

AD-A014 470

CHANGES IN HELICOPTER RELIABILITY/MAINTAINABILITY
CHARACTERISTICS OVER TIME. VOLUME 2. DATA
SUBMITTED BY HELICOPTER MANUFACTURERS

Norman J. Asher, et al

Institute for Defense Analyses

Prepared for:

Office of the Director of Defense Research and
Engineering
Defense Advanced Research Projects Agency

March 1975

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

259128

AD A014470

STUDY S-451

**CHANGES IN HELICOPTER
RELIABILITY/MAINTAINABILITY
CHARACTERISTICS OVER TIME**

**Volume 2:
Data Submitted by Helicopter Manufacturers**

**Norman J. Asher
John Donelson
Gerald F. Higgins**

March 1975

**INSTITUTE FOR DEFENSE ANALYSES
PROGRAM ANALYSIS DIVISION**

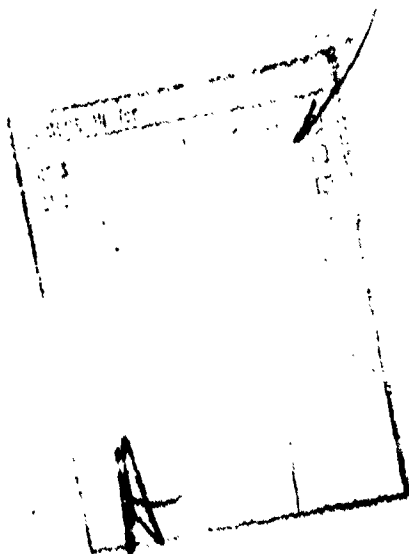
Reproduced by
**NATIONAL TECHNICAL
INFORMATION SERVICE**
U.S. Dept. of Commerce
Natl. Tech. Inf. Serv. Div.
Springfield, MA 01104

**IDA Log No. HQ 75-17099
Copy 55 of 70 copies**



The work reported in this document was conducted under contract DAHC15 73 C 0200 for the Department of Defense. The publication of this IDA Study does not indicate endorsement by the Department of Defense, nor should the contents be construed as reflecting the official position of that agency.

Approved for public release; distribution unlimited.



UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1 REPORT NUMBER S-451	2 GOVT ACCESSION NO.	3 RECIPIENT'S CATALOG NUMBER
4 TITLE (and Subtitle) Changes In Helicopter Reliability/ Maintainability Characteristics Over Time Data Submitted by Helicopter Manufacturers		5 TYPE OF REPORT & PERIOD COVERED Final
7 AUTHOR(s) Norman J. Asher, John Donelson, Gerald F. Higgins		6 PERFORMING ORG REPORT NUMBER S-451
8 PERFORMING ORGANIZATION NAME AND ADDRESS INSTITUTE FOR DEFENSE ANALYSES PROGRAM ANALYSIS DIVISION 400 Army-Navy Drive, Arlington, Virginia 22202		9 CONTRACT OR GRANT NUMBER(s) DAHC15 73 C 0200
11 CONTROLLING OFFICE NAME AND ADDRESS Defense Advanced Research Projects Agency 1400 Wilson Boulevard Arlington, Virginia 22209		10 PROGRAM ELEMENT PROJECT TASK AREA & WORK UNIT NUMBERS Task Order T-105
14 MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Office of Director of Defense Research and Engineering (Tactical Warfare Programs) The Pentagon Washington, D.C. 20301		12 REPORT DATE March 1975
		13 NUMBER OF PAGES
		15 SECURITY CLASS (of this report) Unclassified
		15a DECLASSIFICATION DOWNGRADING SCHEDULE
16 DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17 DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18 SUPPLEMENTARY NOTES		
19 KEY WORDS (Continue on reverse side if necessary and identify by block number) Helicopter, Reliability, Maintainability		
20 ABSTRACT (Continue on reverse side if necessary and identify by block number) This report examines the growth (or lack of it) in reliability and maintainability (R&M) characteristics of past helicopter programs and organizes the data so that they can be used as bases for predicting the R&M characteristics of future helicopter programs. Six types of R&M data are presented: (1) failure rates, (2) component-removal rates, (3) mishap rates, (4) maintenance-action rates, (5) operational		

UNCLASSIFIED

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. cont'd

availability, and (6) maintenance man-hours. Many of the data on past helicopter programs are included in the report, so that they will be available for use by analysts.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

STUDY S-451

CHANGES IN HELICOPTER RELIABILITY / MAINTAINABILITY
CHARACTERISTICS OVER TIME

Volume 2:
Data Submitted by Helicopter Manufacturers

Norman J. Asher
John Donelson
Gerald F. Higgins

March 1975



INSTITUTE FOR DEFENSE ANALYSES
PROGRAM ANALYSIS DIVISION
400 Army-Navy Drive, Arlington, Virginia 22202
Contract DAHC15 73 C 0200
Task T-105

CONTENTS

Part A - Data Submitted by Boeing Vertol

Reliability Growth Analysis - Final Report BV-1*

Part B - Data Submitted by Hughes

YOH-6 and OH-6A Helicopter Reliability Study H-1*

Part C - Data Submitted by Sikorsky

- I. *Operations Reliability/Maintainability Engineering Program Quarterly Evaluation Report [CH-54A]* S-1*
- II. *Eighth (8th) Quarterly CH-53 Readiness Report* S-79

*Three pagination sequences are used in this volume: in both Part A (BV-) and Part B (H-), the lower-case Roman and the Arabic page numbers agree with those in each of the documents here reproduced; in Part C, however, the original page numbers of the two Sikorsky documents are displayed as they were submitted (i.e., centered at the lower edge), but with our single continuous (S-) pagination also indicated (in the lower unbound corner of each page). For the reader's additional convenience, Part B (Hughes) and Part C. II (Sikorsky) are printed on paper of a different color from that used for Part A (Boeing Vertol) and Part C.I (Sikorsky).

Because of the bulk of the Sikorsky reports, only the most interesting sections of them are reproduced in this volume.

Part A

Data Submitted by Boeing Vertol

RELIABILITY GROWTH ANALYSIS ~ FINAL REPORT

Prepared By
J. J. Dougherty, III & O. L. Sandora
THE BOEING VERTOL COMPANY
P. O. Box 16858
Philadelphia, Pennsylvania 19142

for
INSTITUTE FOR DEFENSE ANALYSIS
Program Analysis Division
400 Army-Navy Drive
Arlington, Virginia 22202
ATTENTION
Mr. Norman J. Asher
Ass't Division Director

TABLE OF CONTENTS

	<u>Page</u>
Foreword	iii
Introduction	1
Documentation of Analysis	2

FOREWORD

This report presents a study to identify Reliability, Maintainability, and Safety Growth Trends on helicopters. The work was conducted under Contract Number P. O. 20478 for the Institute of Defense Analysis (IDA), Arlington, Virginia.

IDA technical direction was provided by Mr. Norman J. Asher.

Project Engineer for the Boeing Vertol Company was Mr. J. J. Dougherty, III of the Product Assurance R&D unit. Principal Investigator for the study was Mr. O. L. Sandora, also of the Product Assurance R&D unit. Program Management and Technical Direction were provided by Mr. K. G. Rummel, Manager, Product Assurance Research & Development.

1. INTRODUCTION

Helicopters have consistently exhibited relatively high unscheduled maintenance requirements because of the great percentage of high reliability risk and high-cost components needed for the helicopters unique performance capabilities. This tendency towards high maintenance requirements has generated concurrence among both the contractor and customer that improved reliability must be achieved without a long and expensive period of in-service product improvement. High initial reliability can be achieved only through a well-executed analytical design approach and an enthusiastic and well-controlled developmental testing effort.

The primary reliability effort in the design stage is the analysis and evaluation of the aircraft design and development of Reliability Predictions. Recent work has shown that a point estimate of aircraft or component reliability is meaningless unless accompanied by a quantification of the time in the components maturity (development) cycle for which the estimate is relevant.

Reliability growth prediction techniques have been employed to estimate the number of developmental test hours required to achieve a desired level of reliability with increased confidence in the technology.

However, since reliability continues to be improved by the Product Improvement process throughout most of the in-production life of a helicopter, it is necessary to understand this growth process. The magnitude and the factors affecting this growth process must be determined and quantified if future aircraft programs are to be optimized. Development costs and O&M costs must be viewed as intimately related to reliability. The key to minimum total system costs is the understanding of the reliability growth process through the development and operational phases.

2. DOCUMENTATION OF ANALYSIS

Historically, reliability of helicopters has increased with each new generation of aircraft, as well as increasing during the in-service phase of each individual aircraft. In order to understand these growth patterns and the impact that aircraft reliability growth has on mission reliability, safety, reliability, availability and maintenance manhour expenditures, an analysis of in-service aircraft data is essential.

This can best be achieved with a compilation of reliability growth experience at the aircraft component level, and the impact on the above mentioned parameters after component reliability is analyzed: then total aircraft reliability should be examined and conclusions drawn concerning the factors affecting this growth process.

The data contained in the following chart identifies all pertinent information developed under this contract and contained in this report.

DATA CONTAINED IN THIS REPORT

TASK 1

CH-47 Total Aircraft R Growth Statistics	Table 1
CH-47 Subsystem R Growth Statistics	Table 1
CH-47 Total & Subsystem R Growth Plots	Figure 1-12
CH-47 Total & Subsystem R Growth Parameters	Table 2
CH-46 Total Aircraft R Growth Statistics	Table 5
CH-46 Subsystem R Growth Statistics	Table 5
CH-46 Total & Subsystem R Growth Plots	Figure 43-66
CH-46 Total & Subsystem R Growth Parameters	Table 7
CH-47 Component R Growth Statistics	Tables 8 & 9
CH-47 Component R Growth Plots	Figure 92-115
CH-47 Component R Growth Parameters	Tables 10 & 11
CH-46 Component R Growth Statistics	Table 12
CH-46 Component R Growth Plots	Figure 116-125
CH-46 Component R Growth Parameters	Table 13

TASK 2

Safety Growth Statistics For The	Table 3
UH-1 Army, UH-1 Navy, H-2 Navy, H-3 Navy,	
OH-6 Army, H-19 Navy, H-19 Army,	
H-21 Air Force, H-21 Army, H-34 Army,	
H-34 Navy, H-37 Navy, H-37 Army, H-46 Navy,	
CH-47 Army, CH-53 USMC, CH-54 Army	
Composite Safety Growth Curves	Figure 25
Safety Growth Curves For All Above Aircraft	Figures 26-42
Safety Growth Parameters	Table 4

TASK 3

CH-47 Total Aircraft M Growth Statistics	Table 1
CH-47 Subsystem M Growth Statistics	Table 1
CH-47 Total & Subsystem M Growth Plots	Figures 13-24
CH-47 Total & Subsystem M Growth Parameters	Table 2
CH-46 Total Aircraft M Growth Statistics	Table 6
CH-46 Subsystem M Growth Statistics	Table 6
CH-46 Total & Subsystem M Growth Plots	Figures 67-90
CH-46 Total & Subsystem M Growth Parameters	Table 7
H-21 M Growth Plots	Figure 91

TASK 4

Weight Effect on Cost	Figure 126
Weight Effect on Maintenance	Figure 127
Maintenance Per Pound Growth Curve	Figure 128

ALFANTIONS PER FLANT HOUR

SYSTEM BREAK DOWN NOT AVAILABLE

MAINTENANCE MONITORING FOR FLIGHT MONITORING
(ORGANIZATIONAL + INTEGRATED DIRECT SUPPORT)

Year	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1965	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100

DATA SOURCE - BOEING VECTOR DATA ANAL

2000

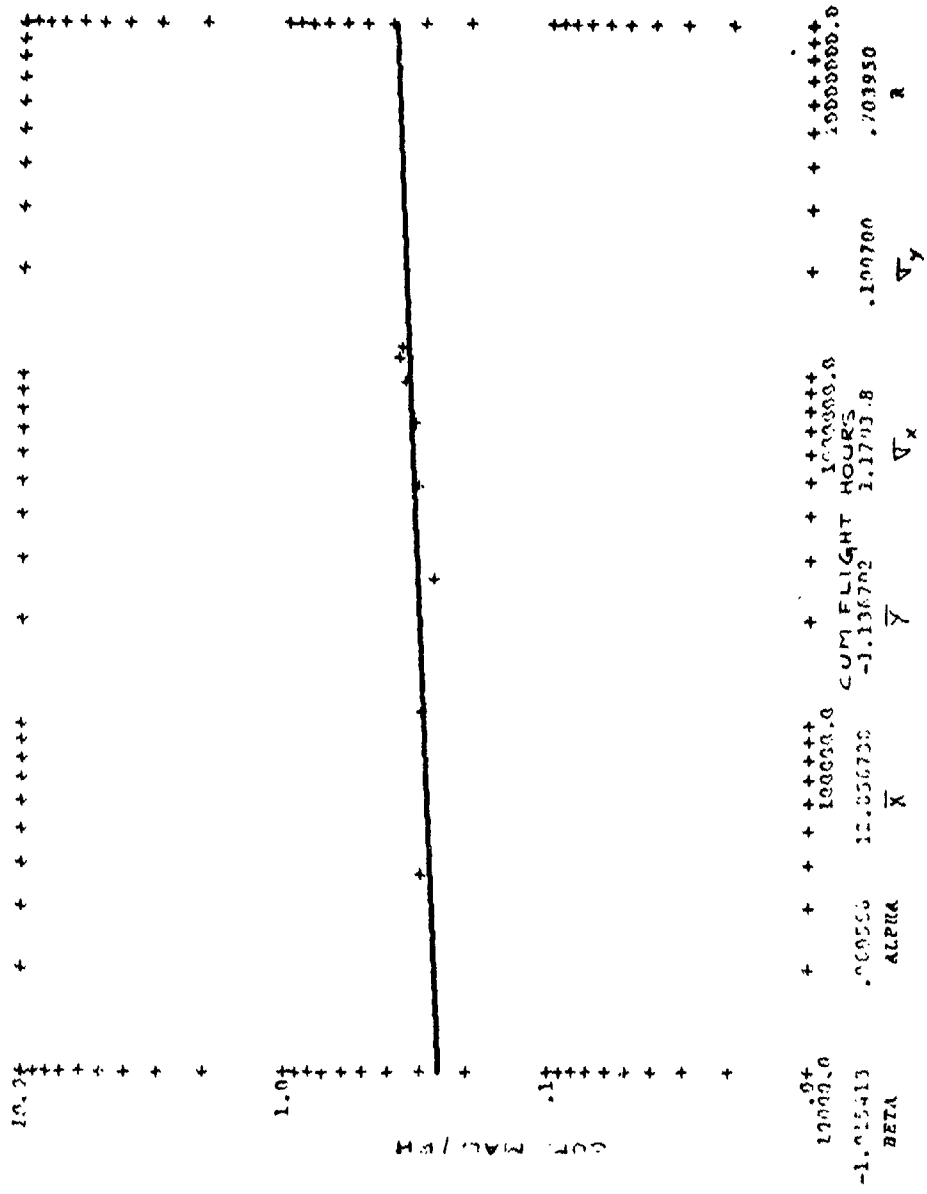
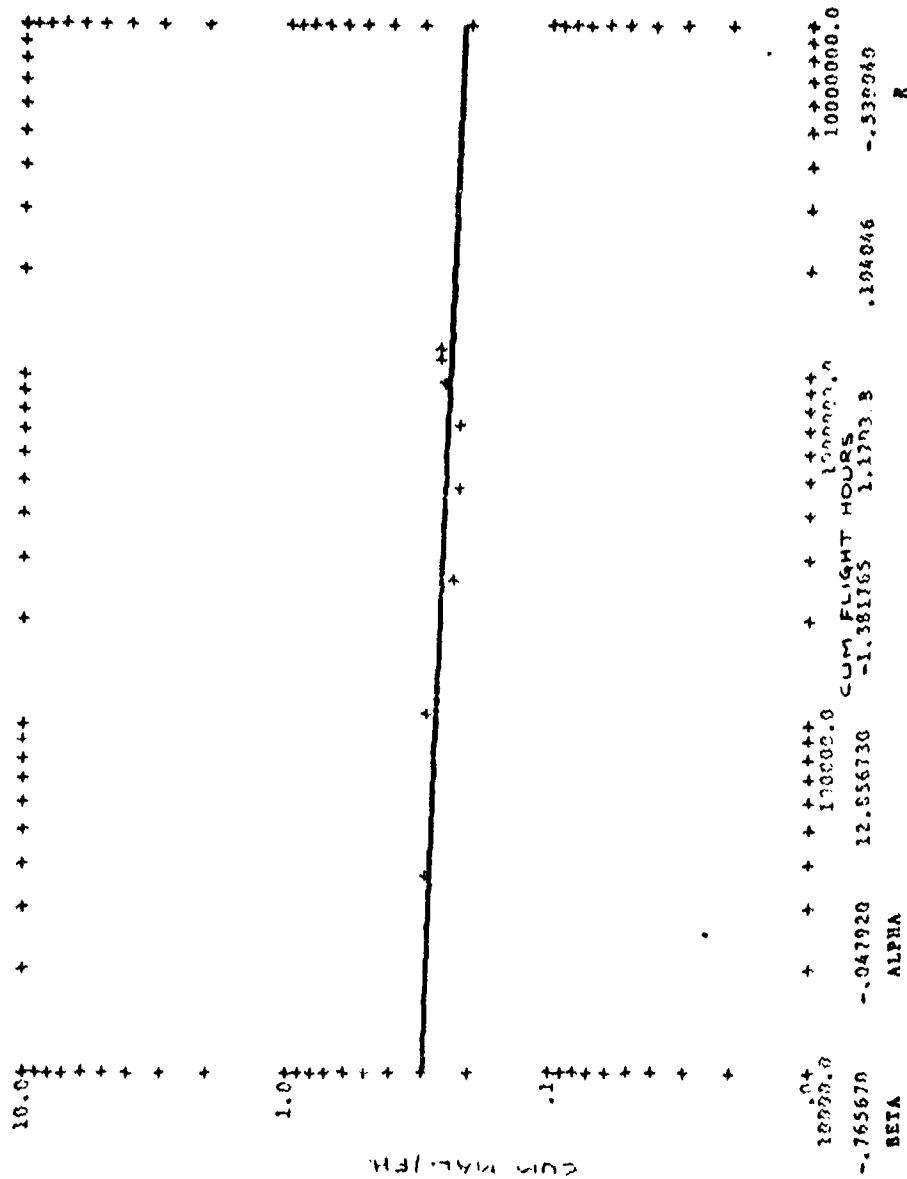


