
-9,000	47
-8,000	2
-7,000	7
-6,000	201
-5,000	915
-4,000	4,348
-3,000	7,533
-2,000	391
-1,000	2
0	0
1,000	0
2,000	0
3,000	742
4,000	94
5,000	247
6,000	13,447
7,000	41,590
8,000	32,768
9,000	38,654
10,000	32,079
11,000	6,686
12,000	1,510
13,000	312
14,000	68
15,000	13
16,000	0
17,000	
18,000	
19,000	
20,000	
21,000	
22,000	
23,000	
24,000	
25,000	
26,000	0
27,000	200
28,000	0

RANGE DISTRIBUTION

Range (psi)	n
1,000	0
2,000	1,317
3,000	132,794
4,000	31,287
5,000	9,390
6,000	2,290
7,000	442
8,000	98
9,000	85
10,000	47
11,000	13
12,000	40
13,000	78
14,000	248
15,000	979
16,000	1,417
17,000	494
18,000	117
19,000	408
20,000	206
21,000	94
22,000	12
23,000	0
24,000	
25,000	
26,000	
27,000	
28,000	
29,000	
30,000	
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	277
-1.5	698
-1.2	559
-1.0	869
-.9	490
-.8	654
-.7	333
-.6	197
-.5	92
-.4	58
-.3	49
-.2	63
-.1	98
0	157
.1	250
.2	927
.3	3,212
.4	16,121
.5	52,756
.6	89,706
.7	844
.8	0
.9	0
1.0	13,446

TABLE B-114
SPECTRUM BS6.COMB11 (NO. 114)

DESCRIPTION: SPECTRUM NO. 103 WITH FLIGHT 1.0g STRESSES = 0, AND THEN, STRESSES INCREASED 100 PERCENT.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 161,813	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 66.8
RANGE TRUNCATION (PSI)	= 4,000 (2)			FLIGHT HOUR	= 64.7
HIGHEST PEAK (PSI)	= 23,419			SMALLEST VALLEY (PSI)	= −23,420

PEAK DISTRIBUTION

Peak (psi)	n
-12,000	
-11,000	
-10,000	
-9,000	
-8,000	
-7,000	
-6,000	
-5,000	
-4,000	
-3,000	
-2,000	0
-1,000	7
0	0
1,000	0
2,000	2,821
3,000	55,336
4,000	13,355
5,000	36,097
6,000	32,559
7,000	9,844
8,000	2,075
9,000	7,072
10,000	229
11,000	1,761
12,000	60
13,000	268
14,000	169
15,000	69
16,000	43
17,000	14
18,000	13
19,000	8
20,000	6
21,000	4
22,000	0
23,000	3
24,000	0
25,000	
26,000	
27,000	

RANGE DISTRIBUTION

Range (psi)	n
1,000	
2,000	
3,000	
4,000	
5,000	
6,000	
7,000	0
8,000	59,419
9,000	14,829
10,000	57,670
11,000	2,090
12,000	19,474
13,000	737
14,000	2,778
15,000	2,713
16,000	741
17,000	176
18,000	821
19,000	59
20,000	210
21,000	5
22,000	30
23,000	31
24,000	12
25,000	8
26,000	5
27,000	2
28,000	1
29,000	2
30,000	0
31,000	
32,000	
33,000	
34,000	
35,000	

R DISTRIBUTION

R	n
	59,630
-1.5	5,012
-1.2	20,684
-1.0	742
-.9	52
-.8	5,367
-.7	46,870
-.6	1,582
-.5	15,770
-.4	4,052
-.3	1,407
-.2	43
-.1	595
0	0
.1	
.2	
.3	
.4	
.5	
.6	
.7	
.8	
.9	0
1.0	7

TABLE B-115
SPECTRUM BS6.COMB12 (NO. 115)

DESCRIPTION: SPECTRUM NO. 80 WITH RANGE TRUNCATION = 3,500 PSI.

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 311,357	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 128.6
RANGE TRUNCATION (PSI)	= 3,500			FLIGHT HOUR	= 124.5
HIGHEST PEAK (PSI)	= 23,293			SMALLEST VALLEY (PSI)	= −24,298

PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000	0			-1.5	293
-11,000	47			-1.2	691
-10,000	0	1,000		-1.0	615
-9,000	9	2,000		-.9	863
-8,000	0	3,000	0	-.8	487
-7,000	223	4,000	131,244	-.7	601
-6,000	943	5,000	75,576	-.6	337
-5,000	1,384	6,000	65,166	-.5	191
-4,000	3,098	7,000	24,006	-.4	91
-3,000	7,719	8,000	7,583	-.3	58
-2,000	739	9,000	2,282	-.2	49
-1,000	54	10,000	1,061	-.1	63
0	2	11,000	280	0	88
1,000	0	12,000	103	.1	137
2,000	0	13,000	88	.2	243
3,000	0	14,000	41	.3	815
4,000	0	15,000	22	.4	3,057
5,000	384	16,000	10	.5	15,674
6,000	414	17,000	12	.6	55,350
7,000	157	18,000	39	.7	99,247
8,000	581	19,000	88	.8	118,189
9,000	7,973	20,000	115	.9	0
10,000	20,915	21,000	836	1.0	0
11,000	35,000	22,000	1,036		14,218
12,000	32,143	23,000	940		
13,000	152,990	24,000	463		
14,000	9,844	25,000	106		
15,000	27,931	26,000	336		
16,000	6,678	27,000	20		
17,000	1,566	28,000	153		
18,000	186	29,000	24		
19,000	197	30,000	6		
20,000	63	31,000	1		
21,000	16	32,000	0		
22,000	31	33,000			
23,000	60	34,000			
24,000	10	35,000			
25,000	0				
26,000					
27,000					

TABLE B-116
SPECTRUM BS6.COMB13 (NO. 116)

DESCRIPTION: SPECTRUM NO. 114 WITH 35 PERCENT HIGHER STRESSES

FLIGHT HOURS	= 2,500	FLIGHTS = 2,422		LANDINGS	= 3,843
TOTAL CYCLES	= 161,813	AVERAGE NO. OF CYCLES PER:		FLIGHT	= 66.8
RANGE TRUNCATION (PSI)	= 4,000 (2.7)			FLIGHT HOUR	= 64.7
HIGHEST PEAK (PSI)	= 31,616			SMALLEST VALLEY (PSI)	= −31,617

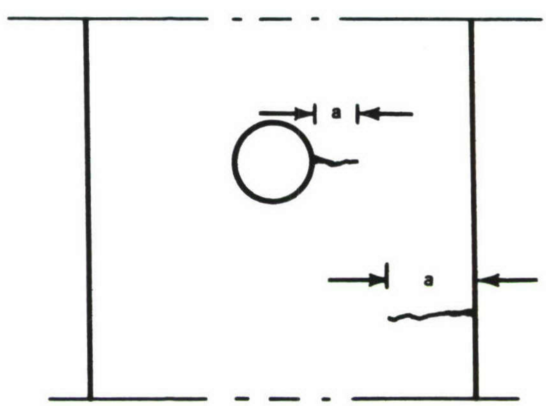
PEAK DISTRIBUTION		RANGE DISTRIBUTION		R DISTRIBUTION	
Peak (psi)	n	Range (psi)	n	R	n
-12,000				-1.5	59,630
-11,000				-1.2	5,012
-10,000		1,000		-1.0	20,684
-9,000		2,000		-.9	742
-8,000		3,000		-.8	52
-7,000		4,000		-.7	5,367
-6,000		5,000		-.6	46,870
-5,000		6,000		-.5	1,582
-4,000		7,000		-.4	15,770
-3,000		8,000		-.3	4,052
-2,000		9,000	0	-.2	1,407
-1,000		10,000	1,184	-.1	43
0		11,000	56,654	0	595
1,000		12,000	3,682	.1	0
2,000	0	13,000	67,618	.2	
3,000	2,821	14,000	2,844	.3	
4,000	31,867	15,000	2,003	.4	
5,000	34,619	16,000	8,649	.5	
6,000	31,017	17,000	11,388	.6	
7,000	7,285	18,000	199	.7	
8,000	32,288	19,000	2,644	.8	
9,000	8,293	20,000	2,787	.9	0
10,000	2,237	21,000	99	1.0	7
11,000	1,620	22,000	700		
12,000	6,950	23,000	170		
13,000	196	24,000	630		
14,000	493	25,000	197		
15,000	1,453	26,000	59		
16,000	66	27,000	207		
17,000	11	28,000	5		
18,000	267	29,000	12		
19,000	161	30,000	21		
20,000	46	31,000	31		
21,000	35	32,000	1		
22,000	33	33,000	11		
23,000	14	34,000	8		
24,000	12	35,000	10		
25,000	1	40,000	0		
26,000	8				
27,000	1				
28,000	12				
32,000	0				

APPENDIX C
EXPERIMENTAL DATA

This appendix contains the experimental data generated in this program. All data pertain to 7475-T7651 aluminum alloy bare plate, t = 0.25 in. The data are summarized in the following tables:

Table	Data
C-1	Chemical Analysis and Tensile Static Strength
C-2, C-3	Constant Amplitude Loading Crack Growth Data
C-4 through C-9	Baseline Spectra Crack Growth Data
C-10 through C-35	Spectra Variation Crack Growth Data
C-36	Sustained Compression Loading Effect Crack Growth Data

In all crack growth data, unless otherwise noted, the crack length 'a' was measured from the edge of the hole, or the edge of the specimen, on one side of the specimen:



Any reference to 'depth' pertains to through-the-thickness crack length. In spectrum loading tests the initial crack length is due to precracking at S_{max} = 12,000 psi, R = 0.02.