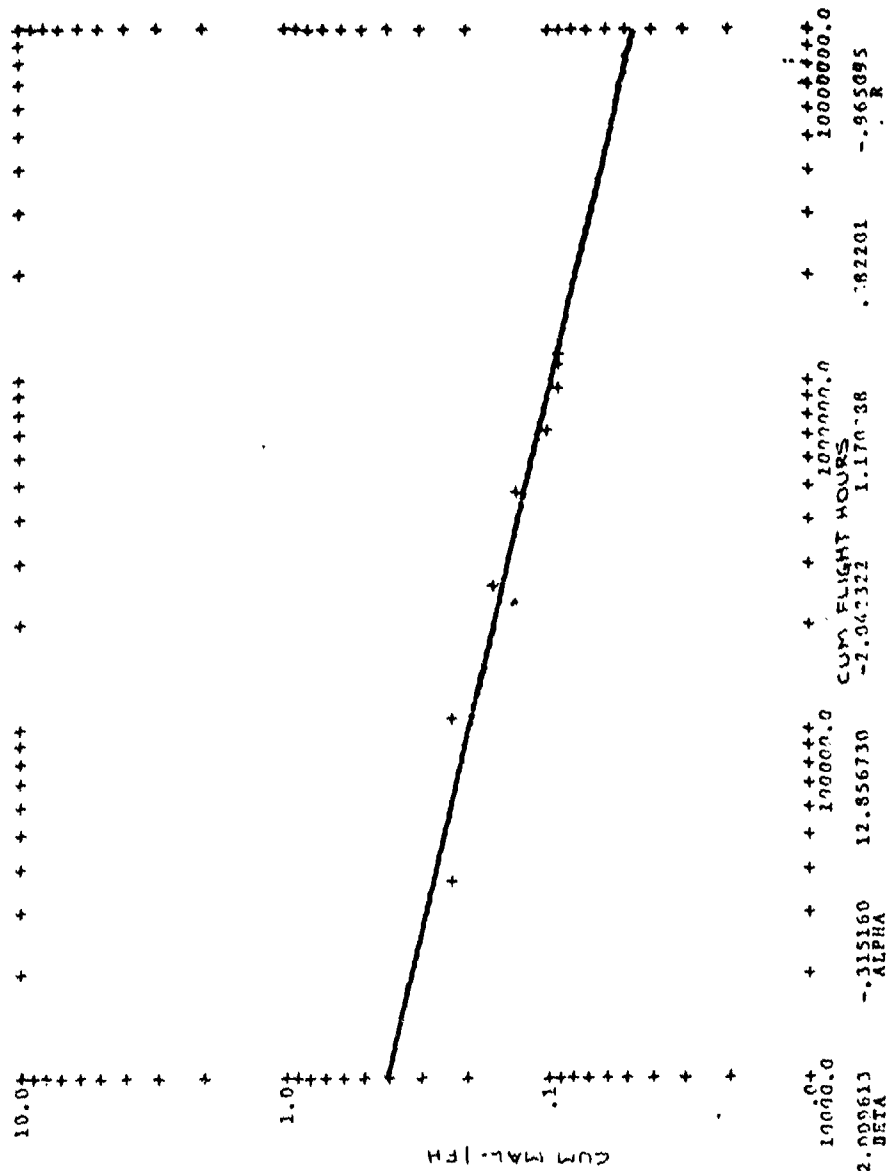
FIGURE 1

BV-6



POWER PLANT
CH-47 MAL./FH- CUM

FIGURE 2

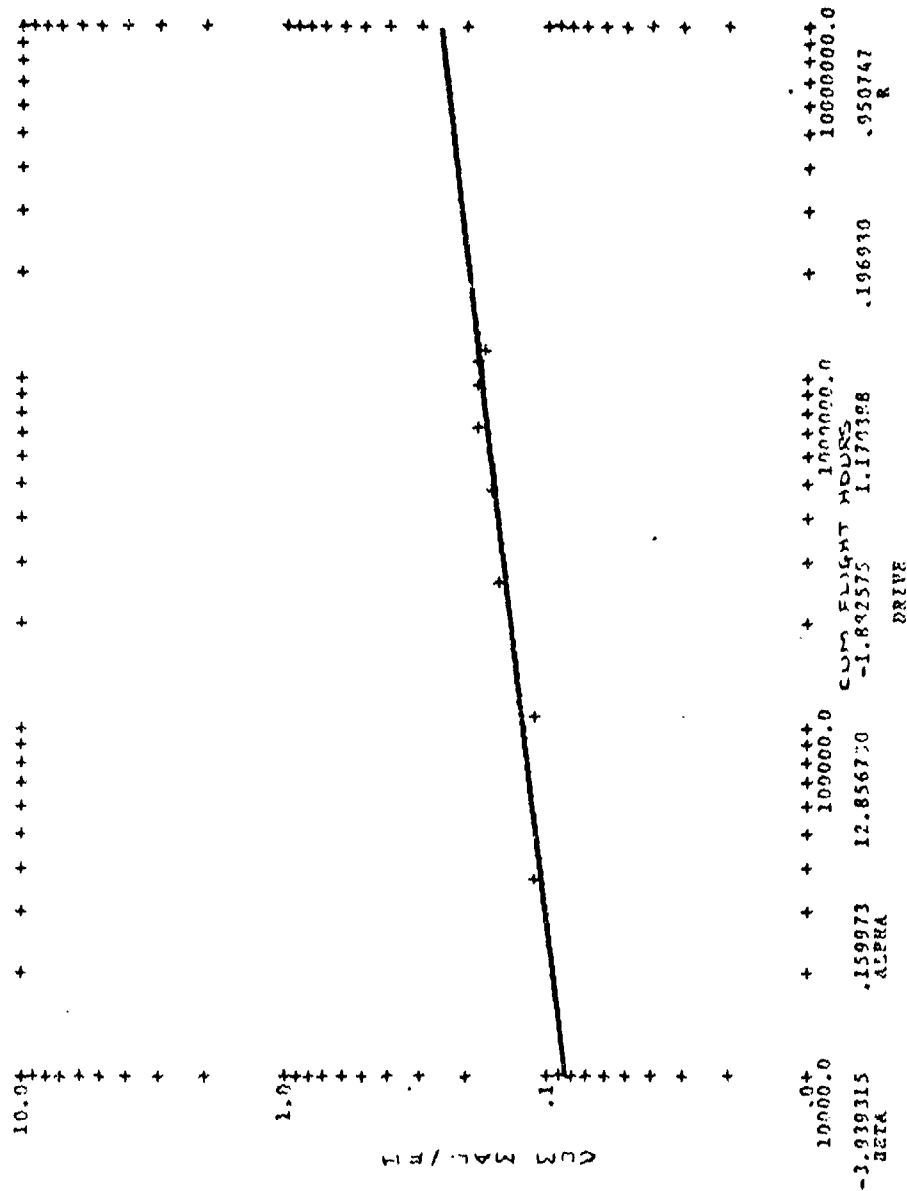


BV-7

FLIGHT CONTROLS
CH-47 MAL./FH- CUM

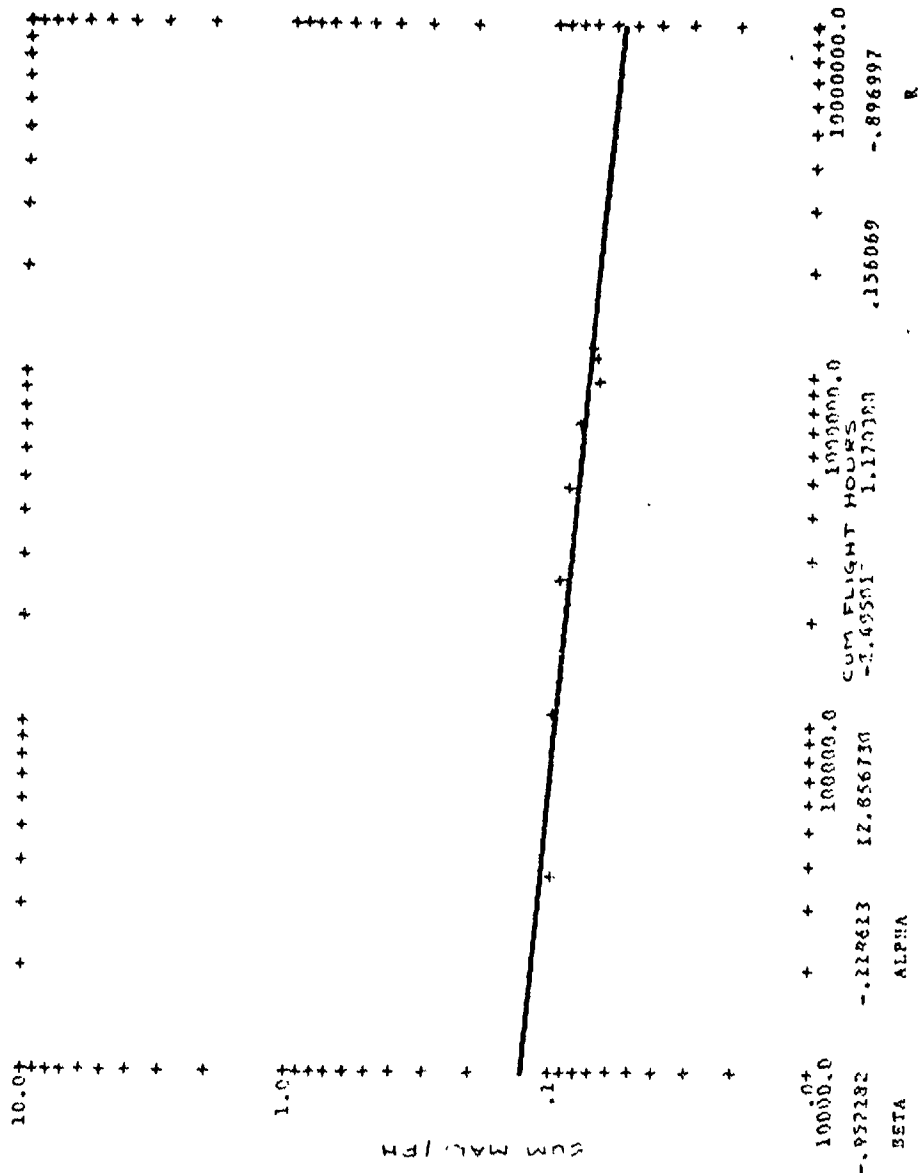
FIGURE 3

BV-8



CH-47 MAL./FH- CUM

FIGURE 4



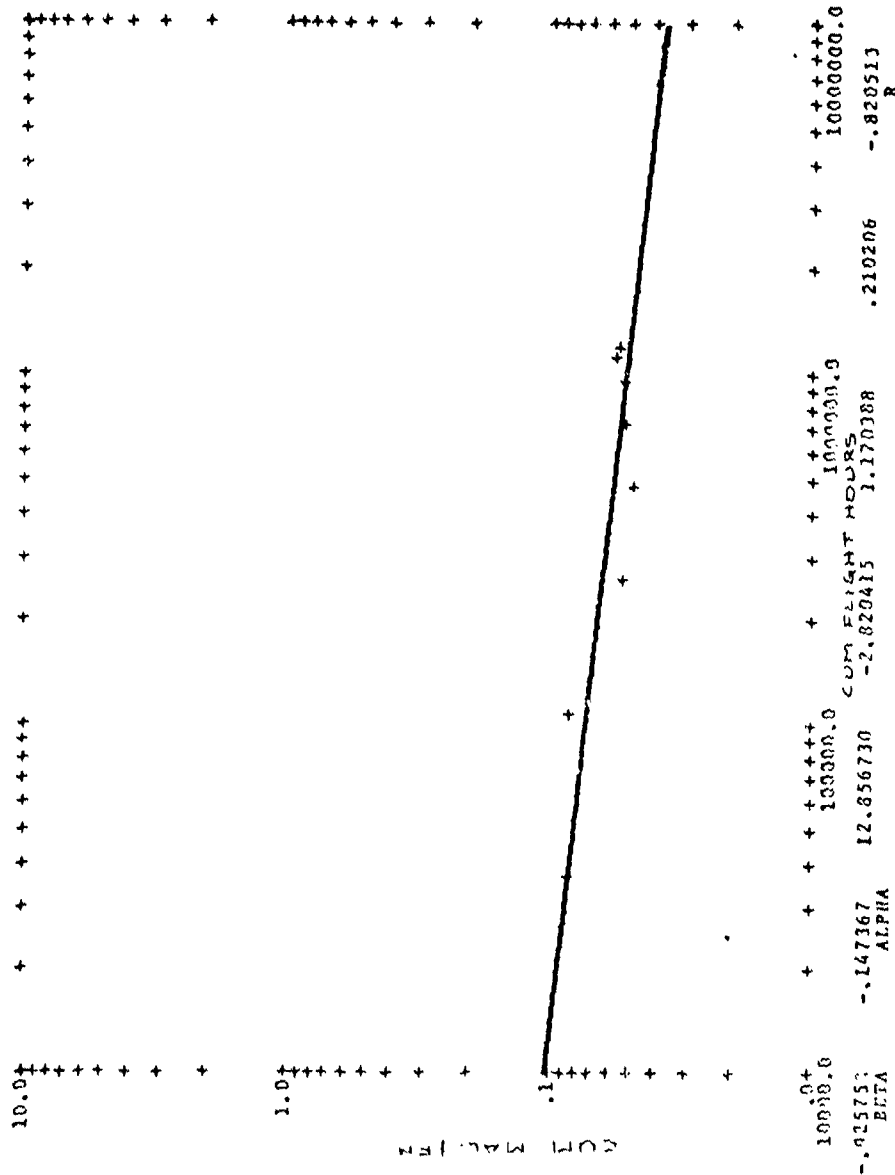
BV-9

FIGURE 5

[illegible]

INDICATING
CH-47 MAL./FH-CUM

FIGURE 6



BV-11

ELECTRICAL
CH-47 MAL/PH- CUM

FIGURE 7

BV-12

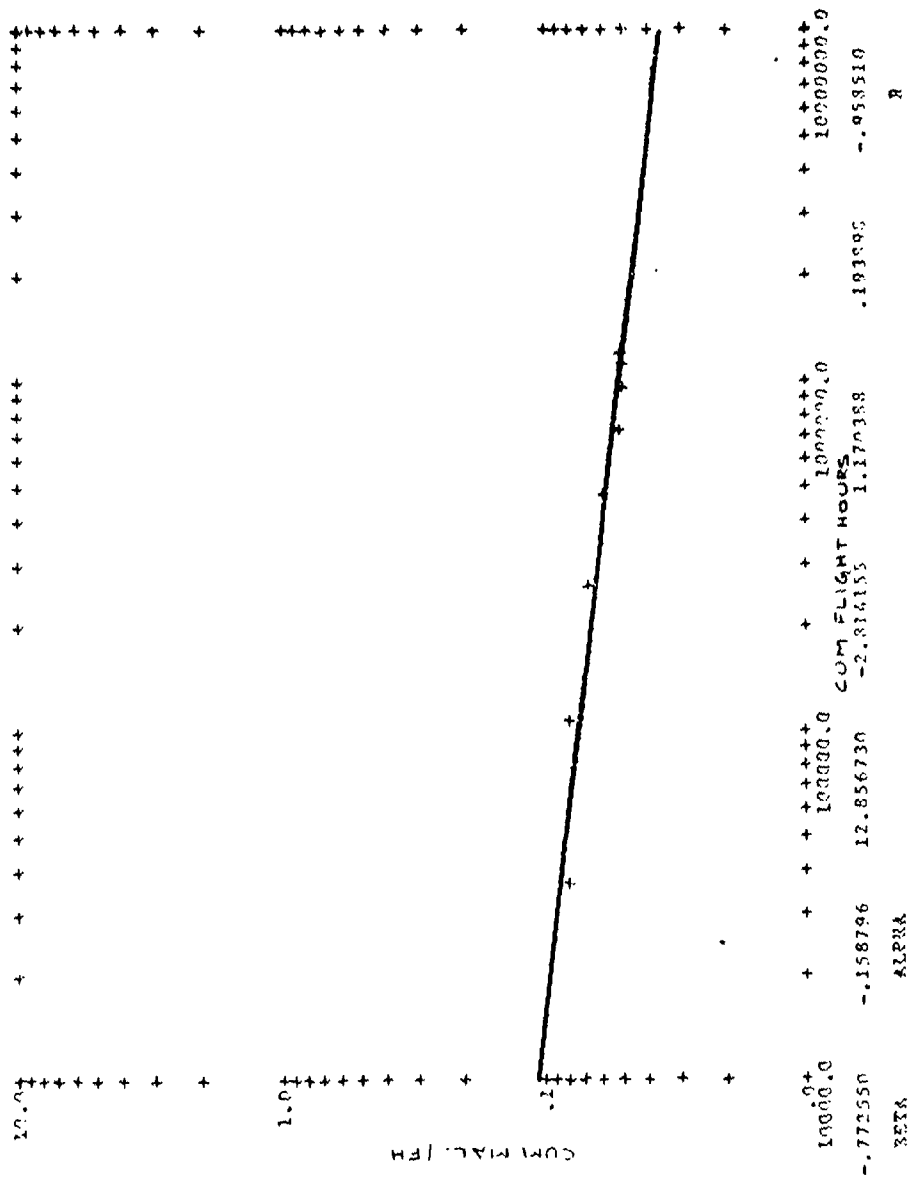


FIGURE B

[illegible]

CH-47 MAL./EH-CUM

FIGURE 9

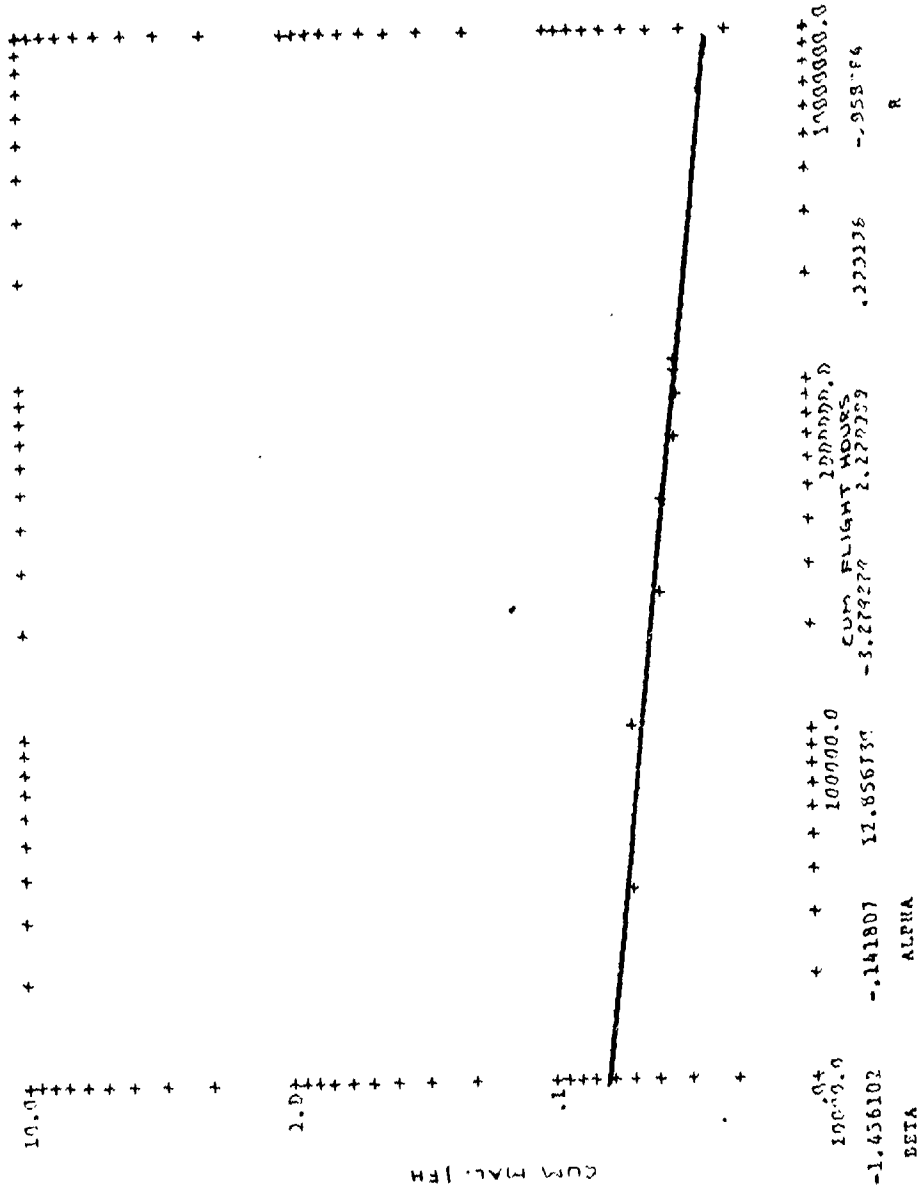
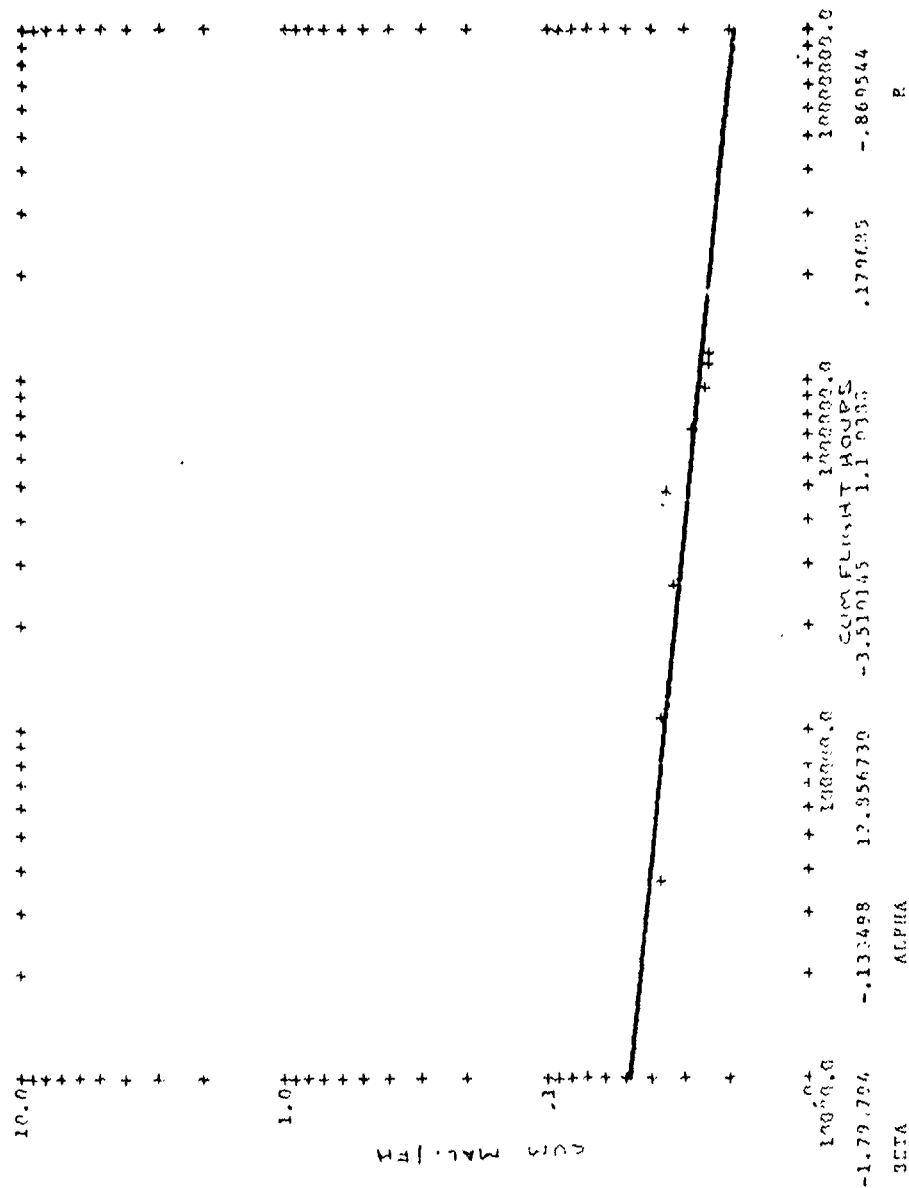


FIGURE 10



BV-15 :

LAPPING GEAR
CH-47 MAL./FH- CUM

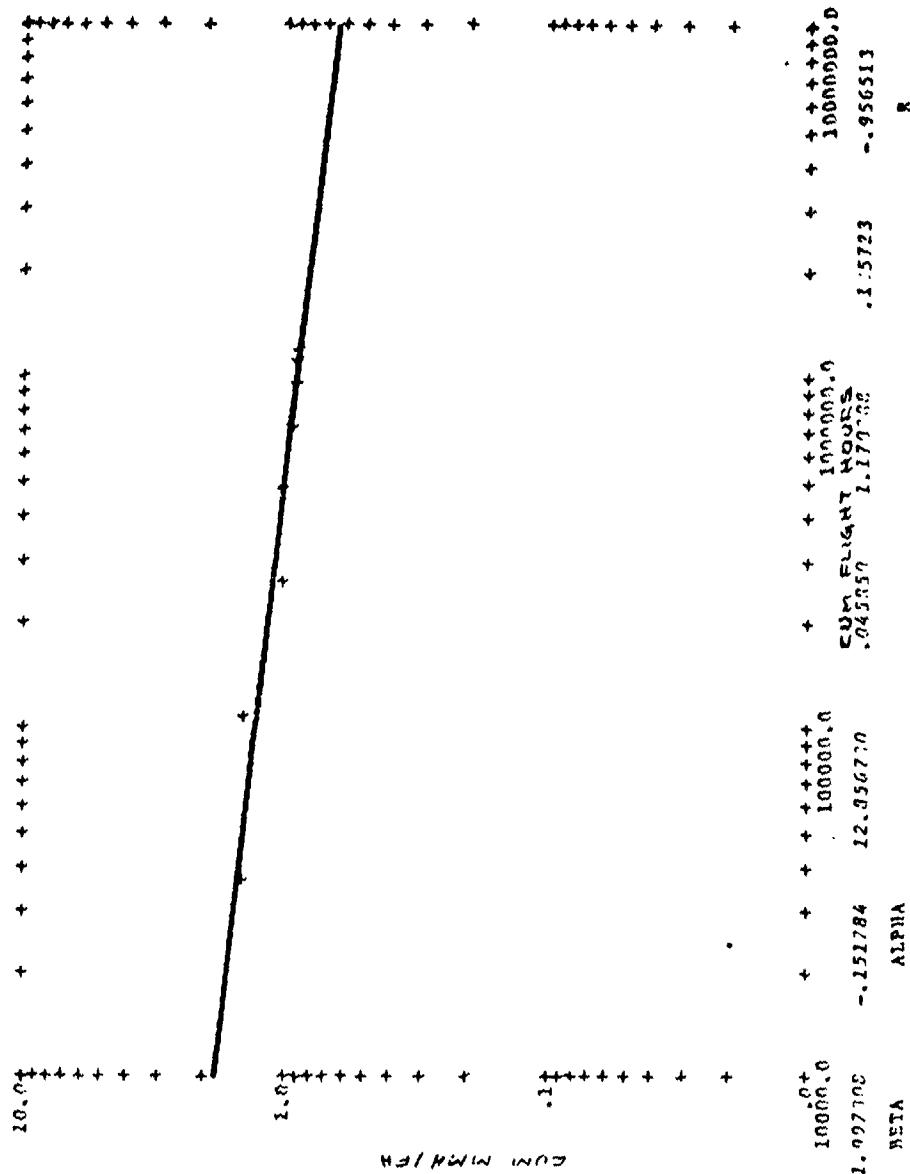
FIGURE 11

[illegible]

TOTAL
CH-47 MAL./FH-CUM

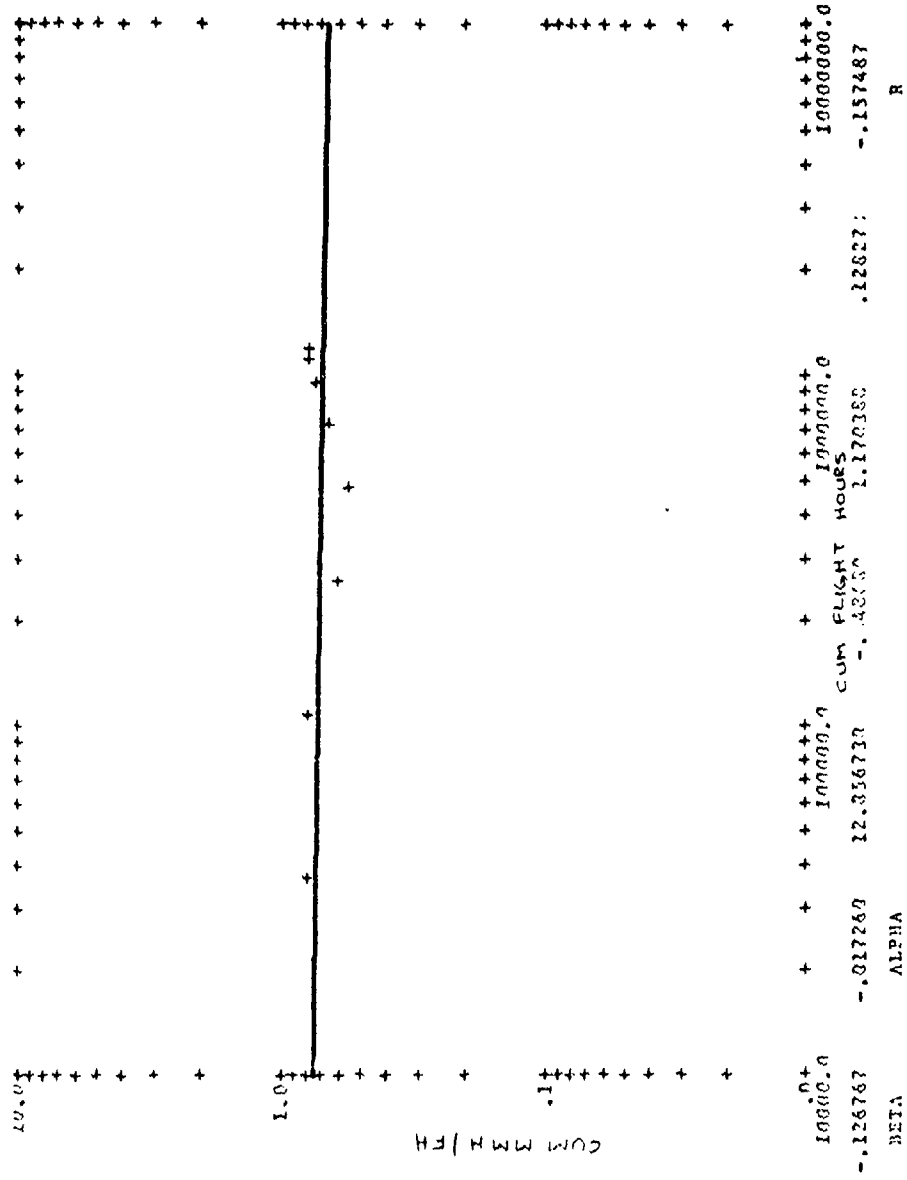
FIGURE 12

BV-17



AIRFRAME
CH-47 MHF/TH- CUM

FIGURE 13



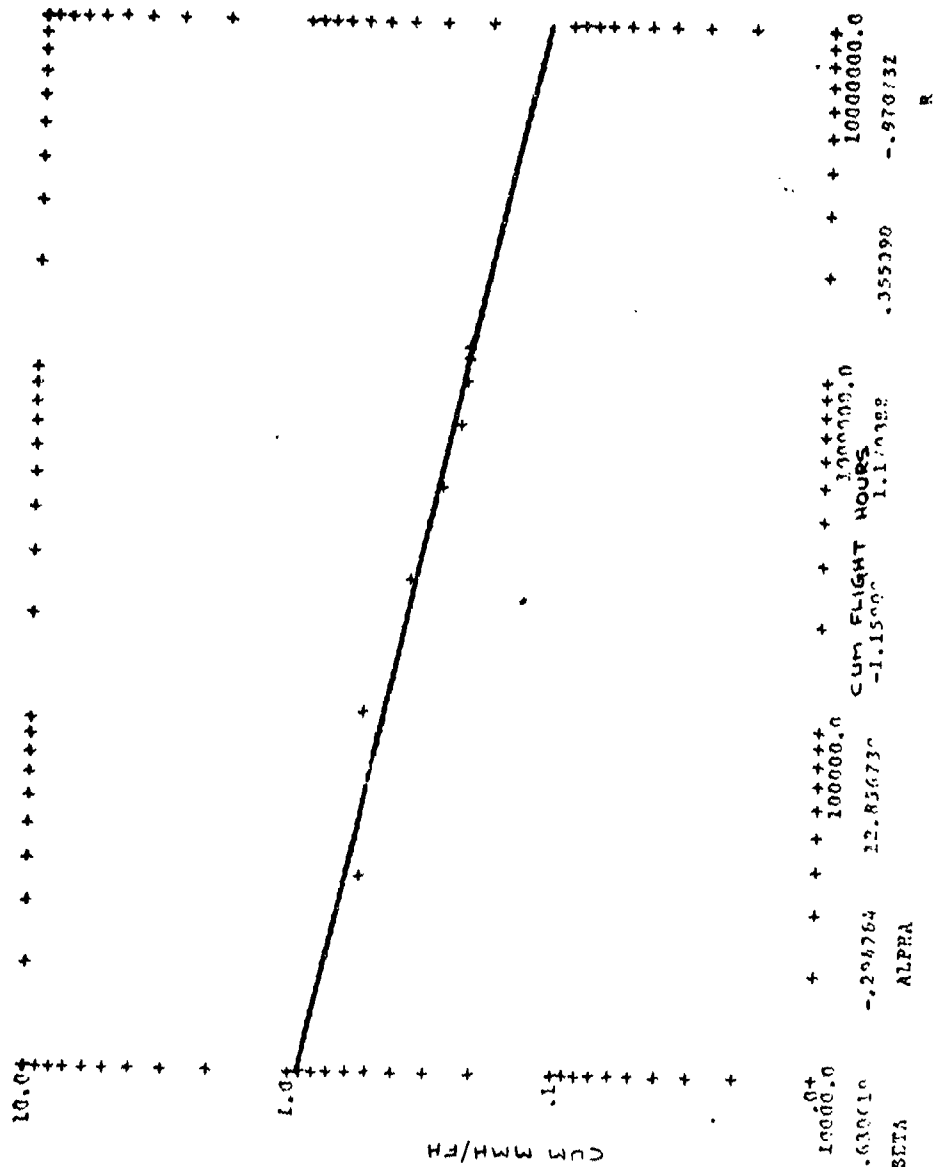
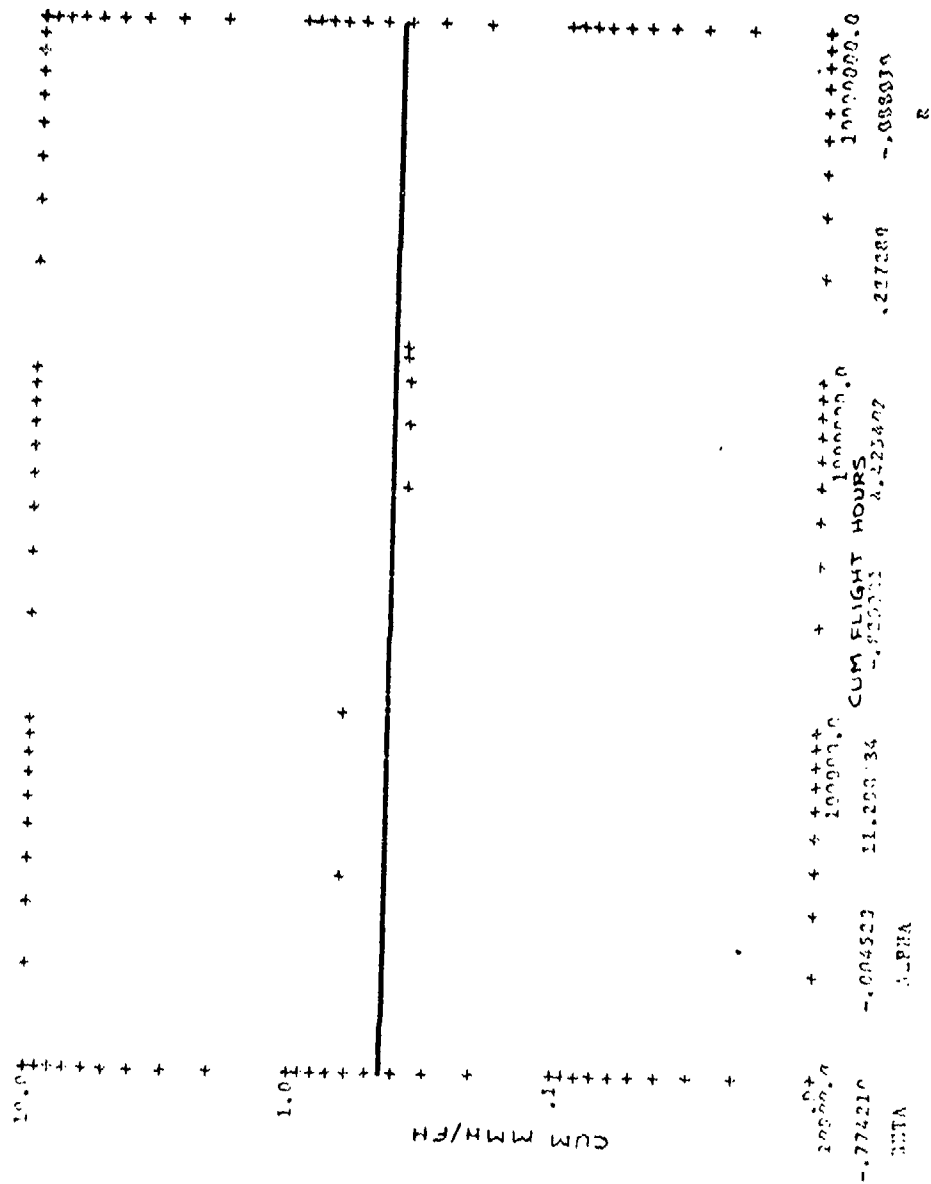


FIGURE 15

[illegible]

CH-47 MHH/FH-CUM
PAGE

FIGURE 16



BV-21

CH-47 MMH/FH- CUM
FIGURE 17

BV-22

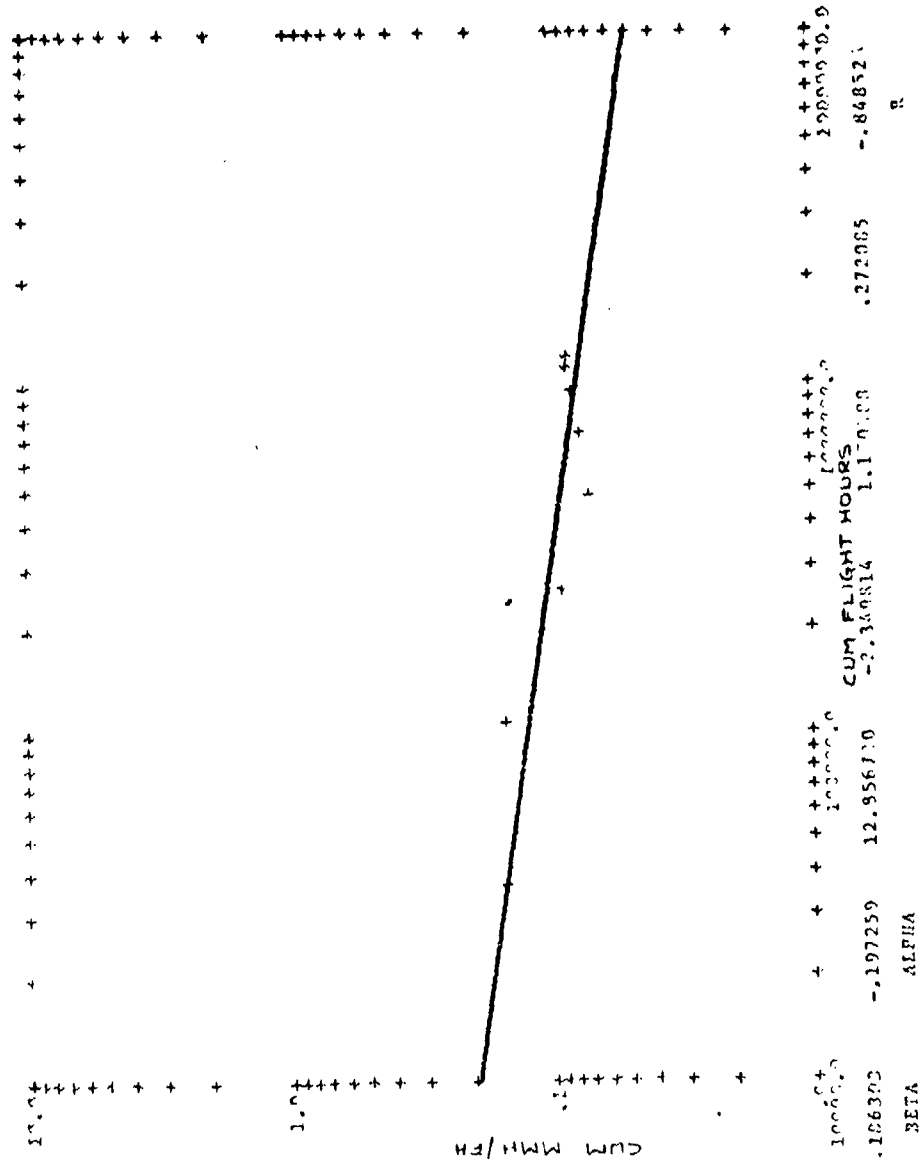
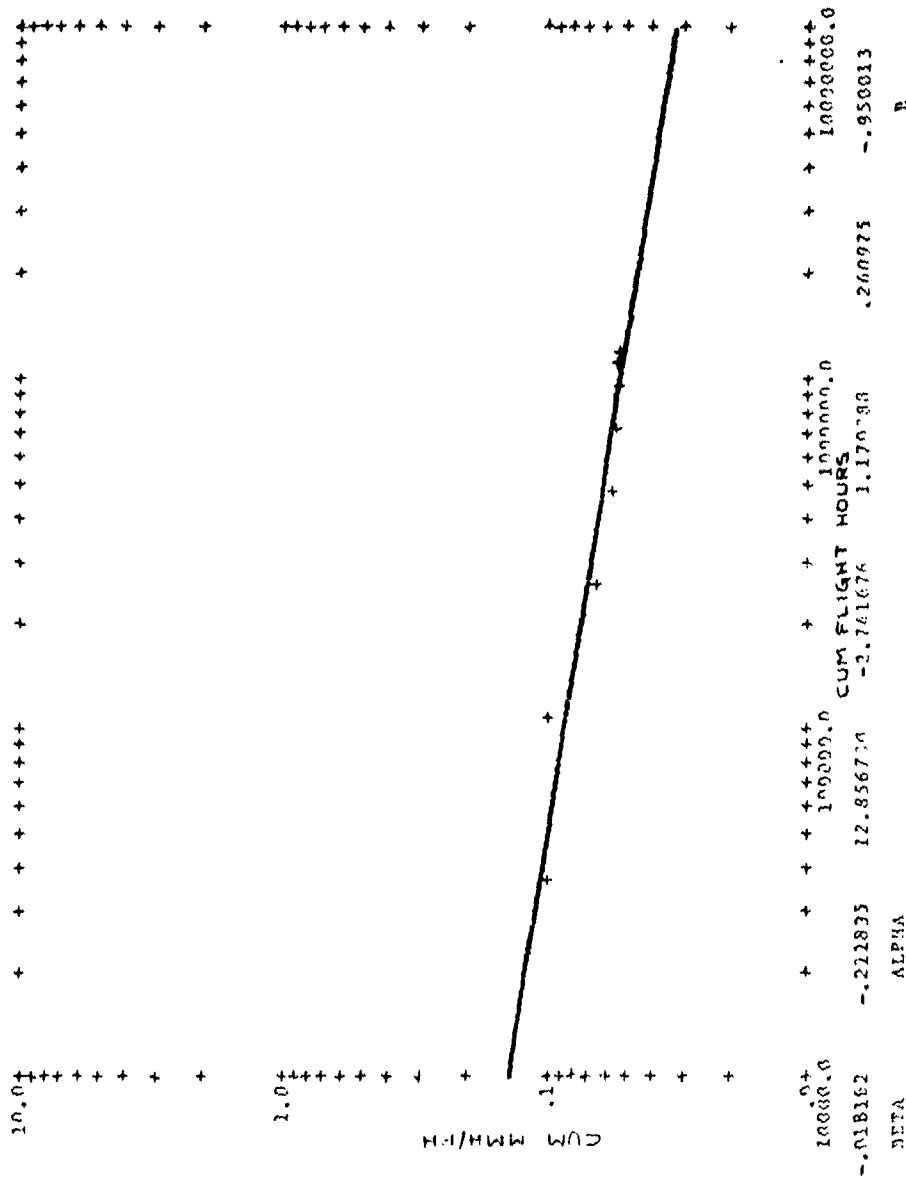