The loading frequency in constant amplitude loading tests ranged between 3 and 6 Hz. The spectrum loading tests were run at 4 Hz.

TABLE C-1

7475-T7651 ALUMINUM ALLOY PLATE (t = 0.25 IN., BARE) CHEMICAL ANALYSIS AND TENSILE STATIC STRENGTH TEST RESULTS

CHEMICAL ANALYSIS:

	ANALYSIS	STANDARD
MG	2.0	1.9 – 2.6
CR	0.24	0.18 – 0.25
ZN	5.2	5.2 – 6.2
CU	1.4	1.2 – 1.9
TI	0.01	0.06 MAX
FL	0.12	0.12 MAX
SI	0.10	0.10 MAX
MN	0.01	0.06 MAX

TENSILE STATIC STRENGTH:

SPECIMEN(1)	YIELD (PSI)	ULTIMATE (PSI)	ELONGATION (%)
1A	67,946	76,332	14.3
1B	66,004	75,919	14.0
1C	65,771	75,077	14.1
AVE	66,574	75,776	14.13

(1) W = 0.5 IN., 2.0-IN. GAGE LENGTH

TABLE C-2
CONSTANT AMPLITUDE LOADING da/dN TEST CRACK GROWTH DATA

SPECIMEN	S_{MAX} (PSI)	R	CYCLES	CRACK LENGTH (IN.) AT HOLE(1) A OR B	
				$(a_A)_i$	$(a_B)_i$ (2)
B1 (W = 11.5 IN.)	6,468	0.4	0	0.032 (3)	0.025 (3)
	↓	↓	500,000	0.032	0.025
	6,468	0.4	650,000	0.054	0.025
	8,620	0.6	0	0.054	0.025
			60,000	0.061	0.025
			120,000	0.068	0.025
			180,000	0.075	0.033
			240,000	0.085	0.036
			300,000	0.092	0.037
			360,000	0.100	0.039
	↓	↓	420,000	0.107	0.041
	8,620	0.6	480,000	0.115	0.041
	6,468	0.4	0	0.115	0.041
			60,000	0.128	0.041
			120,000	0.133	0.042
			180,000	0.141	0.046
	↓	↓	240,000	0.151	0.049
	6,468	0.4	320,000	0.165	0.054
	11,905	0.6	0	0.165	0.054
			20,000	0.176	0.057
			60,000	0.195	0.065
	↓	↓	120,000	0.235	0.078
	11,905	0.6	160,000	0.266	0.088
F2 (W = 11.0 IN.)	11,100	0.4	0	0.193 (4)	0.262 (4)
	↓	↓	16,100	0.210	0.279
	11,100	0.4	26,430	0.243	0.342
	11,100	0.8	0	0.243	0.342
			124,000	0.247	0.359
			174,000	0.260	0.370
			274,000	0.269	0.381
			374,000	0.281	0.389
			474,000	0.292	0.409
			574,000	0.301	0.423
	↓	↓	684,000	0.313	0.437
	11,100	0.8	744,000	0.320	0.443

(1) 1/4-IN. DIAMETER
(2) FASTENER IN HOLE: NET FIT (0.0001 → 0.0002 IN. CLEARANCE) TITANIUM HILOK, NO HEAD NOR NUT
(3) DUE TO PRECRACKING AT S_{MAX} = 12,000 PSI, R = 0.02
(4) DUE TO SPECTRUM F LOADING, SEE TABLE 4-1, LARGEST PEAK IN LAST FLIGHT = 16,138 PSI

TABLE C-2 (CONT)
CONSTANT AMPLITUDE LOADING da/dN TEST CRACK GROWTH DATA

SPECIMEN	S_{MAX} (PSI)	R	CYCLES	CRACK LENGTH (IN.) AT HOLE[1] A OR B	
				$(a_A)_i$	$(a_B)_i$[2]
F3 (W = 11.0 IN.)	5,220	−1.5	0	0.216[3]	0.272[3]
	5,220	−1.5	126,500	0.216	0.272
	10,000	−1.5	0	0.216	0.272
	↓	↓	23,500	0.335	0.427
			27,500	0.354	0.461
			31,500	0.381	0.507
	10,000	−1.5	35,200	0.415	0.552
	7,620	−1.5	0	0.415	0.552
	↓	↓	8,300	0.447	0.599
			18,300	0.491	0.664
			29,300	0.538	0.740
	7,620	−1.5	35,300	0.566	0.787
	5,220	−1.5	0	0.566	0.787
	↓	↓	13,000	0.585	0.822
			23,000	0.598	0.849
			33,000	0.613	0.878
			43,000	0.624	0.902
	5,220	−1.5	53,000	0.639	0.927

(1) 1/4-IN. DIAMETER
(2) PASTENER IN HOLE: NET FIT (0.0001 → 0.0002 IN. CLEARANCE) TITANIUM HILOK, NO HEAD NOR NUT
(3) DUE TO SPECTRUM F LOADING, SEE TABLE 4-1, LARGEST PEAK IN LAST FLIGHT = 16,138 PSI

TABLE C-3

CONSTANT AMPLITUDE LOADING CRACK GROWTH DATA FROM PRECRACKING TESTS

SPECIMEN	S_{MAX} (PSI)	R	CYCLES	CRACK LENGTH (IN.) AT HOLE(1) A OR B	
				a_A	a_B
A1 (W = 9.0 IN.)	12,000	0.02	0	0.018(2)	0.014(2)
			20,000	0.018	0.028
			30,000	0.025	0.040
			40,000	0.027	0.057
			60,000	0.031	0.097
			70,000	0.035	0.117
			80,000	0.047	0.140
	12,000	0.02	89,765	0.064	0.164
A2 (W = 9.0 IN.)	12,000	0.02	0	0.014(2)	0.015(2)
			30,000	0.024	0.024
			40,000	0.040	0.057
	12,000	0.02	48,819	0.064	0.065
B1 (W = 11.5 IN.)	12,000	0.02	0	0.018(2)	0.016(2)
			60,000	0.045	0.016
			70,000	0.051	0.030
	12,000	0.02	80,272	0.064	0.061
F1 (W = 11.25 IN.)	10,000	0.02	0	0.006(3)	0.005(3)
			100,000	0.022	0.018
			130,000	0.054	0.043
			161,000	0.082	0.069
			195,000	0.110	0.090
			220,000	0.135	0.106
	10,000	0.02	240,000	0.157	0.126
F2 (W = 11.25 IN.)	10,000	0.02	0	0.006(3)	0.009(3)
			65,000	0.025	0.038
			85,000	0.040	0.053
			107,500	0.051	0.065
			130,000	0.071	0.092
			167,000	0.100	0.130
	10,000	0.02	184,400	0.117	0.156

(1) 3/16-IN. DIAMETER
(2) SAW-CUT NOTCH
(3) EDM NOTCH

TABLE C-3 (CONT)

CONSTANT AMPLITUDE LOADING CRACK GROWTH DATA FROM PRECRACKING TESTS

SPECIMEN	S_{MAX} (PSI)	R	CYCLES	CRACK LENGTH (IN.) AT HOLE [1] A OR B	
				a_A	a_B
F3 (W = 11.25 IN.)	10,000	0.02	0	0.006[2]	0.006[2]
	↓	↓	88,000	0.025	0.024
			107,000	0.045	0.051
			130,000	0.060	0.077
			169,000	0.090	0.117
	10,000	0.02	195,000	0.120	0.156
F4 (W = 11.25 IN.)	10,000	0.02	0	0.006[2]	0.008[2]
	↓	↓	65,000	0.017	0.072
			87,000	0.037	0.100
			104,700	0.056	0.117
			123,000	0.074	0.139
	10,000	0.02	138,300	0.093	0.156
F5 (W = 11.25 IN.)	10,000	0.02	0	–	0.008[2]
	↓	↓	72,000	–	0.030
			105,000	–	0.049
			130,000	–	0.073
			169,000	–	0.107
			184,400	–	0.125
	10,000	0.02	202,300	–	0.156