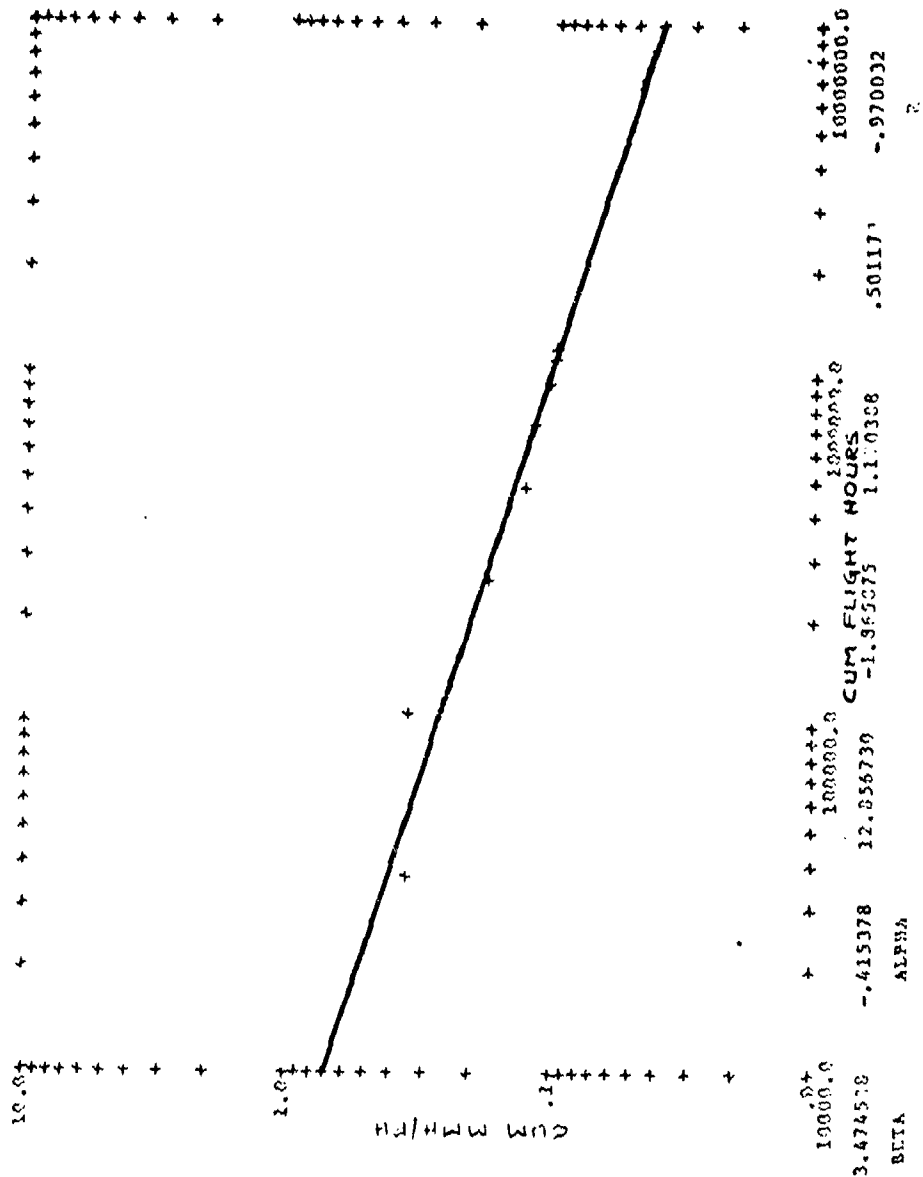
FIGURE 18



BV-23

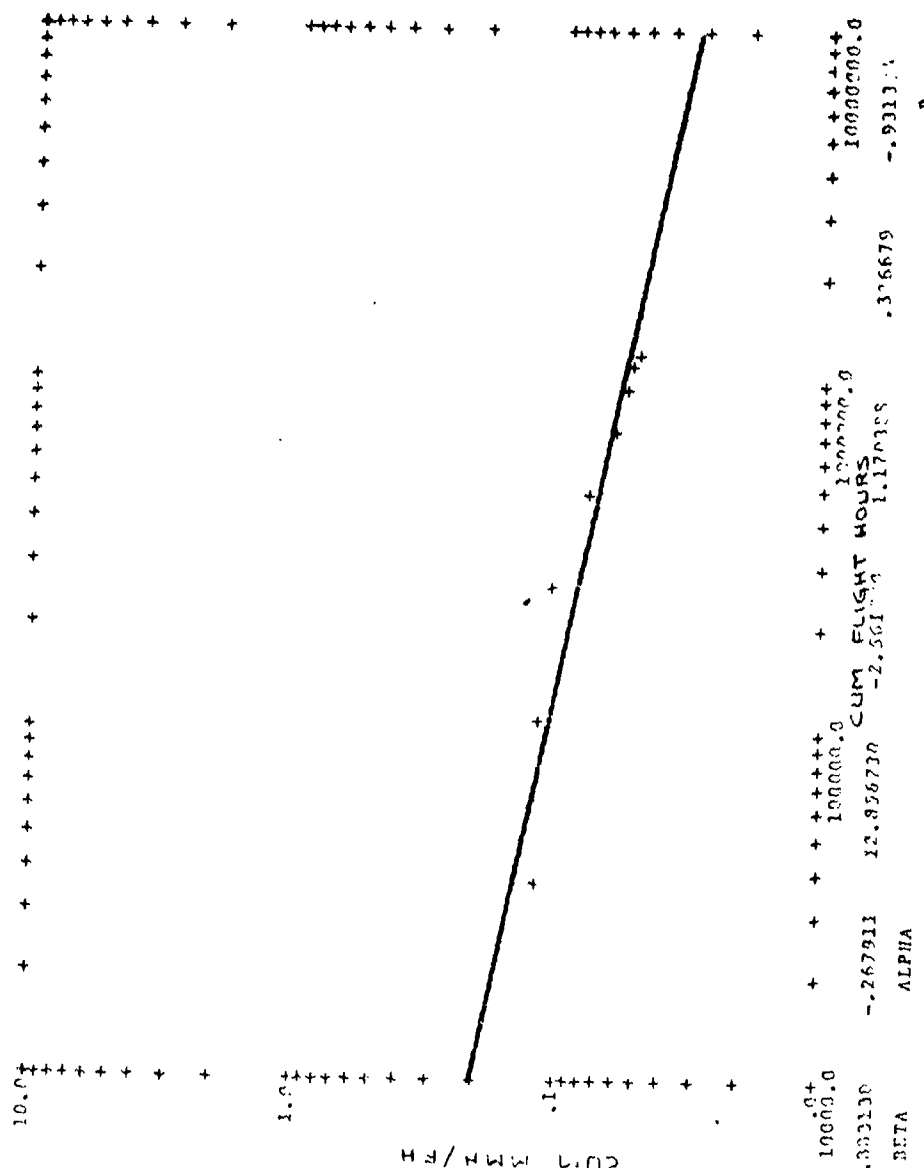
ELECTRICAL
CR-47 MMH/FH- CUM

FIGURE 19



BV-24

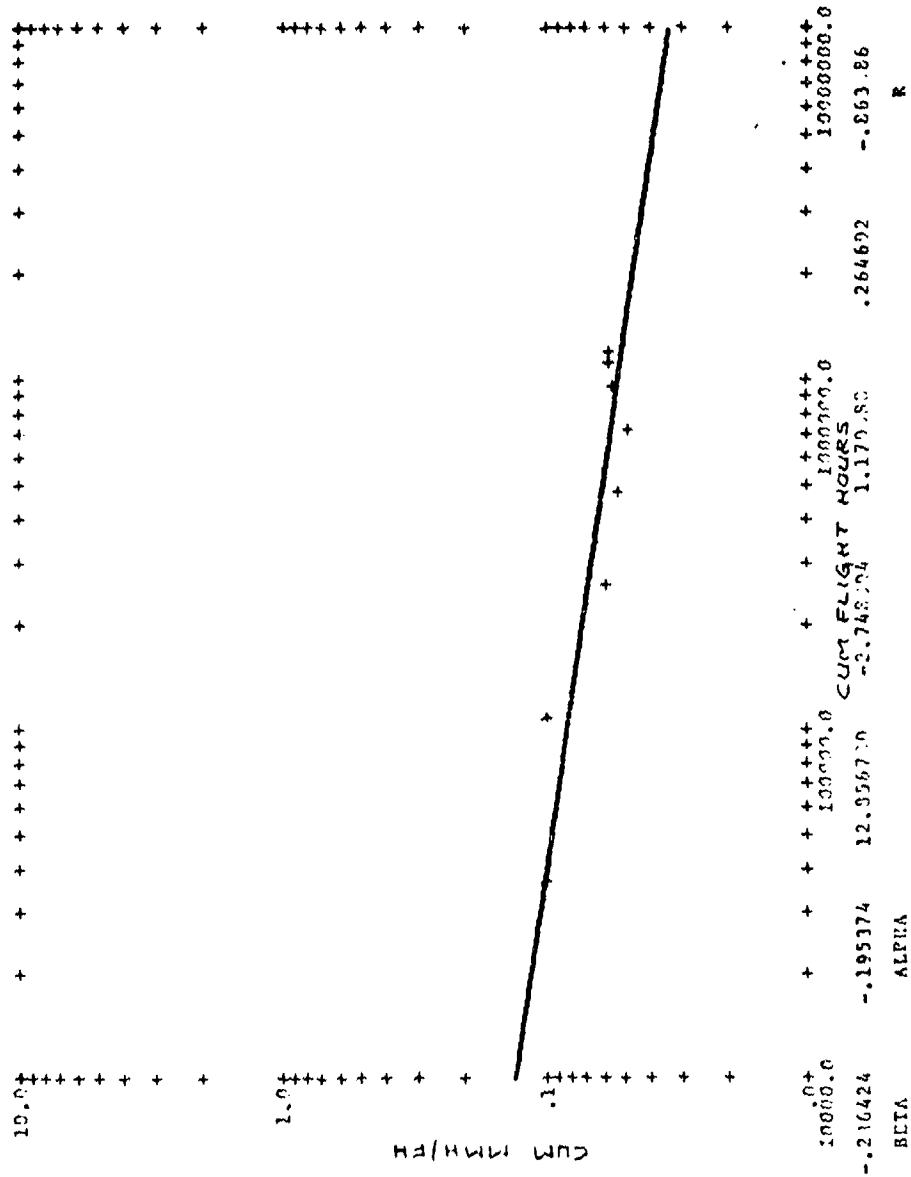
EQUIPMENT
CH-47 MH/PH- CUM
FIGURE 20



10000.0
 .302130
 BETA
 ALPHA
 -.267911
 12.856730
 120000.0
 120000.0
 CUM FLIGHT HOURS
 -2.561112
 1.170328
 .376679
 -9.913314
 10000000.0
 R

CUM FLIGHT HOURS
 CH-47 MMH/FH- CUM
 FIGURE 21

BV-26



HYDRAULIC
CH-47 MHE/PH- CUM

FIGURE 22

TIME	ALTITUDE	CUM FLIGHT HOURS	ALTITUDE
10000.0	10000.0	1.170100	10000.0
10112.4	10000.0	1.170100	10000.0
10224.8	10000.0	1.170100	10000.0
10337.2	10000.0	1.170100	10000.0
10449.6	10000.0	1.170100	10000.0
10562.0	10000.0	1.170100	10000.0
10674.4	10000.0	1.170100	10000.0
10786.8	10000.0	1.170100	10000.0
10899.2	10000.0	1.170100	10000.0
11011.6	10000.0	1.170100	10000.0
11124.0	10000.0	1.170100	10000.0
11236.4	10000.0	1.170100	10000.0
11348.8	10000.0	1.170100	10000.0
11461.2	10000.0	1.170100	10000.0
11573.6	10000.0	1.170100	10000.0
11686.0	10000.0	1.170100	10000.0
11798.4	10000.0	1.170100	10000.0
11910.8	10000.0	1.170100	10000.0
12023.2	10000.0	1.170100	10000.0
12135.6	10000.0	1.170100	10000.0
12248.0	10000.0	1.170100	10000.0
12360.4	10000.0	1.170100	10000.0
12472.8	10000.0	1.170100	10000.0
12585.2	10000.0	1.170100	10000.0
12697.6	10000.0	1.170100	10000.0
12810.0	10000.0	1.170100	10000.0
12922.4	10000.0	1.170100	10000.0
13034.8	10000.0	1.170100	10000.0
13147.2	10000.0	1.170100	10000.0
13259.6	10000.0	1.170100	10000.0
13372.0	10000.0	1.170100	10000.0
13484.4	10000.0	1.170100	10000.0
13596.8	10000.0	1.170100	10000.0
13709.2	10000.0	1.170100	10000.0
13821.6	10000.0	1.170100	10000.0
13934.0	10000.0	1.170100	10000.0
14046.4	10000.0	1.170100	10000.0
14158.8	10000.0	1.170100	10000.0
14271.2	10000.0	1.170100	10000.0
14383.6	10000.0	1.170100	10000.0
14496.0	10000.0	1.170100	10000.0
14608.4	10000.0	1.170100	10000.0
14720.8	10000.0	1.170100	10000.0
14833.2	10000.0	1.170100	10000.0
14945.6	10000.0	1.170100	10000.0
15058.0	10000.0	1.170100	10000.0
15170.4	10000.0	1.170100	10000.0
15282.8	10000.0	1.170100	10000.0
15395.2	10000.0	1.170100	10000.0
15507.6	10000.0	1.170100	10000.0
15620.0	10000.0	1.170100	10000.0
15732.4	10000.0	1.170100	10000.0
15844.8	10000.0	1.170100	10000.0
15957.2	10000.0	1.170100	10000.0
16069.6	10000.0	1.170100	10000.0
16182.0	10000.0	1.170100	10000.0
16294.4	10000.0	1.170100	10000.0
16406.8	10000.0	1.170100	10000.0
16519.2	10000.0	1.170100	10000.0
16631.6	10000.0	1.170100	10000.0
16744.0	10000.0	1.170100	10000.0
16856.4	10000.0	1.170100	10000.0
16968.8	10000.0	1.170100	10000.0
17081.2	10000.0	1.170100	10000.0
17193.6	10000.0	1.170100	10000.0
17306.0	10000.0	1.170100	10000.0
17418.4	10000.0	1.170100	10000.0
17530.8	1		

CH-47 MBI/EH- CUM

FIGURE 23

BV-28

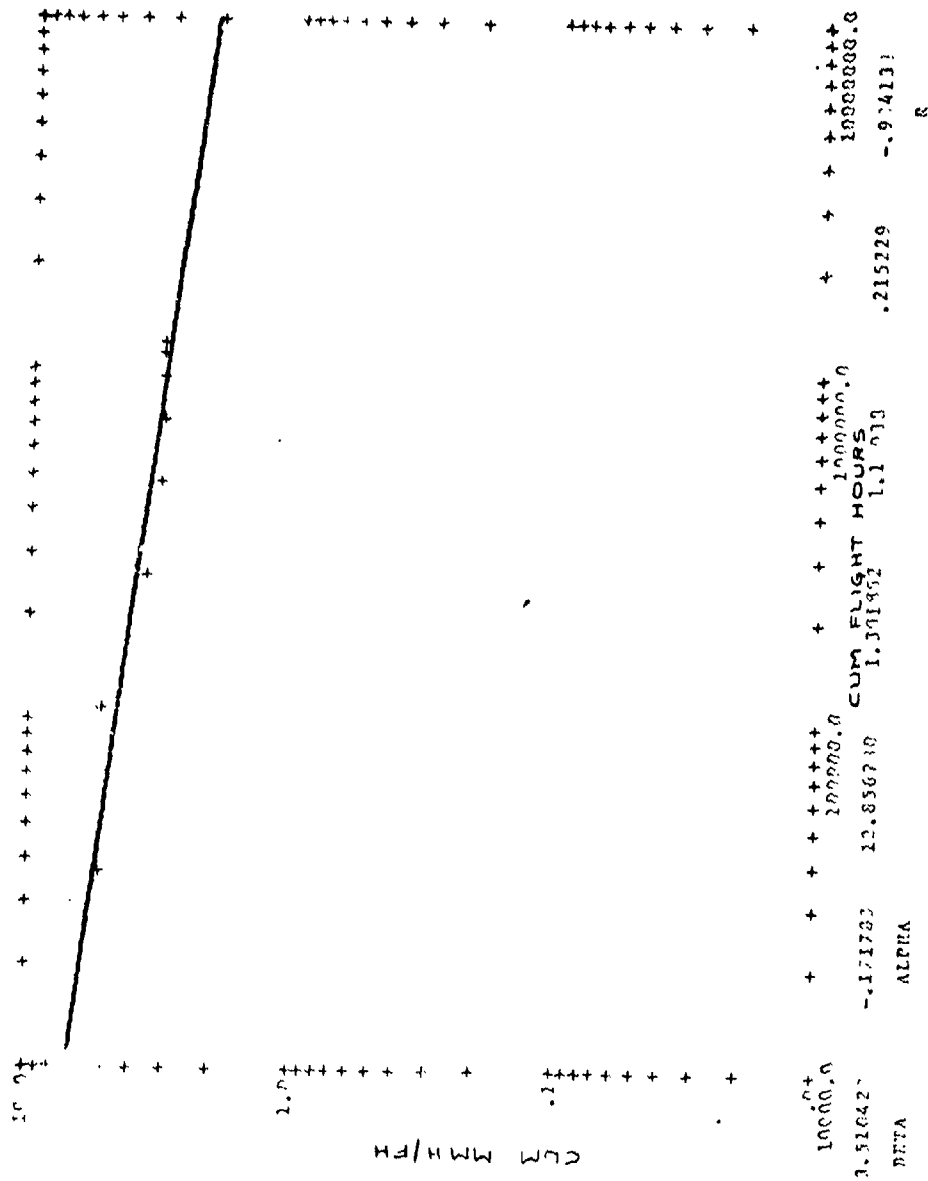


FIGURE 24

TABLE 2 - CH-47 SYSTEM R&H GROWTH PARAMETERS

SYSTEM	MMH/FEH - CUM		MAL/FEH - CUM	
	R	α	R	α
AIRFRAME	1.997	-.152	-.957	-.915
POWER PLANT	-.127	-.017	-.157	-.049
FLIGHT CONTROL	2.631	-.295	-.971	-.315
ROTOR	-.714	-.005	-.088	-.120
INDICATING	.186	.197	-.849	-.073
EQUIPMENT	3.475	.415	-.970	-.159
COMM/NAV	.887	.268	-.931	-.224
HYDRAULIC	-.236	.195	-.864	-.142
LANDING GEAR	.101	.220	-.972	-.133
DRIVE	2.336	-.219	-.948	.160
ELECTRICAL	-.018	-.212	-.950	-.147
TOTAL	3.510	-.172	.934	-.063

* - OPERATIONAL + INTEGRATED
Direct support, Direct
maintenance manhours.

$$\sigma_x = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n}}$$

$$\bar{x} = \frac{\sum x_i}{n}$$

$$\bar{x} = \ln \frac{\sum x_i}{n} = \ln \sqrt{\frac{\sum x_i^2}{n}}$$

R = Correlation co-efficient

also

and $\bar{x}$ = cum flight hours

$\bar{y}$ = cum maintenance manhours
or $\bar{y}$ = cum maintenance manhours
flight hours

where

$$Y = e^{\beta} X^{\alpha}$$

$$\ln Y = \alpha \ln X + \beta$$

ASSUMED RELATIONSHIP

8

UH-1 ARMY

[illegible]

TABLE 3. SAFETY GROWTH STATISTICS

BV-30

Best Available Copy

Dec → June

BV-31

Best Available Copy

[illegible]

TABLE 3-1

Reproduced from
Best available copy.

YEAR	CUMULATIVE					
	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH
1961	2	0	0	2	0	0
1962	1,222	1	81.23	1,224	1	81.83
1963	13,899	12	86.39	15,113	13	86.68
1964	33,756	22	65.13	19,979	35	70.16
1965	37,200	13	34.94	67,079	48	55.12
1966	53,935	12	22.58	129,074	59	45.33
1967	59,827	9	22.04	179,901	68	37.78
1968	39,611	14	35.31	219,542	92	38.94
1969	18,186	5	27.49	229,728	87	38.41
1970	30,753	5	16.24	259,481	92	35.46
1971	27,500	1	3.64	286,981	93	32.41
1972	23,560	4	16.98	310,541	97	31.23
1973	26,714	6	22.46	337,255	103	31.43

FOUR DAY DESIGNATION FUEL

TABLE 3-2

[illegible]

0961 07104770 55174000 7-55" 1999195 05-FOP2 1960

۱۰۰

Reproduced from
best available copy.

Best Available Copy

H-19 NAVY				CUMULATIVE			RATE/ 100,000 FH	CUM ACCIDENTS + HOURS
CV	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH		
1952	35,116	18	51.25	35,116	18	51.25	35,116	
1953	65,256	62	94.99	100,382	80	79.69	100,382	
1954	68,011	42	61.72	168,423	122	72.43	168,423	
1955	65,050	40	62.79	235,321	162	68.84	235,321	
1956	64,012	24	43.15	300,233	190	63.28	300,233	
1957	59,375	31	51.68	360,208	221	61.35	360,208	
1958	56,112	26	46.24	416,310	247	59.33	416,310	
1959	47,012	19	39.26	463,363	266	57.10	463,363	
1960	43,016	13	29.17	507,911	278	54.73	507,911	
1961	34,016	5	17.63	541,925	284	52.42	541,925	
1962	33,132	6	17.94	575,357	290	50.00	575,357	
1963	34,213	9	38.56	609,570	299	49.04	609,570	
1964	35,211	1	2.80	644,682	300	46.60	644,682	
1965	51,117	2	34.74	695,478	302	48.75	695,478	
1966	51,117	2	39.11	746,113	305	40.87	746,113	
1967	47,115	1	20.8	793,266	306	46.42	793,266	
1968	1,112	0	0	794,438	306	46.31	794,438	

19 includes 11-12 (Nov.) and 11-12 (Dec.) and 11-12 (Jan.)

2.

CUM
 APR 4 5
 AIR FORCE 116
 1,109
 4,403
 26,483
 70,772
 152,895
 247,913
 379,011
 476,364
 577,370
 669,357
 754,313
 810,361
 880,577
 971,132
 988,974
 992,615

H-21 A/B USAF				CUMULATIVE		
CV	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH
1953	1,109	1	90.17	1,109	1	90.17
1954	1,537	1	65.23	2,646	2	75.58
1955	13,423	7	52.13	13,069	9	68.86
1956	25,165	11	44.22	37,554	20	53.25
1957	36,458	12	33.27	73,642	32	43.45
1958	44,397	14	31.53	118,039	46	39.90
1959	41,566	15	36.32	159,605	61	38.27
1960	29,777	5	16.79	189,382	66	35.32
1961	29,827	7	23.47	219,209	73	34.32
1962	33,572	5	15.19	252,781	79	31.27
1963	23,174	5	21.53	275,955	84	32.53
1964	24,028	2	8.33	299,983	86	30.92
1965	13,372	3	22.43	313,355	89	28.38
1966	12,711	0	0	326,066	89	27.30
1967	12,711	0	0	338,777	89	26.26
1968	12,711	3	23.59	351,488	92	26.18

TABLE 7

CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	FTEH/ 100,000 FH	CUMULATIVE			RATE/ 100,000 FH
				FLIGHT HOURS	NO. MAJOR ACCIDENTS		
1954	1,257	0	0	1,257	0	0	4,403
1955	21,681	2	5.30	22,938	4	29.81	26,483
1956	10,854	0	0.00	33,792	12	35.12	70,172
1957	45,135	30	32.46	78,927	42	42.77	152,195
1958	71,111	52	72.11	150,038	94	55.03	267,913
1959	60,214	37	52.72	210,252	131	52.76	379,911
1960	68,586	22	31.07	278,838	153	51.67	476,244
1961	72,175	25	32.11	351,013	178	51.73	577,370
1962	18,221	26	55.44	369,234	204	50.25	669,351
1963	42,011	51	51.15	411,245	271	54.63	754,213
1964	35,113	17	45.00	446,358	288	54.31	810,361
1965	25,005	10	42.84	471,363	298	52.53	850,579
1966	12,211	3	21.06	483,574	301	52.70	871,132
1967	12,132	7	57.69	495,706	308	52.80	900,974
1968	16,054	2	19.22	511,760	310	52.20	922,625

Cum
ARMY &
AIRFORCE MS
4,403
26,483
70,172
152,195
267,913
379,911
476,234
577,270
669,351
754,213
810,361
850,579
871,132
900,974
922,625

TABLE 3-8

Reproduced from
best available copy.

260,137
 487,296
 762,580
 1063,364
 1381,490
 1699,211
 201,1790
 2322,630
 2614,307
 2861,777
 3067,209

Cum Arding E
 Mary F. Arding
 260,137
 487,296
 762,680
 1063,364
 1381,490
 1699,211
 2011,790
 2322,630
 2619,307
 2861,777
 3067,209

STANDARD FORM NO. 64

五、五、五

[illegible]

PROJECT: NAVY DESIGNATION: NR2S PROJECTS DATE: 1964

TAF-1 3-11

DV-43

FH/CH-46 ALL MODELS			CUMULATIVE			
CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH
1961						
1962						
1963	125	0	0	125	0	0
1964	3,345	1	29.89	3,470	1	28.81
1965	12,735	0	0	15,245	1	4.34
1966	17,730	3	16.93	20,534	7	12.75
1967	20,430	20	29.33	23,184	31	21.22
1968	31,734	25	17.63	28,304	56	19.45
1969	33,533	26	18.80	34,359	62	18.53
1970	125,451	12	17.25	94,541	99	17.03
1971	169,150	11	16.56	696,560	110	15.92
1972	600	4	4.18	786,460	114	14.49
1973		7	6.23	57,460	121	13.58

4. EVANS GRAND ACQUITTANCE

7-13

Best Available Copy

CY	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH	CUMULATIVE		
				FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH
1961	100	0	0.00	100	0	0.00
1962	100	0	0.00	200	0	0.00
1963	100	1	21.00	300	1	21.00
1964	100	4	42.00	400	5	42.00
1965	100			500	11	29.72
1966	100			600	25	23.07
1967	100			700	5	24.72
1968	100	2	18.00	800	61	22.75
1969	100	2	22.77	900	35	17.77
1970	100	24	16.00	1000	104	11.32
1971	100	18	11.25	1100	121	11.25
1972	100	2	2.64	1200	129	10.75
1973	100	1	1.00	1300	130	10.42

* includes ground accidents

TABLE 3-14

BV-44

Best Available Copy

CH-54 REMIX				CUMULATIVE		
CY	DATE	NO. MAJOR ACCIDENTS	RATE/ INC./100 WH	FLIGHT HOURS	NO. MAJOR ACCIDENTS	RATE/ 100,000 FH
1965	1-1-65	0		1,134	0	0
1966	1-1-66	2	175.90	2,711	2	73.77
1967	1-1-67	3	85.40	7,216	4	55.27
1968	1-1-68	2	13.1	23,275	6	26.25
1969	1-1-69	2	27.3	11,891	8	67.16
1970	1-1-70	2	10.4	19,115	10	52.32
1971	1-1-71	2	10.4	19,115	12	62.81
1972	1-1-72	2	10.4	19,115	14	73.25
1973	1-1-73	1	13.3	7,519	15	19.96

1-6
June
END DATA

TABLE 3-16

Reproduced from
best available copy.

BV-46

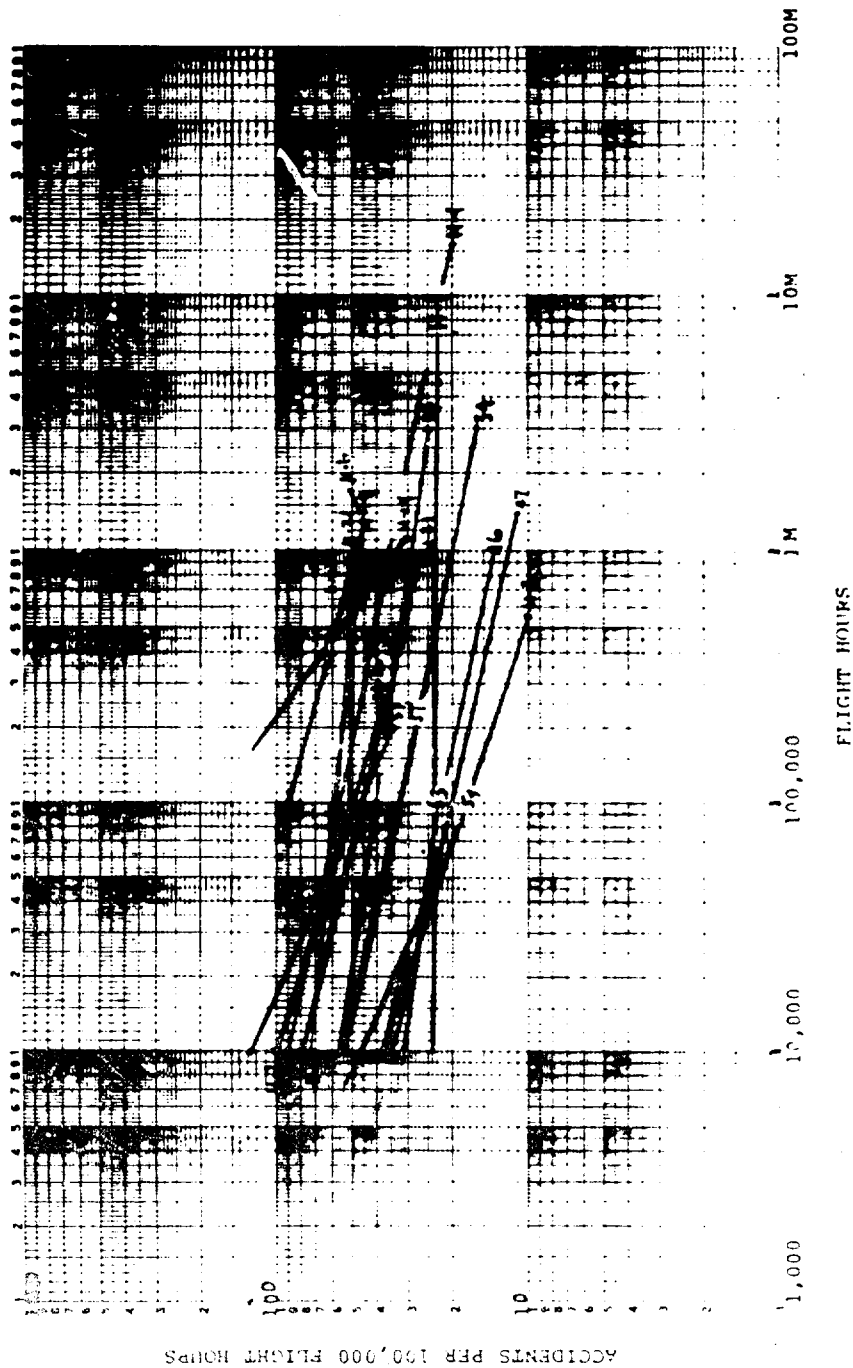
Best Available Copy

NO. 14-1-1 DETAIL OF GROWTH CURVES
 LOGARITHMIC
 GROWTH CURVES

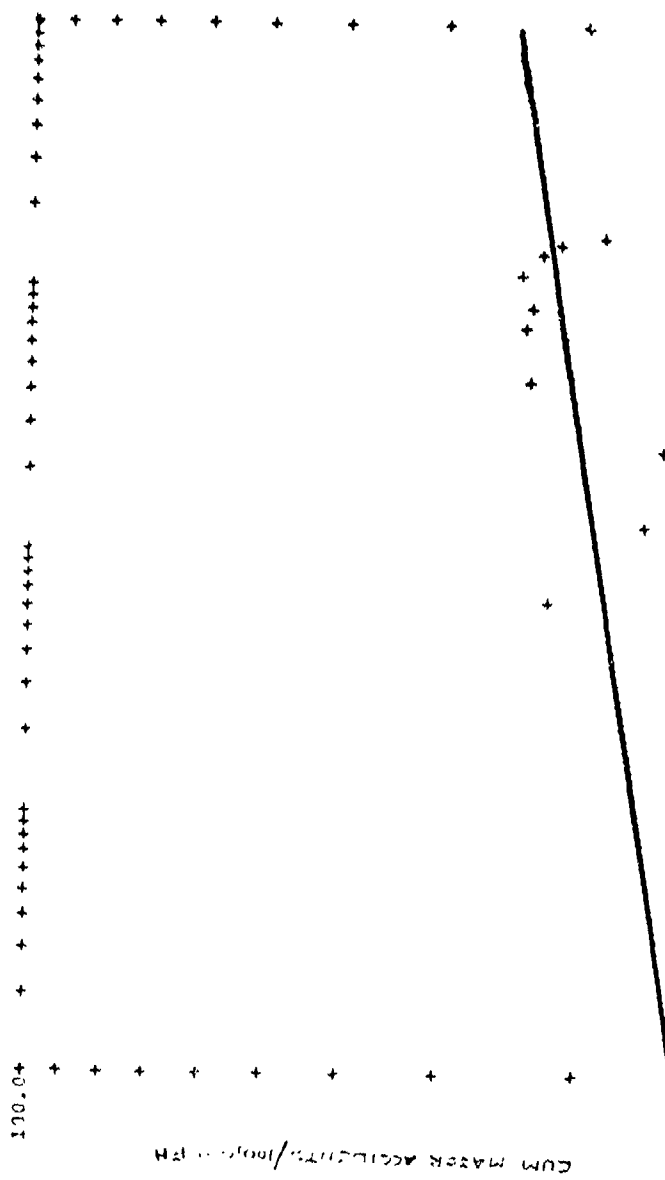
FIGURE 25 - COMPOSITE SAFETY GROWTH CURVES

CUM DATE

NAVY
 NAVY/AIR FORCE



Best Available Copy



CUM WATER ACCUMULATION / 1000000 LBS

BV-49

10.0+
10000.0
2.202014
BETA
+ + + + +
100000.0
15.640577
ALPHA
+ + + + +
1000000.0
3.041873
CUM FLIGHT HOURS
+ + + + +
1000000.0
1.056784
165265
+ + + + +
100000000.0
.394213
R

11-1 NAVY/USMC

FIGURE 27

The graph displays the relationship between cumulative weight percentage and cumulative percentage. The x-axis, labeled 'Cum. Weight Percentage / 100,000 PM', ranges from 0 to 10. The y-axis, labeled 'Cum. Percent', ranges from 0 to 100. The data points, marked with '+', show a non-linear increasing trend, with a smooth curve fitted to the data.

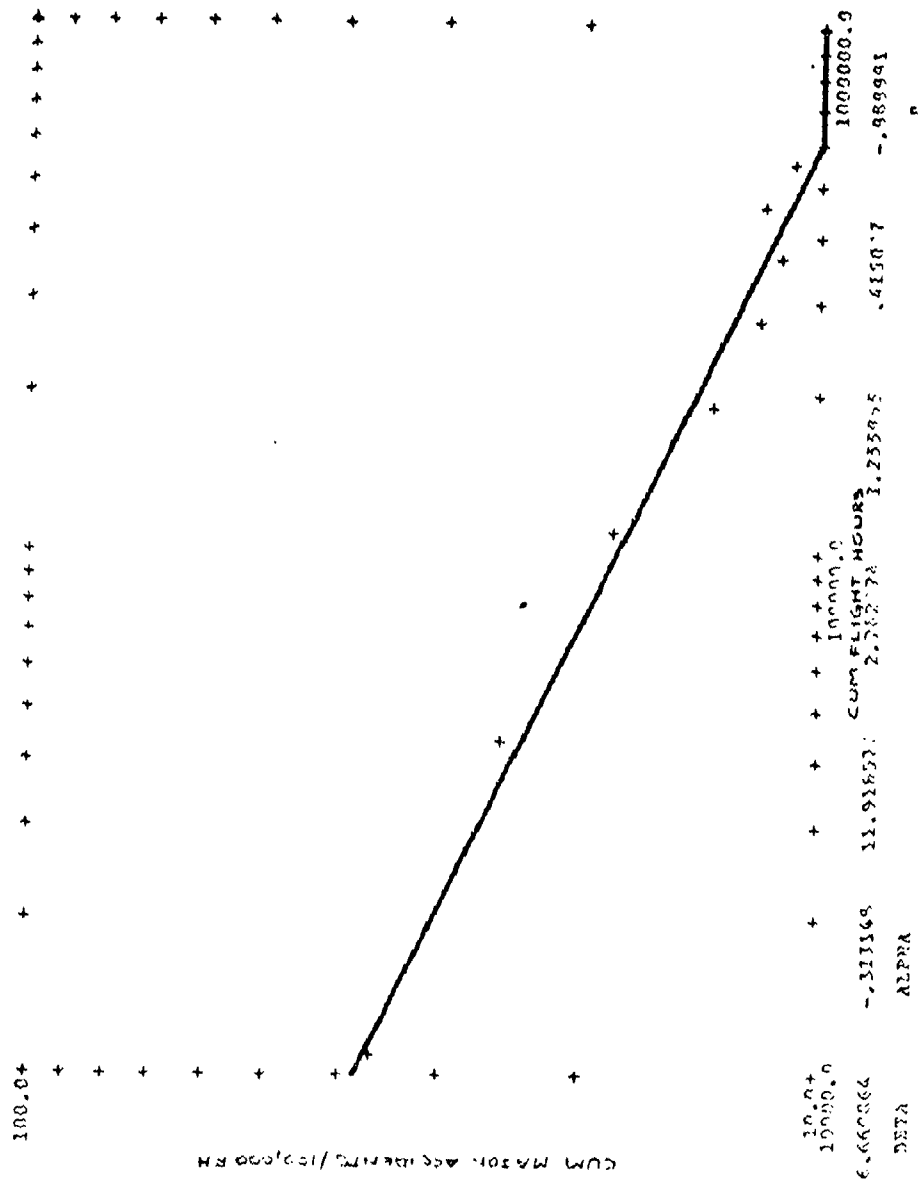
Cum. Weight Percentage / 100,000 PM	Cum. Percent
0.0	0
0.5	10
1.0	20
1.5	30
2.0	40
2.5	50
3.0	60
3.5	70
4.0	80
4.5	90
5.0	100

[illegible]

7-2 HAYY

FIGURE 28

BV-51



2- NAVY

FIGURE 29

[illegible]

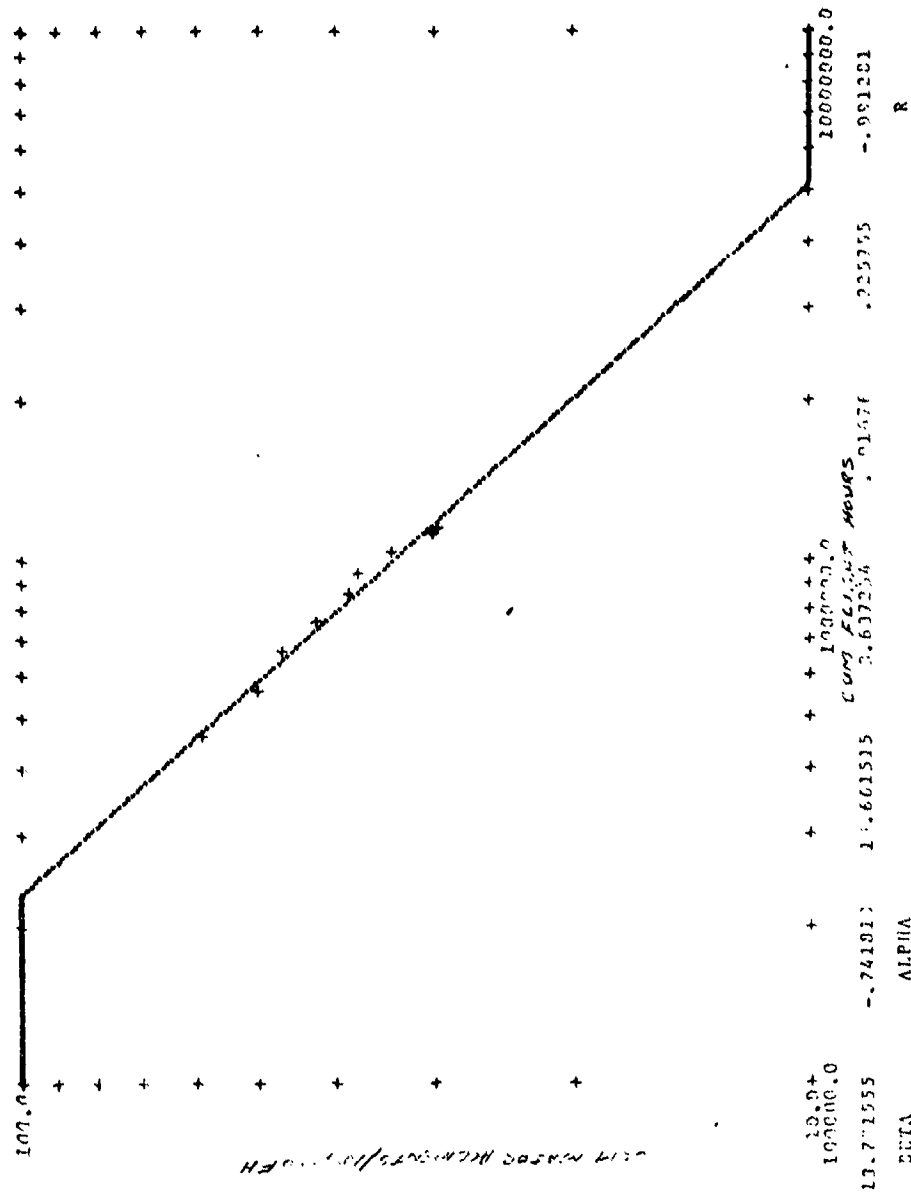
OH-5 AP. Y

FIGURE 30

[illegible]

ii-iv

FIGURE 31



BV-54

R-10 ARMY

FIGURE 32

[illegible]

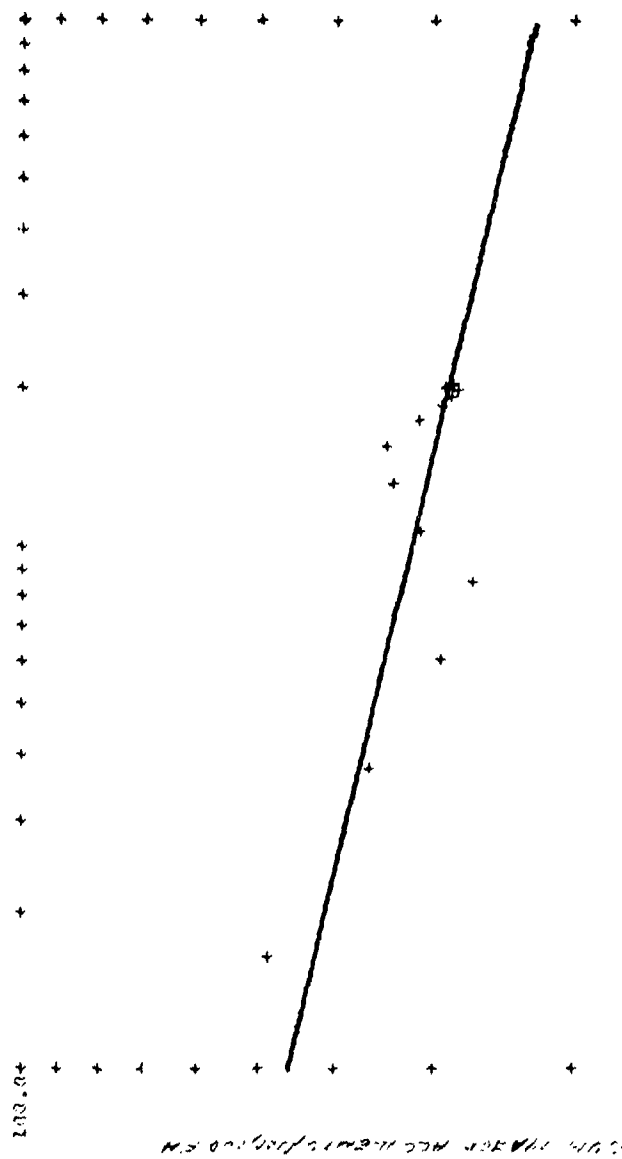
FIGURE 34

A hand-drawn graph showing a linear relationship between two variables. The vertical axis is labeled "CUMULATIVE AREA UNDER CURVE" and the horizontal axis is labeled "CUMULATIVE AREA UNDER CURVE". The data points are plotted as "+" signs, and a straight line is drawn through them, starting from the origin and extending upwards and to the right.