(1) 3/16-IN. DIAMETER
(2) EDM NOTCH

TABLE C-4

SPECTRUM BS6 TEST CRACK GROWTH DATA SPECIMENS A1 AND A2

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A				CRACK LENGTH (IN.) AT HOLE B(1)			
		$(a_A)_i$		$(a_A)_{OSH}$		$(a_B)_i$		$(a_B)_{OSH}$	
SPECIMEN:		A1	A2	A1	A2	A1	A2	A1	A2
0	0	0.030	0.033			0.132	0.036		
18,247	251	0.038	0.048			0.144	0.043		
36,317	500	0.052	0.068			0.163	0.052		
54,755	753	0.068	0.083			0.184	0.057		
88,355	1,216	0.110	0.122			0.216	0.072		
108,905	1,499	0.141	0.149			0.241	0.081		
127,205	1,750	0.169	0.173			0.264	0.090		
145,280	1,999	0.193	0.200			0.296	0.099		
162,905	2,242	0.222	0.225			0.317	0.107		
181,955	2,504	0.256	0.254			0.348	0.117		
199,825	2,750	0.288	0.287			0.378	0.127		
217,957	2,999	0.320	0.328			0.429	0.142		
236,405	3,253	0.370	0.370			0.455	0.152		
254,265	3,499	0.411	0.411			0.494	0.165		
272,415	3,748	0.461	0.466			0.544	0.181		
295,285	4,063	0.517	0.524			0.601	0.199		
308,855	4,250	0.555	0.566			0.639	0.212		
326,930	4,499	0.609	0.634			0.691	0.230		
345,230	4,750	0.659	0.690			0.741	0.244		
363,605	5,003	0.719	0.762			0.800	0.263		
381,475	5,249	0.798	0.873			0.865	0.282		
399,607	5,499	0.868	0.994			0.943	0.305		
413,055	5,752	0.958	1.142			1.025	0.329		
437,255	6,017(2)	1.063	1.359	0.266(1)	0.734(3)	1.110	0.353	(4)	(4)

(1) FASTENER IN HOLE: NET FIT (0.0001-IN. CLERANCE) TITANIUM HILOK, NO HEAD NOR NUT
(2) NO. OF SPECTRUM REPETITIONS = 2.4
(3) NO MEASUREMENT MADE OF THESE CRACKS UNTIL THE END OF TEST
(4) NO CRACK VISIBLE

TABLE C-5

SPECTRUM BS1 TEST CRACK GROWTH DATA SPECIMEN C1

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.022		0.035	
18,000	982	0.033		0.048	
36,000	1,965	0.051		0.066	
54,000	2,947	0.073		0.087	
72,000	3,930	0.097		0.113	
90,000	4,912	0.123		0.139	
108,000	5,895	0.148		0.165	
126,000	6,877	0.178		0.191	
144,000	7,860	0.207		0.219	
162,000	8,842	0.239		0.250	
180,000	9,824	0.268		0.278	
198,000	10,807	0.302		0.312	
216,000	11,789	0.340		0.350	
234,000	12,772	0.382		0.394	
252,000	13,754	0.430		0.445	
270,000	14,737	0.475		0.489	0.020
288,000	15,719	0.530		0.555	0.104
306,000	16,701	0.576		0.621	0.187
324,000	17,684	0.627	0.043	0.699	0.276
342,000	18,666	0.698	0.144	0.794	0.379
360,000	19,649	0.764	0.225	0.895	0.483
378,000	20,631	0.855	0.325	1.030	0.618
396,000	21,614	0.958	0.431	1.186	0.768
414,000	22,596[(1)]	1.088	0.569	1.387	0.972

(1) NO. OF SPECTRUM REPETITIONS = 9.0

TABLE C-6
SPECTRUM BS2 TEST CRACK GROWTH DATA
SPECIMEN C2

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.024		0.034	
18,000	4,318	0.042		0.051	
36,000	8,636	0.062		0.068	
54,000	12,954	0.085		0.090	
72,000	17,271	0.114		0.103	
90,000	21,589	0.134		0.137	
108,000	25,907	0.163		0.165	
126,000	30,225	0.194		0.194	
144,000	34,543	0.228		0.230	
162,000	38,861	0.261		0.262	
180,000	43,178	0.296		0.296	
198,000	47,496	0.332		0.336	
216,000	51,814	0.372		0.368	
234,000	56,132	0.414		0.408	
252,000	60,450	0.459		0.453	
270,000	64,768	0.504		0.496	
288,000	69,085	0.554		0.544	
306,000	73,403	0.607	0.018	0.596	0.094
324,000	77,721	0.669	0.141	0.656	0.182
342,000	82,039	0.745	0.235	0.734	0.274
360,000	86,357	0.832	0.334	0.822	0.374
378,000	90,675	0.935	0.441	0.928	0.485
396,000	94,992 (1)	1.062	0.569	1.060	0.618

(1) NO. OF SPECTRUM REPETITIONS = 38.0

TABLE C-7

SPECTRUM BS3 TEST CRACK GROWTH DATA
SPECIMENS C3 AND D22

SPECIMEN C3:

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.030		0.033	
18,000	69	0.041		0.045	
36,000	139	0.056		0.061	
54,000	208	0.076		0.082	
72,000	277	0.096		0.106	
90,000	347	0.119		0.130	
108,000	416	0.137		0.153	
126,000	485	0.163		0.184	
144,000	554	0.202		0.220	
162,000	624	0.233		0.265	
180,000	693	0.261		0.281	
198,000(1)	762	0.290		0.317	
216,000	832	0.308		0.335	
234,000	901	0.312		0.340	
252,000	970	0.316		0.346	
270,000	1,040	0.319		0.352	
288,000	1,109	0.329		0.370	
306,000	1,178	0.347		0.400	
324,000	1,247	0.371		0.432	
342,000	1,317	0.403		0.466	
360,000	1,386	0.437		0.503	
378,000	1,455	0.469		0.537	
396,000	1,525	0.515		0.577	
414,000	1,594	0.551		0.627	
432,000	1,663(2)	0.600	(3)	0.687	(3)

(1) PEAK OVERLOAD > 31,000 PSI INADVERTENTLY APPLIED TWICE AFTER 198,000 CYCLES
(2) NO. OF SPECTRUM REPETITIONS = 0.7
(3) NO CRACK VISIBLE

TABLE C-7 (CONT)

SPECTRUM BS3 TEST CRACK GROWTH DATA
SPECIMENS C3 AND D22

SPECIMEN D22:

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.029		0.028	
20,000	77	0.044		0.040	
42,480	164	0.064		0.060	
60,000	231	0.082		0.071	
80,000	308	0.101		0.093	
100,000	385	0.120		0.105	
120,000	462	0.141		0.123	
140,000	539	0.165		0.148	
160,000	616	0.191		0.168	
180,000	693	0.218		0.193	
200,000	770	0.246		0.220	
220,000	847	0.275		0.248	
240,000	924	0.313		0.279	
260,000	1,001	0.347		0.309	
280,000	1,078	0.384		0.344	
300,000	1,155	0.425		0.384	
320,000	1,232	0.469		0.420	
340,000	1,309	0.516		0.462	
360,000	1,386	0.570		0.509	
380,000	1,463	0.632	0.122	0.551	
400,000	1,540	0.718	0.231	0.607	
420,000	1,617	0.813	0.336	0.657	
440,000	1,694	0.925	0.453	0.726	
460,000	1,771	1.067	0.594	0.799	0.005
480,000	1,848	1.235	0.760	0.879	0.144
492,560	1,896	1.377	0.900	0.946	0.225
500,000	1,925	1.472	0.996	0.988	0.273
510,000	1,964(1)	1.614	1.139	1.049	0.336

(1) NO. OF SPECTRUM REPETITIONS = 0.8

TABLE C-8

SPECTRUM BS4 TEST CRACK GROWTH DATA
SPECIMEN C4

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.030		0.031	
18,000	226	0.044		0.045	
36,000	452	0.057		0.057	
54,000	678	0.072		0.072	
72,000	904	0.090		0.095	
90,000	1,130	0.110		0.112	
108,000	1,356	0.128		0.128	
126,000	1,583	0.154		0.152	
144,000	1,809	0.178		0.175	
162,000	2,035	0.203		0.205	
180,000	2,261	0.229		0.231	
198,000	2,487	0.256		0.256	
216,000	2,713	0.294		0.293	
234,000	2,939	0.330		0.324	
252,000	3,165	0.365	0.071	0.358	
270,000	3,391	0.411	0.130	0.397	0.043
288,000	3,617	0.455	0.177	0.436	0.089
306,000	3,843	0.496	0.224	0.472	0.131
324,000	4,069	0.554	0.283	0.524	0.180
342,000	4,296	0.610	0.347	0.573	0.237
360,000	4,522	0.690	0.427	0.644	0.309
378,000	4,748	0.764	0.503	0.713	0.381
396,000	4,974	0.863	0.603	0.800	0.470
414,000	5,200	0.981	0.729	0.909	0.568
432,000	5,426[1]	1.128	0.780	1.030	0.666

(1) NO. OF SPECTRUM REPETITIONS = 2.2

TABLE C-9

SPECTRUM BS5 TEST CRACK GROWTH DATA
SPECIMEN C6

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.032		0.0(1)	
18,900	240	0.043		(2)	
36,880	468	0.049		(2)	
54,880	696	0.061		0.026	
72,880	924	0.071		0.042	
90,880	1,152	0.086		0.061	
108,800	1,380	0.095		0.069	
126,800	1,608	0.107		0.080	
144,910	1,837	0.114		0.093	
162,910	2,066	0.125		0.102	
180,920	2,294	0.135		0.116	
198,920	2,522	0.145		0.131	
216,900	2,750	0.157		0.145	
234,910	2,979	0.170		0.158	
252,900	3,207	0.197		0.189	
302,789	3,839	0.222		0.215	
334,090	4,236	0.249		0.241	
370,150	4,694	0.279		0.272	
406,150	5,150	0.319		0.313	
442,430	5,610	0.351		0.347	
460,150	5,835	0.375		0.371	
496,150	6,291	0.420		0.416	
532,150	6,748	0.463		0.457	
568,150	7,204	0.517		0.508	
610,000	7,735	0.589		0.570	
640,170	8,117	0.637		0.624	
676,150	8,574	0.710		0.691	
712,160	9,030	0.795		0.778	
748,150	9,487	0.893		0.875	
784,150	9,943	1.018		0.998	
802,150	10,171(3)	1.086	(4)	1.063	(4)

(1) FROM FRACTURE SURFACE MEASUREMENT a_o = 0.0075 ON OTHER SIDE OF SPECIMEN
(2) NO MEASUREMENT MADE
(3) NO. OF SPECTRUM REPETITIONS = 4.1
(4) NO CRACK VISIBLE. HOWEVER, FROM FRACTURE SURFACE MEASUREMENT, $(a_A)_{OSH}$ = 0.115 ON OTHER SIDE OF SPECIMEN (0.21 DEPTH)

TABLE C-10

SPECTRUM BS4.MM8 TEST CRACK GROWTH DATA SPECIMEN C7

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.022		0.030	
18,000	181	0.038		0.043	
36,000	363	0.050		0.054	
55,800	562	0.069		0.072	
72,000	725	0.080		0.081	
90,000	906	0.096		0.098	
108,000	1,088	0.111		0.113	
126,000	1,269	0.129		0.131	
144,280	1,453	0.146		0.150	
162,000	1,631	0.163		0.168	
180,000	1,813	0.187		0.195	
198,000	1,994	0.212		0.221	
216,000	2,175	0.237		0.247	
234,000	2,356	0.261		0.272	
252,000	2,538	0.286		0.297	
270,000	2,719	0.310		0.323	
288,000	2,900	0.338		0.348	
306,000	3,081	0.368		0.380	
324,000	3,263	0.389		0.401	
342,000	3,444	0.425		0.439	
360,000	3,625	0.449	0.057	0.466	0.024
378,000	3,806	0.492	0.094	0.503	0.107
396,000	3,988	0.542	0.145	0.570	0.175
414,000	4,169	0.590	0.188	0.625	0.234
432,240	4,353	0.670	0.262	0.723	0.337
450,000	4,532	0.754	0.350	0.820	0.437
468,000	4,713	0.838	0.432	0.918	0.536
486,000	4,894	0.946	0.543	1.050	0.665
504,000	5,075(1)	1.054	0.654	1.181	0.798

(1) NO. OF SPECTRUM REPETITIONS = 2.0

TABLE C-11

SPECTRUM BS6.MM13 TEST CRACK GROWTH DATA
SPECIMEN D12

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.035		0.0 (1)	
24,000	1,156	0.053			
48,000	2,312	0.075			
72,000	3,468	0.102			
102,400	4,933	0.137			
120,000	5,780	0.161			
144,000	6,936	0.195			
168,100	8,097	0.228			
192,000	9,249	0.267			
216,000	10,405	0.305			
240,000	11,561	0.346			
288,000	13,873	0.442			
312,000	15,029	0.498	0.035		
336,000	16,185	0.559	0.073		
360,000	17,341	0.641	0.173		
384,000	18,497	0.737	0.272		
408,000	19,653	0.859	0.393		
432,000	20,809	1.004	0.534		
440,000	21,195 (2)	1.058	0.587	(1) (3)	(1)

(1) NO CRACK VISIBLE
(2) NO. OF SPECTRUM REPETITIONS = 8.5
(3) FROM FRACTURE SURFACE MEASUREMENT a = 0.07 (0.205 DEPTH) ON OTHER SIDE OF SPECIMEN

TABLE C-12

SPECTRUM BS1B.FL3 TEST CRACK GROWTH DATA
SPECIMEN D1

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.015(1)		0.029	
16,000	2,192	0.021		0.044	
32,000	4,385	0.034		0.065	
48,000	6,577	0.045		0.091	
64,000	8,769	0.061		0.118	
80,000	10,962	0.082		0.147	
96,000	13,154	0.104		0.177	
112,000	15,346	0.124		0.217	
128,000	17,539	0.147		0.249	
144,000	19,731	0.172		0.287	
160,000	21,923	0.197		0.327	
176,000	24,116	0.224		0.373	
192,000	26,308	0.254		0.423	
208,000	28,500	0.294		0.477	
224,000	30,692	0.334		0.541	
240,000	32,885	0.379		0.625	0.154
256,000	35,077	0.431	0.042	0.728	0.285
272,000	37,269	0.487	0.059	0.852	0.418
288,000	39,462	0.551	0.100	1.018	0.584
304,000	41,654	0.637	0.168	1.243	0.817
320,000	43,846	0.745	0.305	1.622	1.186
324,000	44,394(2)	0.773	0.342	1.738	1.293

(1) FROM FRACTURE SURFACE MEASUREMENT, ALSO, a_o = 0 ON OTHER SIDE OF SPECIMEN
(2) NO. OF SPECTRUM REPETITIONS = 17.8

TABLE C-13

SPECTRUM BS6.ES4 TEST CRACK GROWTH DATA SPECIMEN D7

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.016(1)		0.029	
18,000	383	0.020		0.043	
36,000	766	0.029		0.057	
54,000	1,149	0.042		0.071	
72,000	1,531	0.059		0.090	
90,400	1,923	0.075		0.109	
108,000	2,297	0.091		0.123	
127,200	2,701	0.108		0.147	
144,000	3,063	0.128		0.167	
162,000	3,446	0.137		0.186	
180,000	3,829	0.161		0.209	
198,000	4,211	0.182		0.230	
216,000	4,594	0.204		0.256	
234,000	4,977	0.227		0.284	
252,000	5,360	0.255		0.312	
270,000	5,743	0.277		0.343	
288,000	6,126	0.301		0.369	
306,000	6,509	0.332		0.408	
324,000	6,891	0.359		0.443	
342,000	7,274	0.387		0.478	
360,000	7,657	0.416		0.518	0.016
378,000	8,040	0.447		0.558	0.023
393,733(2)	8,375(3)	0.475	(4)	0.600	0.072

(1) FROM FRACTURE SURFACE MEASUREMENT, ALSO, a_o = 0 ON OTHER SIDE OF SPECIMEN
(2) TEST TERMINATED BECAUSE OF FRETTING-INITIATED FAILURE IN THE GRIP END
(3) NO. OF SPECTRUM REPETITIONS = 3.3
(4) NO CRACK VISIBLE

TABLE C-14

SPECTRUM BS6.DSL1 TEST CRACK GROWTH DATA
SPECIMEN D6

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.023		0.030	
16,000	220	0.037		0.043	
32,000	440	0.057		0.057	
48,000	660	0.077		0.072	
64,000	881	0.101		0.089	
80,000	1,101	0.125		0.109	
96,000	1,321	0.153		0.131	
112,000	1,541	0.195		0.155	
128,000	1,761	0.212		0.177	
144,000	1,981	0.246		0.199	
160,000	2,202	0.280		0.229	
176,000	2,422	0.318		0.260	
192,000	2,642	0.353		0.288	
208,000	2,862	0.400		0.326	
224,000	3,082	0.450		0.368	0.044
240,000	3,302	0.502	0.019	0.419	0.084
256,000	3,523	0.570	0.036	0.482	0.140
272,000	3,743	0.655	0.081	0.556	0.218
288,000	3,963	0.757	0.218	0.649	0.311
304,000	4,183	0.891	0.363	0.767	0.435
320,000	4,403	1.068	0.529	0.924	0.598
330,000	4,541[1]	1.216	0.683	1.054	0.733