[illegible]

FIGURE 37

BV-69

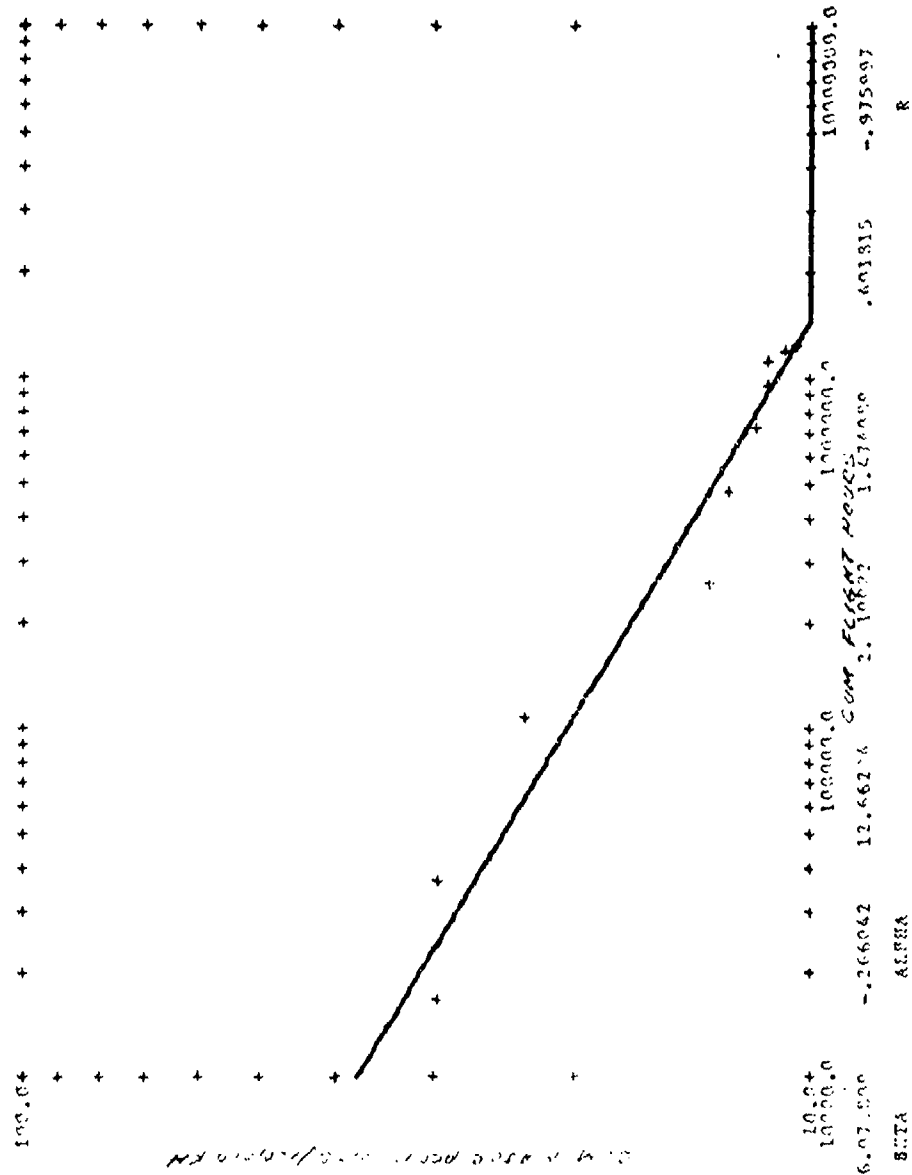


LOG. OF RATIO	10.00	9.99	9.98	9.97	9.96	9.95	9.94	9.93	9.92	9.91	9.90	9.89	9.88	9.87	9.86	9.85	9.84	9.83	9.82	9.81	9.80	9.79	9.78	9.77	9.76	9.75	9.74	9.73	9.72	9.71	9.70	9.69	9.68	9.67	9.66	9.65	9.64	9.63	9.62	9.61	9.60	9.59	9.58	9.57	9.56	9.55	9.54	9.53	9.52	9.51	9.50	9.49	9.48	9.47	9.46	9.45	9.44	9.43	9.42	9.41	9.40	9.39	9.38	9.37	9.36	9.35	9.34	9.33	9.32	9.31	9.30	9.29	9.28	9.27	9.26	9.25	9.24	9.23	9.22	9.21	9.20	9.19	9.18	9.17	9.16	9.15	9.14	9.13	9.12	9.11	9.10	9.09	9.08	9.07	9.06	9.05	9.04	9.03	9.02	9.01	9.00	8.99	8.98	8.97	8.96	8.95	8.94	8.93	8.92	8.91	8.90	8.89	8.88	8.87	8.86	8.85	8.84	8.83	8.82	8.81	8.80	8.79	8.78	8.77	8.76	8.75	8.74	8.73	8.72	8.71	8.70	8.69	8.68	8.67	8.66	8.65	8.64	8.63	8.62	8.61	8.60	8.59	8.58	8.57	8.56	8.55	8.54	8.53	8.52	8.51	8.50	8.49	8.48	8.47	8.46	8.45	8.44	8.43	8.42	8.41	8.40	8.39	8.38	8.37	8.36	8.35	8.34	8.33	8.32	8.31	8.30	8.29	8.28	8.27	8.26	8.25	8.24	8.23	8.22	8.21	8.20	8.19	8.18	8.17	8.16	8.15	8.14	8.13	8.12	8.11	8.10	8.09	8.08	8.07	8.06	8.05	8.04	8.03	8.02	8.01	8.00	7.99	7.98	7.97	7.96	7.95	7.94	7.93	7.92	7.91	7.90	7.89	7.88	7.87	7.86	7.85	7.84	7.83	7.82	7.81	7.80	7.79	7.78	7.77	7.76	7.75	7.74	7.73	7.72	7.71	7.70	7.69	7.68	7.67	7.66	7.65	7.64	7.63	7.62	7.61	7.60	7.59	7.58	7.57	7.56	7.55	7.54	7.53	7.52	7.51	7.50	7.49	7.48	7.47	7.46	7.45	7.44	7.43	7.42	7.41	7.40	7.39	7.38	7.37	7.36	7.35	7.34	7.33	7.32	7.31	7.30	7.29	7.28	7.27	7.26	7.25	7.24	7.23	7.22	7.21	7.20	7.19	7.18	7.17	7.16	7.15	7.14	7.13	7.12	7.11	7.10	7.09	7.08	7.07	7.06	7.05	7.04	7.03	7.02	7.01	7.00	6.99	6.98	6.97	6.96	6.95	6.94	6.93	6.92	6.91	6.90	6.89	6.88	6.87	6.86	6.85	6.84	6.83	6.82	6.81	6.80	6.79	6.78	6.77	6.76	6.75	6.74	6.73	6.72	6.71	6.70	6.69	6.68	6.67	6.66	6.65	6.64	6.63	6.62	6.61	6.60	6.59	6.58	6.57	6.56	6.55	6.54	6.53	6.52	6.51	6.50	6.49	6.48	6.47	6.46	6.45	6.44	6.43	6.42	6.41	6.40	6.39	6.38	6.37	6.36	6.35	6.34	6.33	6.32	6.31	6.30	6.29	6.28	6.27	6.26	6.25	6.24	6.23	6.22	6.21	6.20	6.19	6.18	6.17	6.16	6.15	6.14	6.13	6.12	6.11	6.10	6.09	6.08	6.07	6.06	6.05	6.04	6.03	6.02	6.01	6.00	5.99	5.98	5.97	5.96	5.95	5.94	5.93	5.92	5.91	5.90	5.89	5.88	5.87	5.86	5.85	5.84	5.83	5.82	5.81	5.80	5.79	5.78	5.77	5.76	5.75	5.74	5.73	5.72	5.71	5.70	5.69	5.68	5.67	5.66	5.65	5.64	5.63	5.62	5.61	5.60	5.59	5.58	5.57	5.56	5.55	5.54	5.53	5.52	5.51	5.50	5.49	5.48	5.47	5.46	5.45	5.44	5.43	5.42	5.41	5.40	5.39	5.38	5.37	5.36	5.35	5.34	5.33	5.32	5.31	5.30	5.29	5.28	5.27	5.26	5.25	5.24	5.23	5.22	5.21	5.20	5.19	5.18	5.17	5.16	5.15	5.14	5.13	5.12	5.11	5.10	5.09	5.08	5.07	5.06	5.05	5.04	5.03	5.02	5.01	5.00	4.99	4.98	4.97	4.96	4.95	4.94	4.93	4.92	4.91	4.90	4.89	4.88	4.87	4.86	4.85	4.84	4.83	4.82	4.81	4.80	4.79	4.78	4.77	4.76	4.75	4.74	4.73	4.72	4.71	4.70	4.69	4.68	4.67	4.66	4.65	4.64	4.63	4.62	4.61	4.60	4.59	4.58	4.57	4.56	4.55	4.54	4.53	4.52	4.51	4.50	4.49	4.48	4.47	4.46	4.45	4.44	4.43	4.42	4.41	4.40	4.39	4.38	4.37	4.36	4.35	4.34	4.33	4.32	4.31	4.30	4.29	4.28	4.27	4.26	4.25	4.24	4.23	4.22	4.21	4.20	4.19	4.18	4.17	4.16	4.15	4.14	4.13	4.12	4.11	4.10	4.09	4.08	4.07	4.06	4.05	4.04	4.03	4.02	4.01	4.00	3.99	3.98	3.97	3.96	3.95	3.94	3.93	3.92	3.91	3.90	3.89	3.88	3.87	3.86	3.85	3.84	3.83	3.82	3.81	3.80	3.79	3.78	3.77	3.76	3.75	3.74	3.73	3.72	3.71	3.70	3.69	3.68	3.67	3.66	3.65	3.64	3.63	3.62	3.61	3.60	3.59	3.58	3.57	3.56	3.55	3.54	3.53	3.52	3.51	3.50	3.49	3.48	3.47	3.46	3.45	3.44	3.43	3.42	3.41	3.40	3.39	3.38	3.37	3.36	3.35	3.34	3.33	3.32	3.31	3.30	3.29	3.28	3.27	3.26	3.25	3.24	3.23	3.22	3.21	3.20	3.19	3.18	3.17	3.16	3.15	3.14	3.13	3.12	3.11	3.10	3.09	3.08	3.07	3.06	3.05	3.04	3.03	3.02	3.01	3.00	2.99	2.98	2.97	2.96	2.95	2.94	2.93	2.92	2.91	2.90	2.89	2.88	2.87	2.86	2.85	2.84	2.83	2.82	2.81	2.80	2.79	2.78	2.77	2.76	2.75	2.74	2.73	2.72	2.71	2.70	2.69	2.68	2.67	2.66	2.65	2.64	2.63	2.62	2.61	2.60	2.59	2.58	2.57	2.56	2.55	2.54	2.53	2.52	2.51	2.50	2.49	2.48	2.47	2.46	2.45	2.44	2.43	2.42	2.41	2.40	2.39	2.38	2.37	2.36	2.35	2.34	2.33	2.32	2.31	2.30	2.29	2.28	2.27	2.26	2.25	2.24	2.23	2.22	2.21	2.20	2.19	2.18	2.17	2.16	2.15	2.14	2.13	2.12	2.11	2.10	2.09	2.08	2.07	2.06	2.05	2.04	2.03	2.02	2.01	2.00	1.99	1.98	1.97	1.96	1.95	1.94	1.93	1.92	1.91	1.90	1.89	1.88	1.87	1.86	1.85	1.84	1.83	1.82	1.81	1.80	1.79	1.78	1.77	1.76	1.75	1.74	1.73	1.72	1.71	1.70	1.69	1.68	1.67	1.66	1.65	1.64	1.63	1.62	1.61	1.60	1.59	1.58	1.57	1.56	1.55	1.54	1.53	1.52	1.51	1.50	1.49	1.48	1.47	1.46	1.45	1.44	1.43	1.42	1.41	1.40	1.39	1.38	1.37	1.36	1.35	1.34	1.33	1.32	1.31	1.30	1.29	1.28	1.27	1.26	1.25	1.24	1.23	1.22	1.21	1.20	1.19	1.18	1.17	1.16	1.15	1.14	1.13	1.12	1.11	1.10	1.09	1.08	1.07	1.06	1.05	1.04	1.03	1.02	1.01	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81	0.80	0.79	0.78	0.77	0.76	0.75	0.74	0.73	0.72	0.71	0.70	0.69	0.68	0.67	0.66	0.65	0.64	0.63	0.62	0.61	0.60	0.59	0.58	0.57	0.56	0.55	0.54	0.53	0.52	0.51	0.50	0.49	0.48	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01	0.00

CU-17 ARMY

FIGURE 38

BY-62



CH-47 ALL MODELS

FIGURE 40

[illegible]

FIGURE 42

SAFETY GROWTH PARAMETERS

AIRCRAFT	MAJOR ACCIDENT RATE / 100,000 FLT. HRS.		
	B	α	R
UH-1 ARMY	5.775	- .161	-.940
UH-1 NAVY/USMC	2.202	.054	.394
H-2 NAVY	7.796	- .339	-.978
H-3 NAVY	6.661	- .327	-.990
OH-6 ARMY	5.185	- .096	-.948
H-19 NAVY	5.350	- .102	-.636
H-19 ARMY	13.772	- .742	-.991
H-21A/B USAF	6.706	- .243	-.982
H-21C ARMY	1.848	.158	.906
H-34 ARMY	8.031	- .335	-.973
H-34 NAVY/USMC	6.528	- .254	-.983
H-37 NAVY	9.362	- .479	-.997
H-37 ARMY	5.266	- .156	-.776
UH/CH-46 ^{ALL} MODELS	2.985	- .015	-.075
CH-47 ALL MODELS	6.079	- .266	-.976
CH-53 USMC	6.175	- .270	-.948
CH-54 ARMY	6.846	- .354	-.966

TABLE 4

PREPARED BY
CHECKED BY
DATE

MODEL NO

WITNESSES

MALEFIC ACTIONS 1:1 FLIGHT SCENE

[illegible]