(1) NO. OF SPECTRUM REPETITIONS = 1.8

TABLE C-15

SPECTRUM BS6.DSL3 TEST CRACK GROWTH DATA SPECIMEN D17

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.007 (1)		0.026	
24,000	330	0.008		0.032	
49,280	678	0.010		0.035	
72,000	991	0.014		0.042	
96,000	1,321	0.019		0.045	
120,000	1,651	0.020		0.050	
144,000	1,981	0.022		0.057	
168,000	2,312	0.026		0.062	
192,000	2,642	0.031		0.071	
216,000	2,972	0.036		0.079	
264,000	3,633	0.043		0.095	
312,000	4,293	0.052		0.112	
360,000	4,954	0.066		0.130	
408,000	5,614	0.080		0.151	
456,000	6,275	0.090		0.167	
504,320	6,939	0.113		0.190	
552,000	7,596	0.133		0.212	
600,000	8,256	0.153		0.238	
648,000	8,916	0.175		0.265	
696,000	9,577	0.200		0.297	
744,000	10,237	0.222		0.325	
792,000	10,898	0.249		0.359	
840,000	11,558	0.280		0.396	
888,000	12,219	0.312		0.437	
936,000	12,879	0.344		0.480	
984,000	13,540	0.381		0.527	
1,032,000	14,200	0.421		0.580	
1,057,920	14,557	0.442		0.612	
1,104,000	15,191	0.481		0.665	
1,152,000	15,852 (2)	0.531	(3)	0.726	(3)

(1) FROM FRACTURE SURFACE MEASUREMENT a_o = 0.018 AT THE OTHER SIDE OF SPECIMEN
(2) NO. OF SPECTRUM REPETITIONS = 6.3
(3) NO CRACK VISIBLE

TABLE C-16

SPECTRUM BS6.DSL4 TEST CRACK GROWTH DATA SPECIMEN D3

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.017		0.027	
8,000	110	0.027		0.041	
16,000	220	0.039		0.044	
24,000	330	0.058		0.056	
32,000	440	0.079		0.072	
40,000	550	0.103		0.095	
48,000	660	0.127		0.118	
56,000	771	0.154		0.142	
64,000	881	0.178		0.167	
72,000	991	0.208		0.192	
80,000	1,101	0.241		0.221	
88,300	1,215	0.276		0.255	
96,000	1,321	0.313		0.293	
104,000	1,431	0.357		0.339	
112,000	1,541	0.407	0.046	0.381	
120,000	1,651	0.458	0.085	0.427	
128,000	1,761	0.512	0.132	0.475	
136,000	1,871	0.586	0.178	0.540	0.101
144,000	1,981	0.684	0.303	0.624	0.196
152,000	2,092	0.788	0.421	0.721	0.298
160,000	2,202	0.929	0.558	0.842	0.421
168,000	2,312	1.072	0.698	0.962	0.543
176,000	2,422(1)	1.362	0.975	1.189	0.772

(1) NO. OF SPECTRUM REPETITIONS = 1.0

TABLE C-17
SPECTRUM BS3-VPC1 TEST CRACK GROWTH DATA
SPECIMEN D4

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.015		0.026	
16,000	103	0.033		0.042	
32,000	206	0.058		0.062	
48,000	309	0.091		0.088	
64,000	412	0.120		0.108	
80,000	514	0.155		0.134	
96,000	617	0.197		0.162	
112,000	720	0.239		0.196	
128,000	823	0.288		0.235	
144,000	926	0.340		0.274	
160,000	1,029	0.400		0.322	
176,000	1,132	0.462		0.369	
192,000	1,235	0.535		0.426	
208,000	1,337	0.621		0.498	
224,000	1,440	0.730	0.035	0.579	
240,000	1,543	0.844	0.122	0.662	
256,000	1,646	1.007	0.300	0.768	0.015
272,000	1,749	1.256	0.552	0.921	0.263
282,210	1,815(1)	1.457	0.749	1.036	0.393

(1) NO. OF SPECTRUM REPETITIONS = 0.7

TABLE C-18

SPECTRUM BS3.LLT1 TEST CRACK GROWTH DATA SPECIMEN D8

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.0(1)		0.029	
18,000	97	0.029		0.040	
36,000	193	0.042		0.057	
54,000	290	0.061		0.076	
72,000	387	0.080		0.098	
92,400	496	0.100		0.123	
108,000	580	0.123		0.147	
127,200	683	0.151		0.176	
144,000	773	0.178		0.208	
162,000	870	0.207		0.240	
180,000	967	0.237		0.272	
198,000	1,063	0.272		0.310	
216,000	1,160	0.309		0.348	
234,000	1,257	0.349		0.390	
252,000	1,353	0.393		0.438	
270,000	1,450	0.437		0.488	
288,000	1,547	0.489		0.546	
306,000	1,643	0.549		0.601	
324,000	1,740	0.625	0.142	0.668	
342,000	1,837	0.709	0.250	0.737	
360,000	1,933	0.813	0.367	0.812	0.028
378,000	2,030	0.952	0.512	0.909	0.063
388,640(2)	2,087(3)	1.050	0.615	0.984	0.105(4)

(1) FROM FRACTURE SURFACE MEASUREMENT, a_o = 0.015 AND 0.03 ON THE OTHER SIDE OF SPECIMEN AND THROUGH MOST OF THE THICKNESS
(2) TEST TERMINATED BECAUSE OF FRETTING-INITIATED FAILURE IN THE GRIP END
(3) NO. OF SPECTRUM REPETITIONS = 0.8
(4) FROM FRACTURE SURFACE MEASUREMENT, DEPTH = 0.20

TABLE C-19

SPECTRUM BS3.LLT2 TEST CRACK GROWTH DATA SPECIMEN E1

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.042(1)		(2)	
20,000	43	0.054			
42,480	91	0.065			
60,000	128	0.078			
80,000	171	0.096			
100,000	214	0.114			
120,000	257	0.134			
140,000	300	0.158			
160,000	342	0.180			
180,000	385	0.205			
200,000	428	0.233			
220,000	471	0.259			
240,000	514	0.293			
260,000	556	0.323			
280,000	599	0.361			
300,000	642	0.399			
320,000	685	0.439			
340,000	728	0.470			
360,000	770	0.526			
380,000	813	0.578			
400,000	856	0.632			
420,000	899	0.694		0.067	
440,000	942	0.758		0.102	
460,000	984	0.825		0.132	
480,000	1,027	0.902		0.158	
500,000	1,070	0.991	0.082	0.189	
520,000	1,113	1.109	0.239	0.215	
540,000	1,156(3)	1.266	0.410	0.247	(2)

(1) FROM FRACTURE SURFACE MEASUREMENT a_o = 0.08 ON THE OTHER SIDE OF SPECIMEN

(2) NO CRACK VISIBLE

(3) NO. OF SPECTRUM REPETITIONS = 0.5

TABLE C-20

SPECTRUM BS6.LLT2 TEST CRACK GROWTH DATA SPECIMEN D13

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.013		0.034	
24,000	193	(1)		0.045	
48,000	385	(1)		0.055	
72,000	578	0.033		0.066	
102,400	822	0.045		0.076	
120,000	964	0.054		0 093	
144,000	1,156	0.080		0.106	
168,100	1,350	0.083		0.122	
192,000	1,542	0.099		0.147	
216,000	1,734	0.110		0.154	
240,000	1,927	0.129		0.172	
288,000	2,313	0.166		0.209	
312,000	2,505	0.187		0.231	
336,000	2,698	0.207		0.254	
360,000	2,891	0.234		0.280	
384,000	3,084	0.255		0.305	
408,000	3,276	0.279		0.330	
432,000	3,469	0.306		0.356	
456,000	3,662	0.337		0.388	
480,000	3,854	0.369		0.423	
504,000	4,047	0.400		0.460	
528,000	4,240	0.437		0.497	
554,000	4,449	0.479		0.541	
578,000	4,641	0.520		0.582	
586,000	4,706 (2)	0.533	(3)	0.598	(3)