INCLUDE VIETNAM OPERATIONS

AAK-ZATA SOURCE B & UC-VENTOL DATE 1986 AAK

KEY

ALPHA	BETA	CUM FLIGHT HOURS	ETA
.151560	11.108218	-2.5318 5	.059945
100000.0			100000.0

ROTOR
CH-46 VAL.-/FH - CUM

FIGURE 44

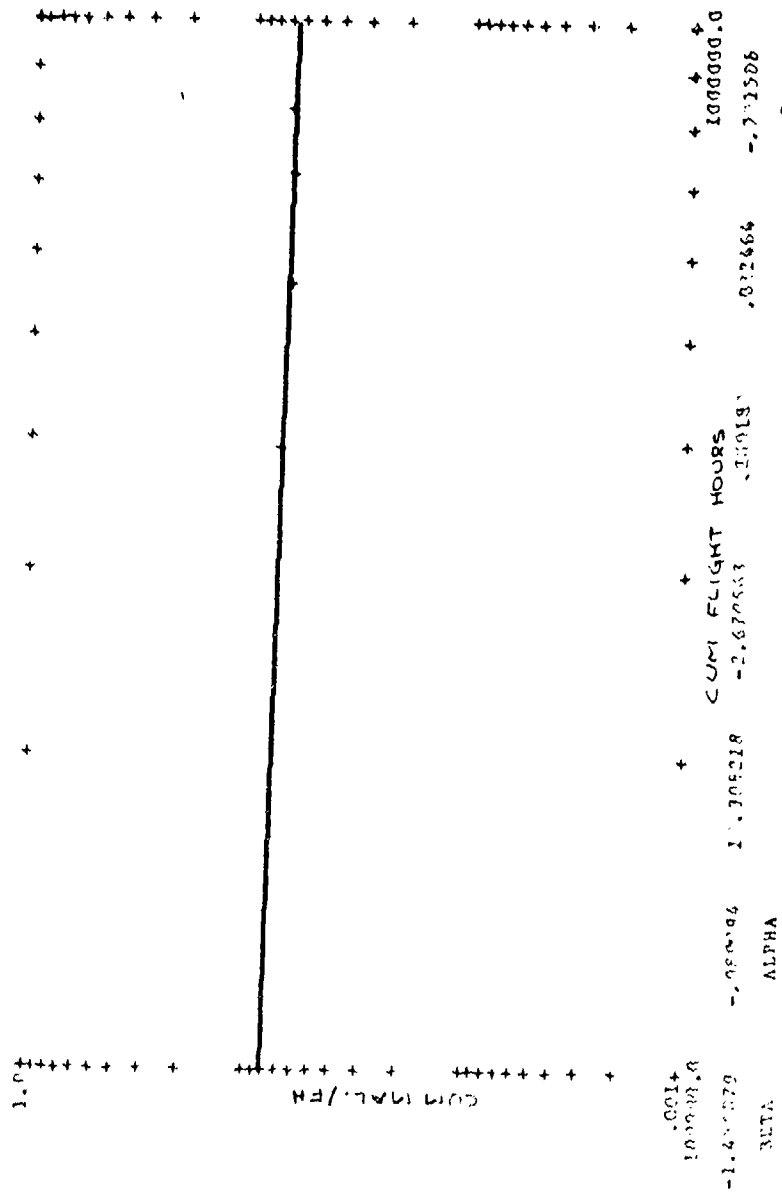


FIGURE 45

CC3	MAL./FH	ALPHA	BETA	CUM FLIGHT HOURS	1000000.0	1000000.0
0.044623	13.308218	0.057863	0.409755			
-4.159243						

LANDING GEAR
CH-46 MAL./FH - CUM

FIGURE 46

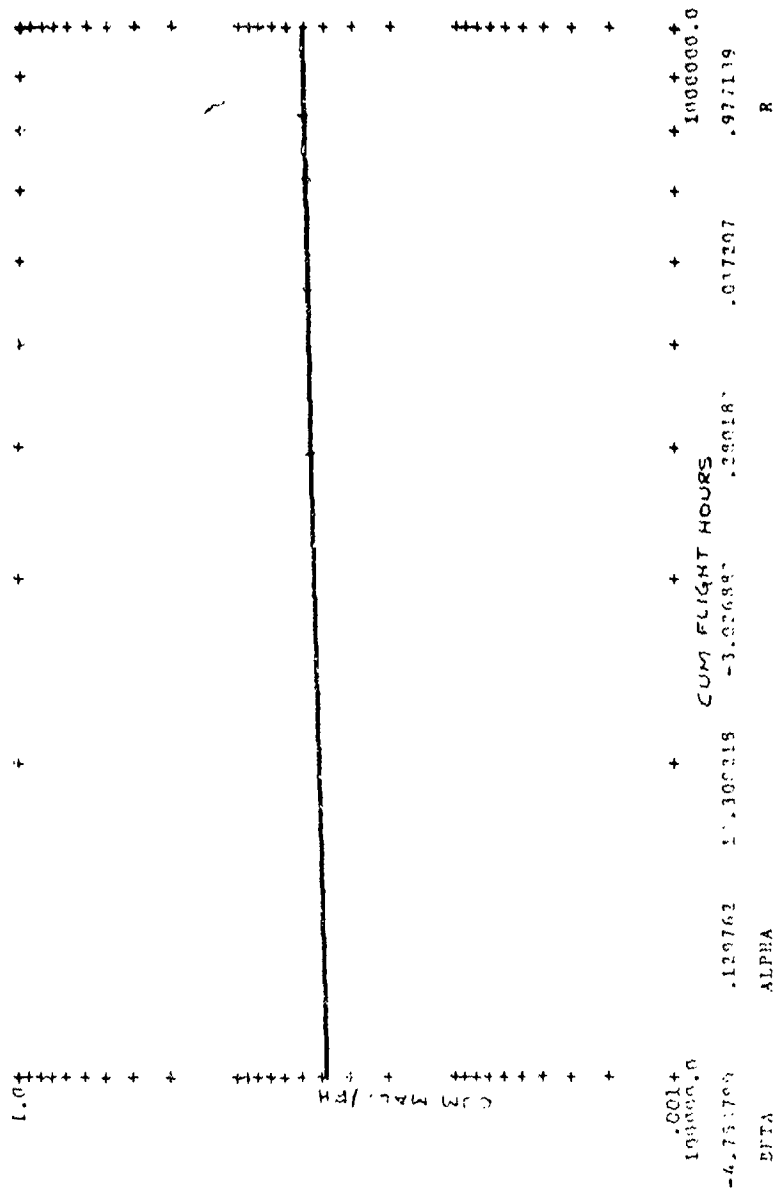
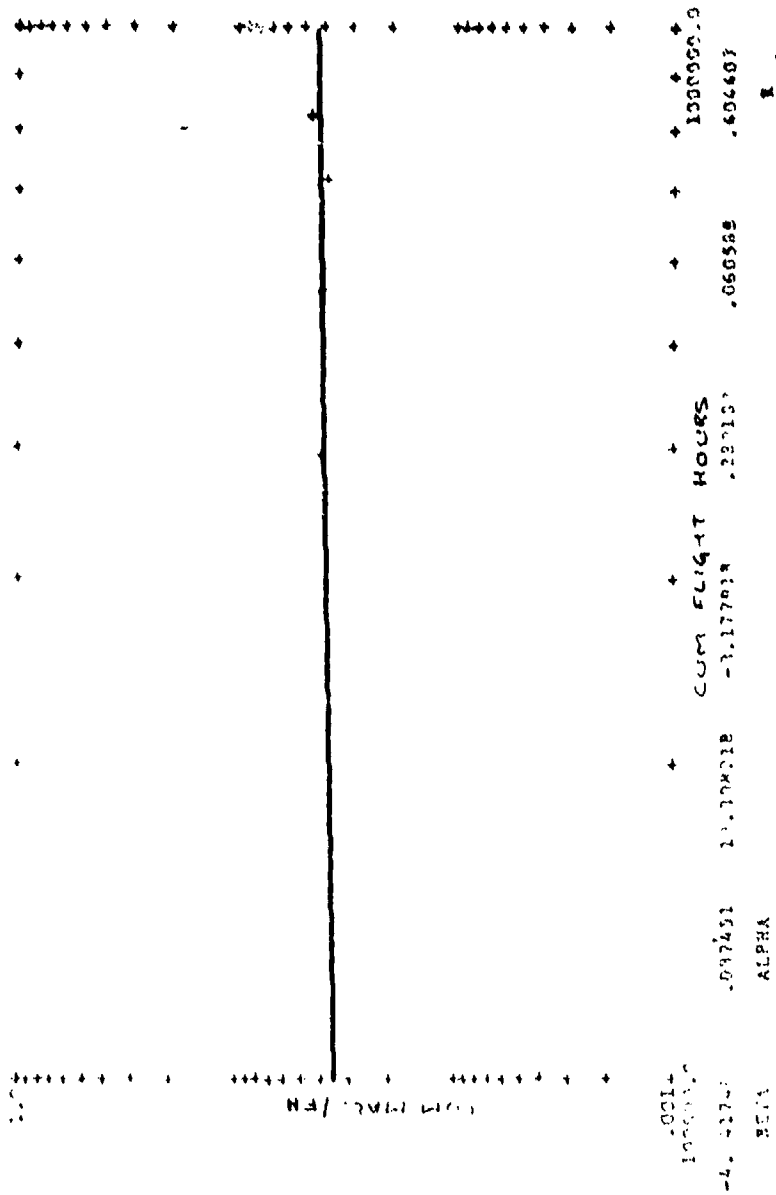
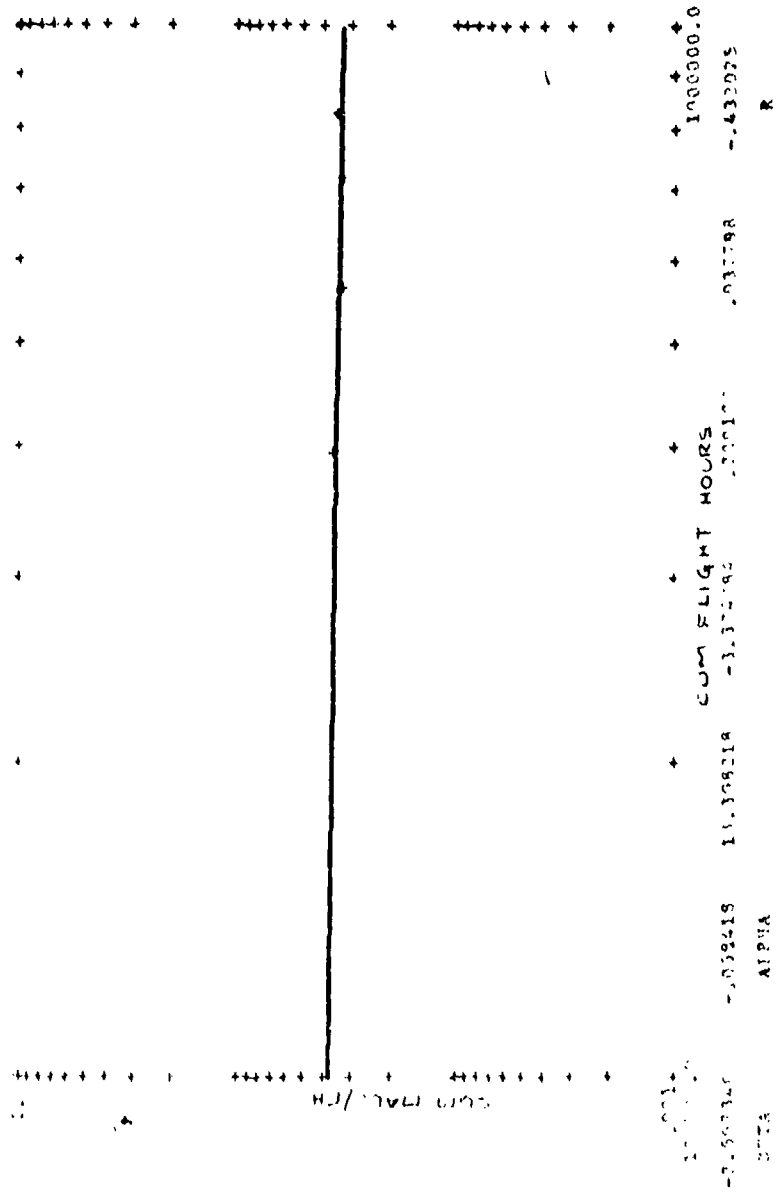