(1) NO MEASUREMENT MADE
(2) NO. OF SPECTRUM REPETITIONS = 1.9
(3) NO CRACK VISIBLE

TABLE C-21

SPECTRUM BS6.LLT5 TEST CRACK GROWTH DATA SPECIMEN D14

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.020(1)		0.031	
24,000	224	0.031		0.044	
48,000	448	0.049		0.058	
72,000	672	0.072		0.076	
102,400	955	0.101		0.096	
120,000	1,120	0.123		0.119	
144,000	1,344	0.149		0.144	
168,000	1,567	0.175		0.168	
192,000	1,791	0.207		0.194	
216,000	2,015	0.240		0.221	
240,000	2,239	0.271		0.249	
288,000	2,687	0.348		0.318	
312,000	2,911	0.390		0.358	
336,000	3,135	0.428		0.407	
360,000	3,359	0.492		0.452	
384,000	3,583	0.548		0.504	
408,000	3,807	0.616	0.100	0.569	0.034
432,000	4,031	0.703	0.167	0.649	0.114
456,000	4,254	0.788	0.247	0.730	0.174
480,000	4,478	0.905	0.348	0.832	0.301
504,000	4,702	1.045	0.484	0.963	0.429
512,000	4,777	1.110	0.546	1.017	0.482
516,000	4,814(2)	1.133	0.570	1.034	0.507

(1) FROM FRACTURE SURFACE MEASUREMENT, ALSO $a_o = 0.30 \rightarrow 0.40$ THROUGH THE REST OF SPECIMEN THICKNESS

(2) NO. OF SPECTRUM REPETITIONS = 1.9

TABLE C-22

SPECTRUM BS6.LLT6 TEST CRACK GROWTH DATA SPECIMEN D5

CYCLES	FLIGHT HOURS	CRACK LENTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.026		0.039	
16,000	340	0.039		0.055	
32,000	681	0.056		0.071	
48,000	1,021	0.078		0.093	
64,000	1,362	0.102		0.117	
80,000	1,702	0.126		0.141	
96,000	2,043	0.152		0.162	
112,000	2,383	0.181		0.197	
128,000	2,724	0.214		0.224	
144,000	3,064	0.241		0.257	
160,000	3,405	0.278		0.290	
176,000	3,745	0.312		0.327	
192,000	4,086	0.358		0.370	
208,000	4,426	0.397		0.413	
224,000	4,767	0.442	0.038	0.458	
240,000	5,107	0.496	0.090	0.509	
256,000	5,448	0.557	0.147	0.564	
272,000	5,788	0.624	0.206	0.619	
288,000	6,129	0.705	0.285	0.681	0.036
304,000	6,469	0.821	0.398	0.765	0.098
320,000	6,810	0.968	0.542	0.866	0.198
336,000	7,150	1.128	0.705	0.973	0.310
344,000	7,320(1)	0.230	0.805	1.037	0.372

(1) NO. OF SPECTRUM REPETITIONS = 2.9

TABLE C-23
SPECTRUM BS6.HIL1 TEST GROWTH DATA
SPECIMEN C8

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_B)_i$	$(a_B)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.030		0.031	
18,000	248	0.043		0.041	
36,000	495	0.055		0.052	
55,800	768	0.068		0.062	
72,000	991	0.082		0.072	
90,000	1,138	0.097		0.086	
108,000	1,486	0.113		0.100	
126,000	1,734	0.127		0.114	
144,280	1,985	0.142		0.130	
162,000	2,229	0.160		0.146	
180,000	2,477	0.180		0.164	
198,000	2,724	0.194		0.178	
216,000	2,972	0.211		0.198	
234,000	3,220	0.237		0.218	
252,000	3,468	0.243		0.238	
270,000	3,715	0.264		0.262	
288,000	3,963	0.281		0.282	
306,000	4,211	0.303		0.305	
324,000	4,458	0.323		0.333	
342,000	4,706	0.346		0.363	
360,000	4,954	0.369		0.395	
378,000	5,201	0.392		0.427	
396,000	5,449	0.440		0.467	
414,000	5,697	0.479		0.504	
432,240	5,948	0.523	0.016	0.547	
450,000	6,192	0.572	0.022	0.599	
468,000	6,440	0.619	0.033	0.648	
486,000	6,687	0.675	0.040/0.053[1]	0.700	
504,000	6,935	0.747	0.040/0.123	0.770	0.111
522,000	7,183	0.806	0.040/0.183	0.841	0.199
540,000	7,430	0.904	0.040/0.271	0.943	0.320
558,000	7,678	1.006	0.040/0.375	1.052	0.436
576,000	7,926[2]	1.135	0.040/0.504	1.192	0.578

(1) SECOND CRACK, FIRST CRACK STOPPED AT 0.04
(2) NO. OF SPECTRUM REPETITIONS = 3.2

TABLE C-24

SPECTRUM BS6.HIL2 TEST CRACK GROWTH DATA
SPECIMEN D18

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.025		0.030	
24,000	330	0.040		0.042	
49,280	678	0.055		0.056	
72,000	990	0.076		0.069	
96,000	1,320	0.095		0.086	
120,000	1,650	0.113		0.106	
144,000	1,980	0.135		0.129	
168,000	2,310	0.157		0.146	
192,000	2,640	0.181		0.164	
216,000	2,970	0.205		0.188	
264,000	3,630	0.260		0.239	
312,000	4,290	0.319		0.291	
352,000	4,840	0.375		0.345	
384,000	5,280	0.425		0.392	
408,000	5,610	0.466		0.431	0.028
432,000	5,940	0.512		0.470	0.040
456,000	6,270	0.565		0.520	0.063
480,000	6,600	0.626	0.025	0.575	0.096
504,320	6,934	0.681	0.074	0.639	0.136
520,000	7,150	0.728	0.111	0.678	0.161
536,000	7,370	0.776	0.158	0.725	0.191
552,000	7,590	0.839	0.215	0.783	(2)
568,000	7,810	0.899	0.281	0.841	0.317
584,000	8,030	0.988	0.360	0.915	0.397
600,000	8,250	1.062	0.440	0.992	0.476
608,000	8,360(1)	1.105	0.486	1.034	0.522

(1) NO. OF SPECTRUM REPETITIONS = 3.3

(2) NO MEASUREMENT MADE

TABLE C-25

SPECTRUM BS6.HIL3 TEST CRACK GROWTH DATA
SPECIMEN D15

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.030		0.022	
24,000	330	0.050		0.039	
48,000	660	0.072		0.061	
72,000	991	0.088		0.076	
102,400	1,409	0.107		0.092	
120,000	1,651	0.117		0.100	
144,000	1,981	0.141		0.122	
168,000	2,312	0.147		0.122	
192,000	2,642	0.159		0.131	
216,000	2,972	0.177		0.149	
240,000	3,302	0.215		0.184	
288,000	3,962	0.246		0.207	
312,000	4,293	0.269		0.227	
336,000	4,623	0.298		0.247	
360,000	4,954	0.307		0.258	
384,000	5,284	0.319		0.262	
408,000	5,614	0.376		0.305	0.020
432,000	5,944	0.427		0.360	0.084
456,000	6,275	0.453		0.383	0.112
480,000	6,605	0.501		0.437	0.174
504,000	6,935	0.573		0.521	0.261
516,000	7,100(1)	0.624	0.066	0.580	0.321

(1) NO. OF SPECTRUM REPETITIONS = 2.8

TABLE C-26

SPECTRUM BS6.HIL4 TEST CRACK GROWTH DATA
SPECIMEN D9

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.020		0.031(1)	
18,000	230	0.030		0.043	
36,000	459	0.042		0.056	
54,000	689	0.055		0.073	
72,000	919	0.070		0.080	
90,400	1,154	0.087		0.094	
108,000	1,378	0.105		0.108	
127,200	1,623	0.129		0.126	
144,000	1,837	0.146		0.144	
162,000	2,067	0.162		0.156	
180,000	2,297	0.185		0.178	
198,000	2,526	0.208		0.197	
216,000	2,756	0.237		0.223	
234,000	2,986	0.265		0.251	
252,000	3,216	0.288		0.278	
270,000	3,445	0.314		0.293	
288,000	3,675	0.348		0.325	
306,000	3,905	0.385		0.358	
324,000	4,134	0.420		0.389	
342,000	4,364	0.438		0.407	
360,000	4,594	0.476		0.441	
378,000	4,823	0.509		0.467	
397,600	5,073	0.563		0.518	0.013
414,000	5,283	0.608	0.035	0.562	0.077
433,200	5,528	0.651	0.064	0.605	0.136
450,000(2)	5,742	0.693	0.098	0.644	0.191
468,000	5,972	0.791	0.213	0.730	0.291
486,000	6,201	0.912	0.344	0.847	0.422
504,400	6,436	1.056	0.488	0.981	0.560
514,000	6,559(3)	1.110	0.538	1.029	0.608

(1) FROM FRACTURE SURFACE MEASUREMENT, a_o = 0 AT OTHER SIDE OF SPECIMEN
(2) FREQUENCY CHANGED FROM 4.0 TO 4.5 Hz
(3) NO. OF SPECTRUM REPETITIONS = 2.6

TABLE C-27

SPECTRUM BS6.HIL5 TEST CRACK GROWTH DATA
SPECIMEN D19

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.025		0.027	
24,000	330	0.037		0.038	
49,280	678	0.045		0.049	
72,000	990	0.050		0.055	
96,000	1,320	0.059		0.062	
120,000	1,650	0.065		0.072	
144,000	1,980	0.073		0.081	
168,000	2,310	0.079		0.088	
192,000	2,640	0.089		0.097	
216,000	2,970	0.096		0.106	
264,000	3,630	0.125		0.125	
312,000	4,290	0.134		0.147	
360,000	4,950	0.160		0.173	
408,000	5,610	0.186		0.197	0.032
456,000	6,270	0.222	0.051	0.234	0.063
480,000	6,600	0.250	0.072	0.259	0.083
504,320	6,934	0.272	0.090	0.279	0.102
552,000	7,590	0.315	0.131	0.322	0.146
600,000	8,250	0.366	0.175	0.368	0.189
624,000	8,580	0.393	0.199	0.397	0.218
648,000	8,910	0.427	0.249	0.428	0.252
672,000	9,240	0.462	0.284	0.461	0.283
696,000	9,570	0.498	0.323	0.495	0.320
720,000	9,900	0.530	0.354	0.524	0.348
744,000	10,230	0.569	0.383	0.554	0.380
768,000	10,560	0.594	0.413	0.587	0.417
792,000	10,890	0.627	0.453	0.622	0.450
816,000	11,220	0.672	0.491	0.671	0.493
840,000	11,550	0.722	0.541	0.722	0.545
864,000	11,880	0.764	0.584	0.766	0.589
888,000	12,210	0.804	0.632	0.806	0.630
912,000	12,540	0.846	0.678	0.849	0.679
936,000	12,870	0.871	0.701	0.875	0.698
960,000	13,200	0.911	0.738	0.914	0.737
984,000	13,530	0.952	0.771	0.944	0.778
1,008,000	13,860	1.012	0.826	1.004	0.818
1,032,000	14,190	1.081	0.900	1.073	0.904
1,057,920	14,546(1)	1.173	0.974	1.148	0.977

(1) NO. OF SPECTRUM REPETITIONS = 5.8

TABLE C-28

SPECTRUM BS6.CLP3 TEST CRACK GROWTH DATA
SPECIMEN C9

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.016(1)		0.030	
18,000	267	0.020		0.042	
36,000	535	0.027		0.050	
55,800	829	0.040		0.059	
72,000	1,070	0.050		0.069	
90,000	1,337	0.068		0.086	
108,000	1,605	0.082		0.104	
126,000	1,872	0.096		0.119	
144,280	2,144	0.113		0.134	
162,000	2,407	0.129		0.151	
180,000	2,675	0.145		0.170	
198,000	2,942	0.166		0.193	
216,000	3,210	0.183		0.212	
234,000	3,477	0.202		0.235	
252,000	3,745	0.228		0.263	
270,000	4,012	0.257		0.292	
288,000	4,280	0.283		0.322	
306,000	4,547	0.312		0.352	
324,000	4,815	0.340		0.382	
342,000	5,082	0.374		0.422	
360,000	5,350	0.412		0.459	
378,000	5,617	0.451		0.496	
396,000	5,885	0.491		0.538	
414,000	6,152	0.534		0.584	
432,240	6,423	0.587		0.641	
450,000	6,687	0.647		0.703	
468,000	6,954	0.702		0.758	
486,000	7,222	0.769		0.825	
504,000	7,489	0.847		0.905	
522,000	7,757	0.918		0.976	
540,000	8,024	1.004		1.057	
558,000	8,292(2)	1.107	0.160	1.146	(3)

(1) FROM FRACTURE SURFACE MEASUREMENT, ALSO, a_o = 0 ON OTHER SIDE OF SPECIMEN
(2) NO. OF SPECTRUM REPETITIONS = 3.3
(3) NO CRACK VISIBLE

TABLE C-29

SPECTRUM BS1.MISC9 TEST CRACK GROWTH DATA
SPECIMEN C10

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.026		0.030	
18,000	794	0.049		0.053	
36,000	1,587	0.071		0.075	
55,800	2,460	0.097		0.104	
72,000	3,174	0.122		0.131	
90,000	3,968	0.149		0.162	
108,000	4,762	0.183		0.195	
126,000	5,555	0.220		0.233	
144,280	6,361	0.256		0.272	
162,000	7,143	0.297		0.313	
180,000	7,936	0.344		0.363	
198,000	8,730	0.394		0.416	
216,000	9,523	0.444		0.476	0.068
234,000	10,317	0.506		0.555	0.167
252,000	11,111	0.573		0.651	0.274
270,000	11,904	0.654	0.075	0.772	0.398
288,000	12,698	0.756	0.174	0.930	0.560
306,000	13,492	0.880	0.314	1.136	0.767
324,000	14,285(1)	1.035	0.476	1.405	1.036

(1) NO. OF SPECTRUM REPETITIONS = 5.7

TABLE C-30

SPECTRUM BS6.MISC2 TEST CRACK GROWTH DATA SPECIMEN D16

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.005(1)		0.031	
24,000	160	0.014		0.043	
48,000	319	0.031		0.057	
72,000	479	0.048		0.071	
102,400	681	0.071		0.092	
120,000	798	0.082		0.102	
144,000	958	0.097		0.114	
168,000	1,117	0.120		0.135	
192,000	1,277	0.141		0.160	
216,000	1,436	0.162		0.179	
240,000	1,596	0.190		0.198	
288,000	1,915	0.237		0.244	
312,000	2,075	0.270		0.283	
336,000	2,234	0.305		0.318	
360,000	2,394	0.340		0.349	
384,000	2,554	0.377		0.387	
408,000	2,713	0.414		0.420	
432,000	2,873	0.456		0.473	
456,000	3,032	0.503		0.520	
480,000	3,192	0.554		0.574	
504,000	3,352	0.592	0.013	0.629	
512,000	3,405(2)	0.630	0.025	0.649	(3)

(1) FROM FRACTURE SURFACE MEASUREMENT, ALSO a ≈ 0.02 → 0.025 THROUGH MOST OF THE SPECIMEN THICKNESS
(2) NO. OF SPECTRUM REPETITIONS = 1.4
(3) NO CRACK VISIBLE

TABLE C-31

SPECTRUM BS6.MISC6 TEST CRACK GROWTH DATA SPECIMEN D10

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.029		0.030	
18,000	255	0.044		0.044	
36,000	509	0.062		0.059	
54,000	764	0.082		0.079	
72,000	1,018	0.106		0.099	
90,400	1,278	0.128		0.122	
108,000	1,527	0.153		0.145	
127,200	1,799	0.180		0.173	
144,000	2,036	0.207		0.199	
162,000	2,291	0.236		0.224	
180,000	2,545	0.266		0.256	
198,000	2,800	0.299		0.287	
216,000	3,054	0.332		0.319	
234,000	3,309	0.370		0.355	
252,000	3,563	0.410		0.391	
270,000	3,818	0.453		0.435	
288,000	4,072	0.497		0.477	
306,000	4,327	0.546		0.522	
324,000	4,581	0.598		0.570	
342,000	4,836	0.648		0.623	
360,000	5,090	0.705		0.676	0.007
378,000	5,345	0.767	0.022	0.736	0.057
397,600	5,622	0.852	0.152	0.817	0.166
414,000	5,854	0.939	0.256	0.900	0.262
433,200	6,125	1.052	0.387	1.016	0.389
440,000	6,222[1]	1.105	0.441	1.066	0.442

(1) NO. OF SPECTRUM REPETITIONS = 2.5

TABLE C-32

SPECTRUM BS6.COMB3 TEST CRACK GROWTH DATA SPECIMEN D11

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.010[1]		0.035	
18,000	145	0.015		0.053	
36,000	289	0.026		0.073	
54,000	434	0.040		0.093	
72,000	578	0.055		0.114	
90,400	726	0.068		0.139	
108,000	867	0.086		0.166	
127,200	1,021	0.105		0.194	
144,000	1,156	0.124		0.228	
162,000	1,301	0.144		0.263	
180,000	1,445	0.166		0.296	
198,000	1,590	0.187		0.334	
216,000	1,734	0.213		0.378	
234,000	1,879	0.238		0.421	
252,000	2,024	0.269		0.472	
270,000	2,168	0.295		0.530	0.074
288,000	2,313	0.332		0.600	0.165
306,000	2,457	0.369		0.692	0.264
324,000	2,602	0.410		0.795	0.372
342,000	2,746	0.453	0.037	0.922	0.505
360,000	2,891	0.496	0.086	1.071	0.660
378,000	3,035	0.542	0.130	1.236	0.827
394,327	3,166[2]	0.587	0.172	1.404	1.007

(1) FROM FRACTURE SURFACE MEASUREMENT, a_o = 0 MIDPOINT THROUGH THICKNESS AND ON THE OTHER SIDE OF SPECIMEN
(2) NO. OF SPECTRUM REPETITIONS = 1.3

TABLE C-33

SPECTRUM BS6.COMB6 TEST CRACK GROWTH DATA SPECIMEN D20

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.017		0.024	
24,000	193	0.020		0.034	
49,280	396	0.030		0.044	
72,000	578	0.037		0.049	
96,000	771	0.045		0.060	
120,000	964	0.054		0.073	
144,000	1,156	0.065		0.085	
168,000	1,349	0.075		0.099	
192,000	1,542	0.083		0.112	
216,000	1,734	0.093		0.127	
264,000	2,120	0.113		0.154	
312,000	2,505	0.139		0.185	
360,000	2,891	0.163		0.217	
408,000	3,276	0.192		0.256	
432,000	3,469	0.207		0.272	
456,000	3,662	0.222		0.300	
480,000	3,854	0.243		0.327	
504,320	4,050	0.263		0.354	
552,000	4,433	0.299		0.408	
578,400	4,645	0.326		0.439	
600,000	4,818	0.344		0.470	
624,000	5,011	0.370		0.505	
648,000	5,203	0.398		0.544	
696,000	5,589	0.460		0.625	
720,000	5,782	0.498		0.671	
744,000	5,974	0.533		0.723	
768,000	6,167	0.575		0.778	
792,000	6,360	0.622		0.840	
816,000	6,552	0.668		0.903	
840,000	6,745	0.714		0.965	
864,000	6,938	0.766	0.022	1.040	0.050
888,000	7,131	0.824	0.062	1.125	0.112
912,000	7,323	0.889	0.145	1.215	0.231
936,000	7,516	0.956	0.229	1.313	0.329
960,000	7,709[1]	1.055	0.333	1.450	0.459

(1) NO. OF SPECTRUM REPETITIONS = 3.1

TABLE C-34

SPECTRUM BS6.COMB11 TEST CRACK GROWTH DATA SPECIMEN D21

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.024		0.025(1)	
24,000	371	0.027		0.025	
49,280	761	0.030		0.032	
72,000	1,112	0.032		0.038	
96,000	1,483	0.033		0.039	
120,000	1,854	0.037		0.041	
144,000	2,225	0.039		0.045	
168,000	2,596	0.045		0.048	
192,000	2,966	0.049		0.054	
216,000	3,337	0.052		0.063	
264,000	4,079	0.057		0.064	
312,000	4,820	0.062		0.071	
360,000(2)	5,562	0.069		0.078	
408,000	6,304	0.080		0.088	
456,000	7,045	0.085		0.102	
504,320	7,792	0.097		0.113	
552,000	8,528	0.104		0.121	
600,000	9,270	0.113		0.131	
648,000	10,012	0.122		0.141	
696,000	10,753	0.134		0.155	
744,000	11,495	0.146		0.164	
792,000	12,236	0.159		0.179	
840,000	12,978	0.170		0.191	
888,000	13,720	0.179		0.202	
936,000(3)	14,461	0.188		0.213	
960,000	14,832	0.225		0.252	
984,000	15,203	0.237		0.263	
1,008,000	15,574	0.247		0.276	
1,057,920	16,345	0.287	0.035	0.320	0.050
1,104,000	17,057	0.327	0.068	0.364	0.101
1,152,000	17,798(4)	0.372	0.136	0.408	0.141

(1) FROM FRACTURE SURFACE MEASUREMENT, a_o = 0 ON THE OTHER SIDE OF SPECIMEN

(2) STARTING WITH CYCLE 360,001, FOR 50 CYCLES, ALL LOADS WERE INADVERTENTLY INCREASED BY 8890 PSI

(3) ALL LOADS INCREASED 35 PERCENT BECAUSE OF VERY SLOW CRACK GROWTH

(4) NO. OF SPECTRUM REPETITIONS = 7.1

TABLE C-35

SPECTRUM BS6.COMB12 TEST CRACK GROWTH DATA
SPECIMEN D23

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A		CRACK LENGTH (IN.) AT HOLE B	
		$(a_A)_i$	$(a_A)_{OSH}$	$(a_B)_i$	$(a_B)_{OSH}$
0	0	0.015		0.031	
20,000	161	0.023		0.042	
42,480	341	0.034		0.057	
60,000	482	0.044		0.068	
80,000	642	0.059		0.082	
100,000	803	0.074		0.102	
120,000	964	0.086		0.113	
140,000	1,124	0.104		0.133	
160,000	1,285	0.118		0.153	
180,000	1,445	0.136		0.170	
200,000	1,606	0.154		0.191	
220,000	1,767	0.170		0.211	
240,000	1,927	0.189		0.234	
260,000	2,088	0.211		0.263	
280,000	2,248	0.232		0.286	
300,000	2,409	0.257		0.312	
320,000	2,570	0.281		0.340	
340,000	2,730	0.304		0.366	
360,000	2,891	0.330		0.400	
380,000	3,051	0.360		0.436	
400,000	3,212	0.388		0.466	
420,000	3,373	0.422		0.507	
440,000	3,533	0.456		0.546	
460,000	3,694	0.495		0.591	
480,000	3,854	0.534		0.636	
500,000	4,015	0.576		0.689	0.017
520,000	4,176	0.613		0.738	0.030
540,000	4,336	0.669		0.817	0.070
560,000	4,497	0.724	0.041	0.900	0.221
580,000	4,657	0.780	0.092	0.986	0.326
600,000	4,818	0.849	0.142	1.093	0.436
621,840	4,993	0.934	0.187	1.232	0.575
640,000	5,139	1.015	0.290	1.369	0.712
644,000	5,171(1)	1.032	0.312	1.395	0.733

(1) NO. OF SPECTRUM REPETITIONS = 2.1

TABLE C-36

SUSTAINED COMPRESSION LOADING (SCL) EFFECT TEST CRACK GROWTH DATA SPECIMENS F1 THROUGH F5

CYCLES	FLIGHT HOURS	CRACK LENGTH (IN.) AT HOLE A OR B OR EDGE C											
		SPECTRUM F WITH SCL						SPECTRUM F, NO SCL					
		SPECIMEN F1			F2			F3		F4			F5
		$(a_A)_i$	$(a_B)_i$ (1)	$(a_C)_i$	$(a_A)_i$	$(a_B)_i$ (1)	$(A_C)_i$	$(a_A)_i$	$(a_B)_i$ (1)	$(a_A)_i$	$(a_B)_i$ (1)	$(a_C)_i$	$(a_B)_i$ (1)
0	0	0.160	0.140	0.264	0.096	0.140 (2)	0.048	0.104	0.140	0.074	0.140 (2)	0.060	0.140 (2)
10,956	400	0.166	0.152	0.281	0.103	0.153	0.048	0.109	0.153	0.084	0.150	0.063	0.150
16,790	613	0.171	0.157	0.286	0.108	0.159	0.048	(3)	(3)	(3)	(3)	(3)	(3)
21,912	800	(3)	(3)	(3)	(3)	(3)	(3)	0.123	0.163	0.094	0.157	0.064	0.158
32,868	1200	0.182	0.166	0.291	0.120	0.172	0.052	0.132	0.173	0.103	0.162	0.066	0.166
43,824	1600	0.194	0.171	0.336	0.132	0.183	0.052	0.140	0.186	0.109	0.169	0.068	0.174
54,780	2000	(3)	(3)	(3)	(3)	(3)	(3)	0.151	0.197	0.123	0.177	0.070	0.185
65,736	2400	0.213	0.189	0.380	0.148	0.208	0.054	0.163	0.211	0.136	0.184	0.075	0.192
76,692	2800	0.219	0.196	0.407	0.151	0.219	0.055	0.175	0.227	0.148	0.193	0.079	0.204
87,648	3200	0.235	0.205	0.436	0.172	0.233	0.057	0.185	0.242	0.165	0.200	0.083	0.214
98,604	3600	0.247	0.219	0.471	0.180	0.246	0.057	0.201	0.257	0.177	0.213	0.088	0.225
109,560	4000	0.255	0.232	0.515	0.193	0.262	0.060	0.216	0.272	0.192	0.224	0.093	0.243

(1) FASTENER IN HOLE: NET FIT (0.0001 → 0.0002 IN. CLEARANCE) TITANIUM HILOK, NO HEAD NOR NUT

(2) FROM FRACTURE SURFACE MEASUREMENT THE CRACK LENGTH OF THE OTHER SIDE OF THE SPECIMEN, a_o: F2 (0.190), F4 (0.100), F5 (0.10)

(3) NO MEASUREMENT MADE

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