FIGURE 47



FLIGHT CONTROL
CH-46 PAL/TH - CUM

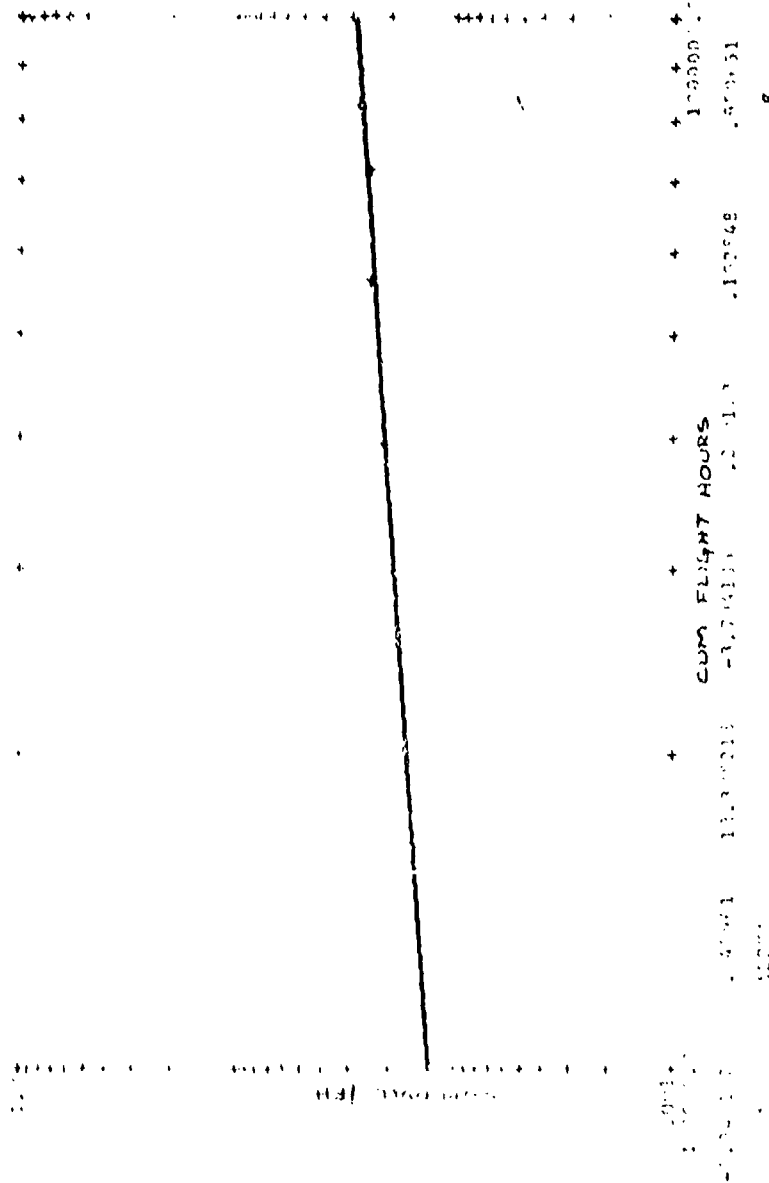
FIGURE 4B



HYDRAULIC POWER SUPPLY

CH-46 MAL./PH - CUM

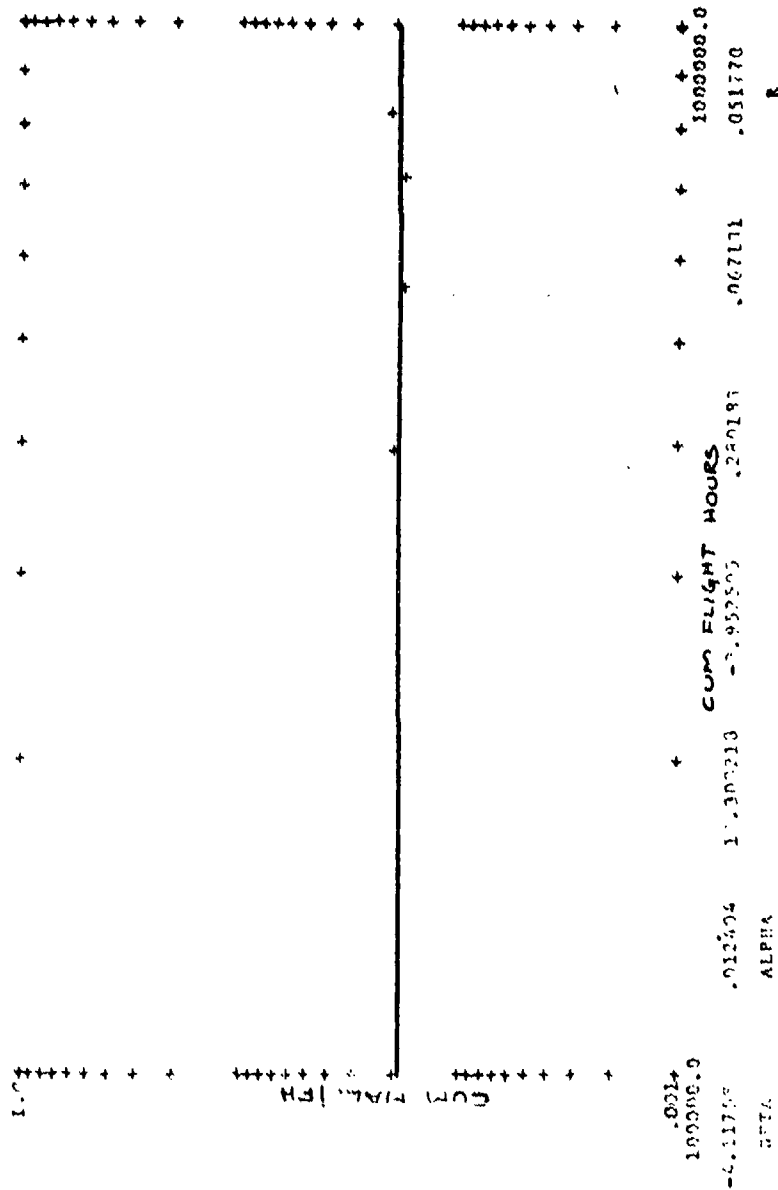
FIGURE 49



PORTUGAL INFORMATION

CH-46 VAL./FH - CUM

FIGURE 54

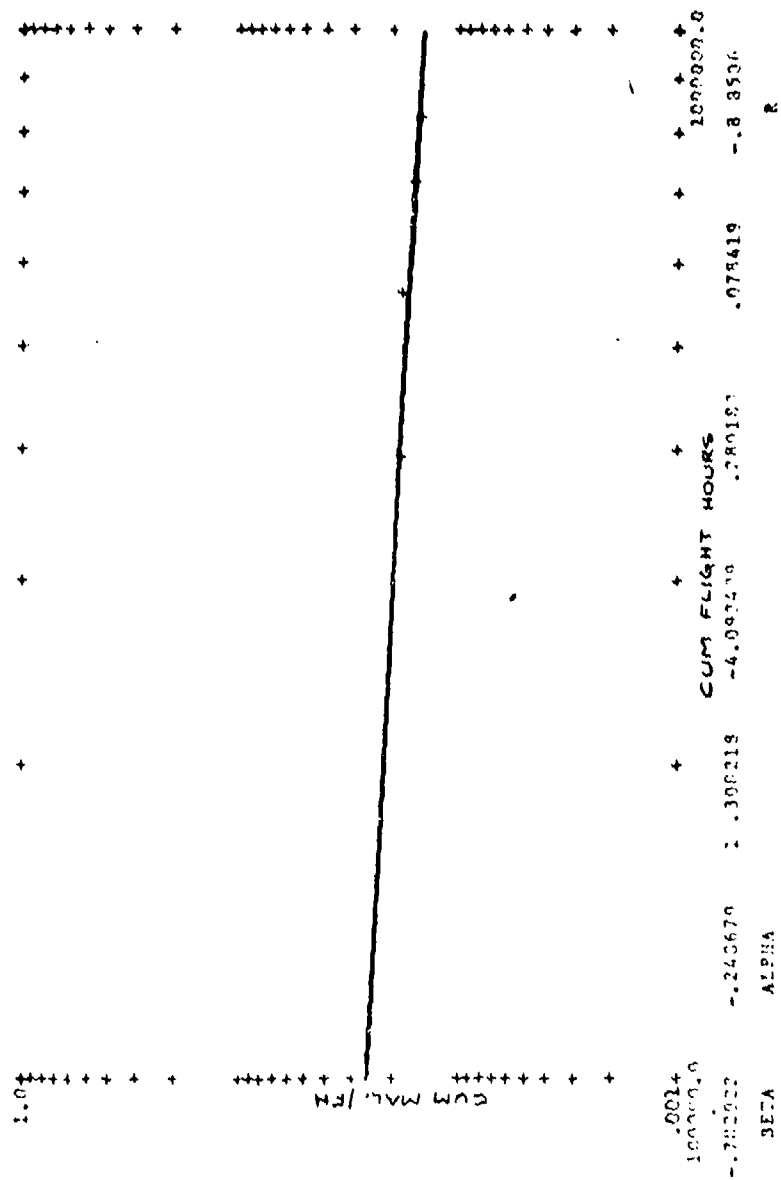


TURBOCHARGED ENGINES

CH-46 MAL./FH - CUM

FIGURE 55

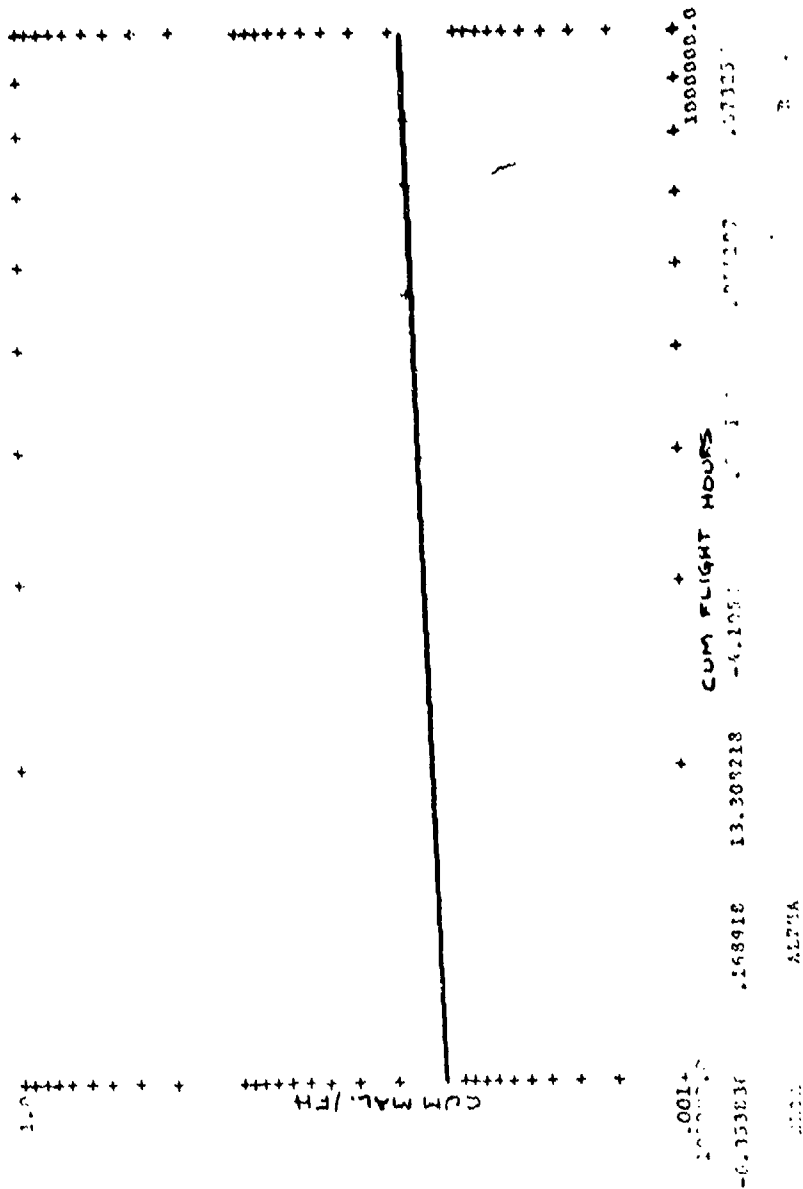
BV-80



INTERPHONE

CR-46 MAL/PH - CUM

FIGURE 56



BY-8

CH-46 MAL./FH - CUM

FIGURE 57

BV-82

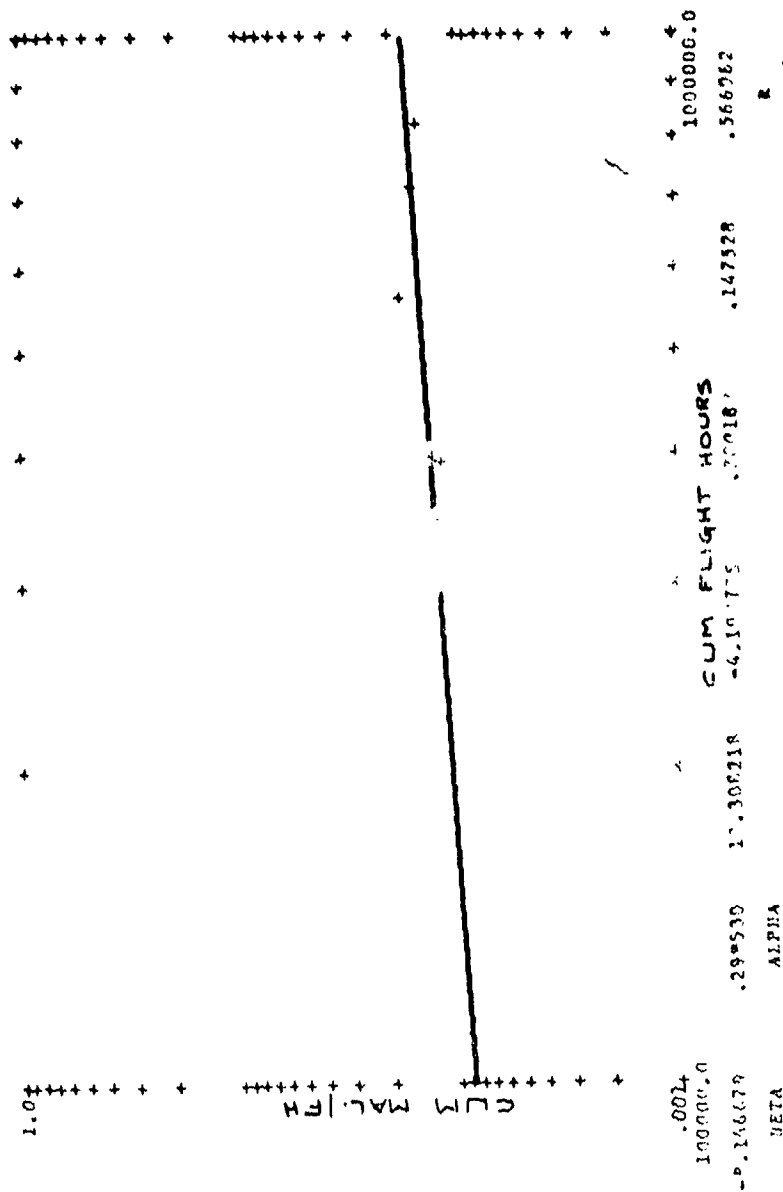
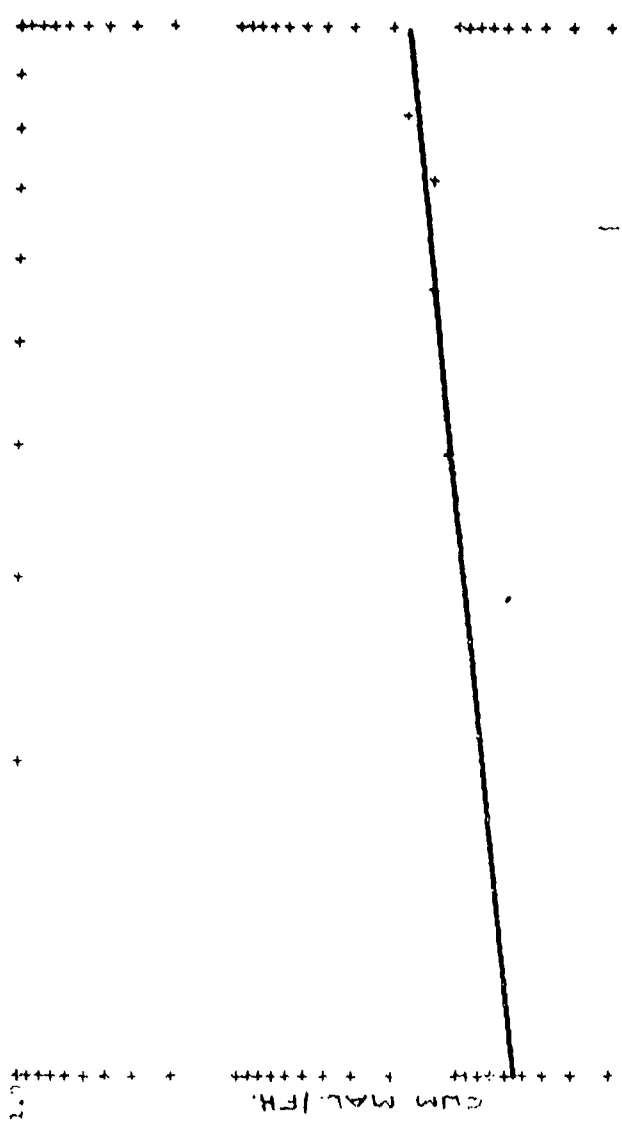


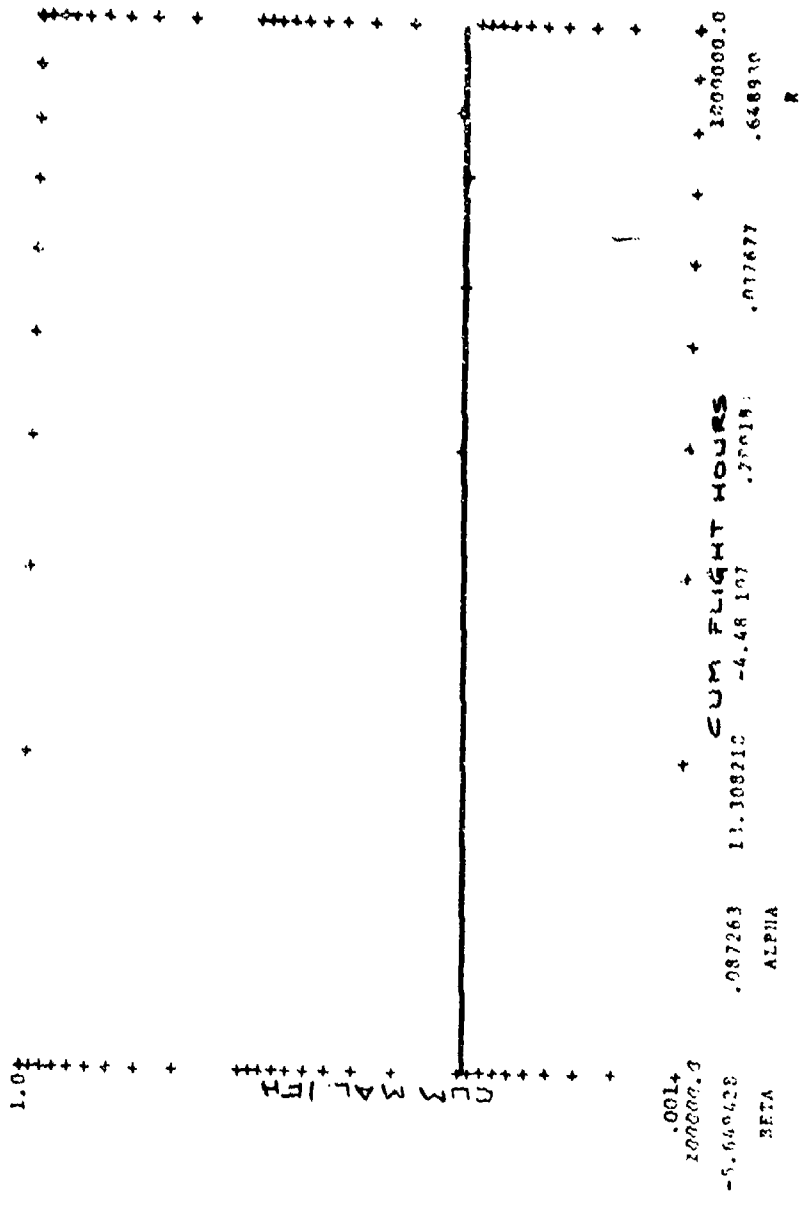
FIGURE 58



1000000.0	1000000.0	1000000.0	1000000.0
-10.107331	-6.317601	.290181	.889281
DETA	ALPHA		R

FUELAGE COMPARTMENT
CH-46 MAL./FH - CUM

FIGURE 59



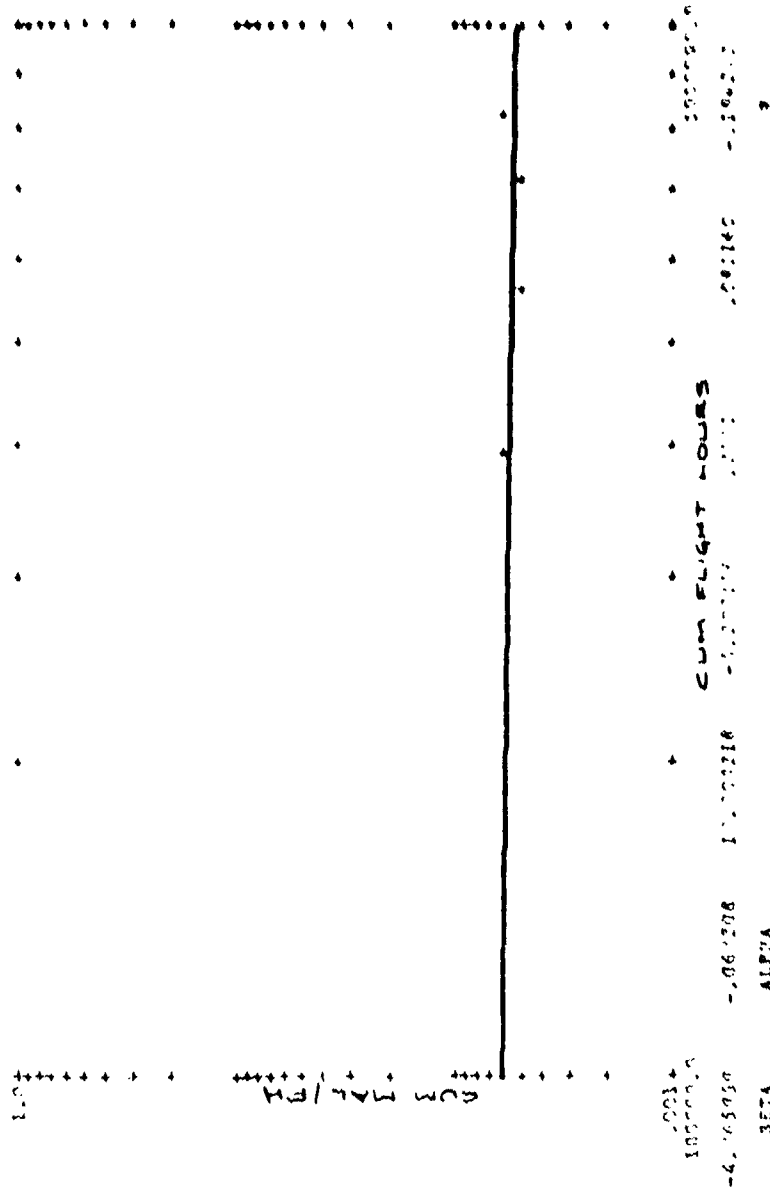
AUX. POWERPLANT
CH-46 MAL./FH - CUM

FIGURE 60

TIME	ALPHA	CUM FLIGHT HOURS	REMARKS
1.000000	0.001	0.000000	
2.000000	0.002	0.000000	
3.000000	0.003	0.000000	
4.000000	0.004	0.000000	
5.000000	0.005	0.000000	
6.000000	0.006	0.000000	
7.000000	0.007	0.000000	
8.000000	0.008	0.000000	
9.000000	0.009	0.000000	
10.000000	0.010	0.000000	
11.000000	0.011	0.000000	
12.000000	0.012	0.000000	
13.000000	0.013	0.000000	
14.000000	0.014	0.000000	
15.000000	0.015	0.000000	
16.000000	0.016	0.000000	
17.000000	0.017	0.000000	
18.000000	0.018	0.000000	
19.000000	0.019	0.000000	
20.000000	0.020	0.000000	
21.000000	0.021	0.000000	
22.000000	0.022	0.000000	
23.000000	0.023	0.000000	
24.000000	0.024	0.000000	
25.000000	0.025	0.000000	
26.000000	0.026	0.000000	
27.000000	0.027	0.000000	
28.000000	0.028	0.000000	
29.000000	0.029	0.000000	
30.000000	0.030	0.000000	
31.000000	0.031	0.000000	
32.000000	0.032	0.000000	
33.000000	0.033	0.000000	
34.000000	0.034	0.000000	
35.000000	0.035	0.000000	
36.000000	0.036	0.000000	
37.000000	0.037	0.000000	
38.000000	0.038	0.000000	
39.000000	0.039	0.000000	
40.000000	0.040	0.000000	
41.000000	0.041	0.000000	
42.000000	0.042	0.000000	
43.000000	0.043	0.000000	
44.000000	0.044	0.000000	
45.000000	0.045	0.000000	
46.000000	0.046	0.000000	
47.000000	0.047	0.000000	
48.000000	0.048	0.000000	
49.000000	0.049	0.000000	
50.000000	0.050	0.000000	
51.000000	0.051	0.000000	
52.000000	0.052	0.000000	
53.000000	0.053	0.000000	
54.000000	0.054	0.000000	
55.000000	0.055	0.000000	
56.000000	0.056	0.000000	
57.000000	0.057	0.000000	
58.000000	0.058	0.000000	
59.000000	0.059	0.000000	
60.000000	0.060	0.000000	
61.000000	0.061	0.000000	
62.000000	0.062	0.000000	
63.000000	0.063	0.000000	
64.000000	0.064	0.000000	
65.000000	0.065	0.000000	
66.000000	0.066	0.000000	
67.000000	0.067	0.000000	
68.000000	0.068	0.000000	
69.000000	0.069	0.000000	
70.000000	0.070	0.000000	
71.000000	0.071	0.000000	
72.000000	0.072	0.000000	
73.000000	0.073	0.000000	
74.000000	0.074	0.000000	
75.000000	0.075	0.000000	
76.000000	0.076	0.000000	
77.000000	0.077	0.000000	
78.000000	0.078	0.000000	

CH-46 MAL./PH - COM

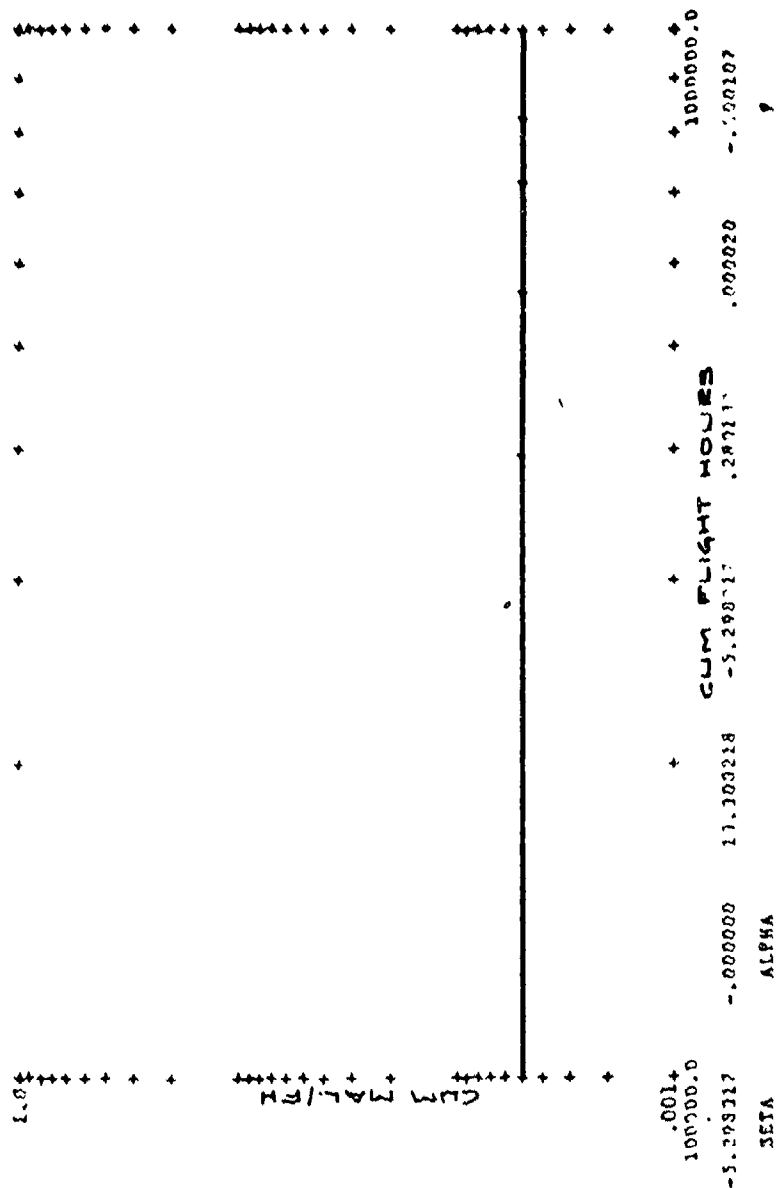
FIGURE 62



AIR CONDITIONING - ICE CONTROL

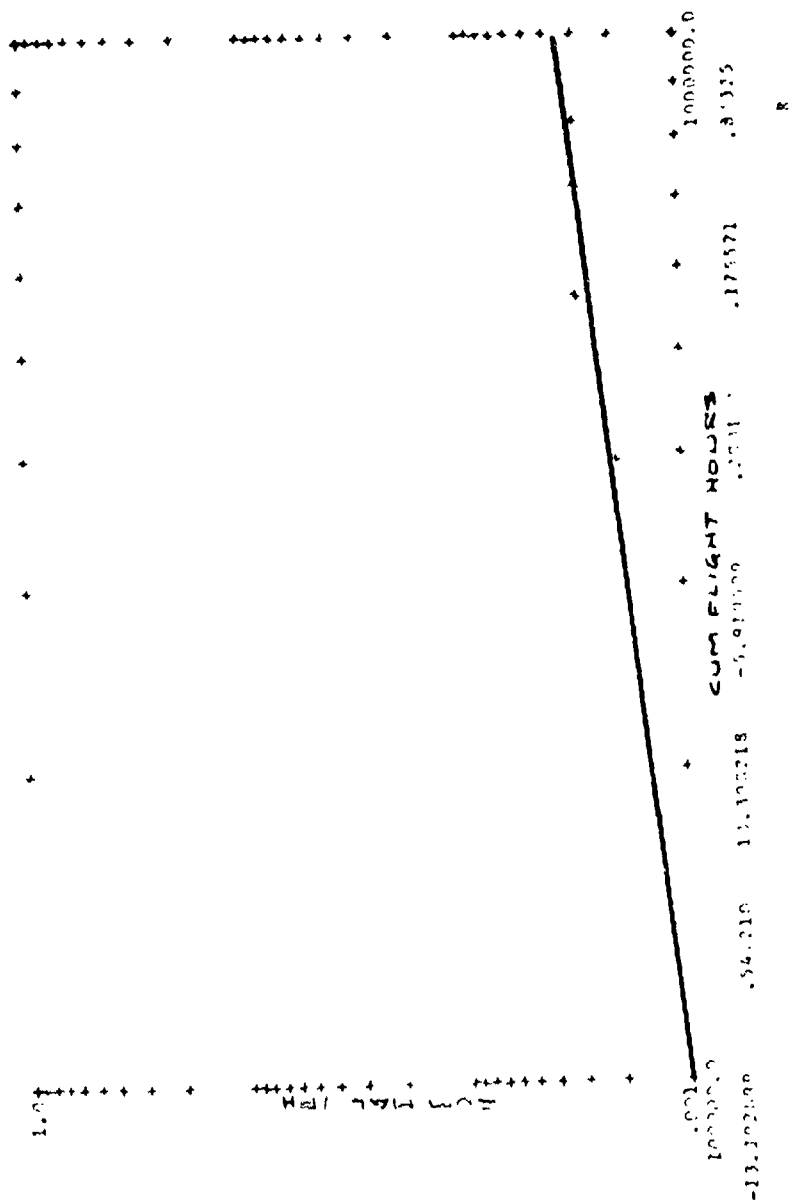
CB-46 MAL/FH - COM

FIGURE 63



FUEL
CH-46 MAL./PH - CUM

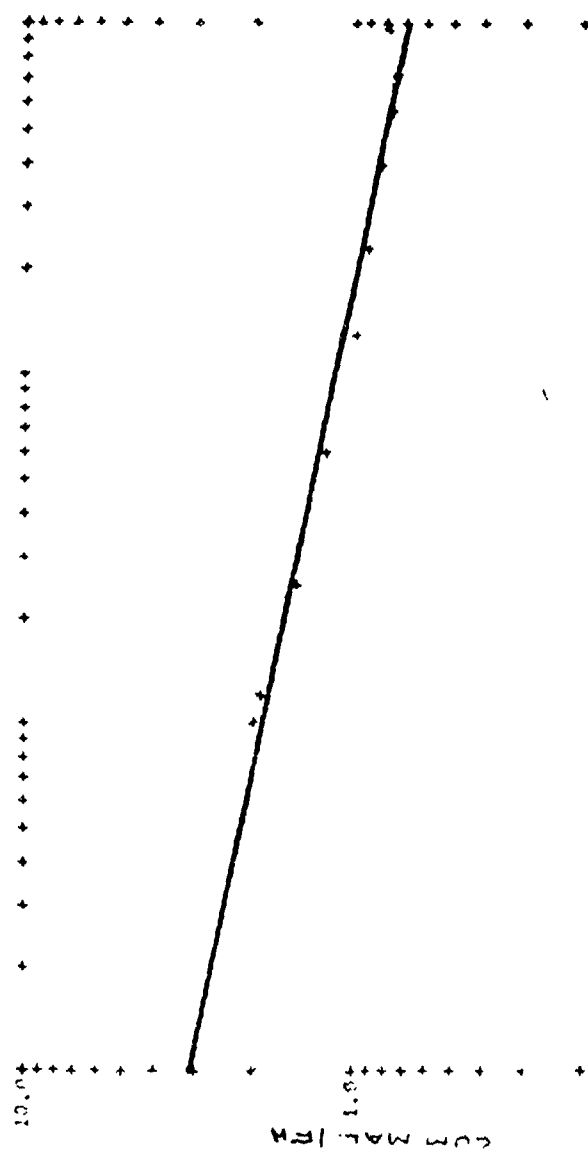
FIGURE 64



ISC. UTILITIES

CH-46 MAL. /FR - CUM

FIGURE 65



BV-90

1000.0	1000.0	1000.0	1000.0	100000.0
2.618514	-0.21735	11.72282	0.955763	1.61810
BETA	ALPHA			
			0.35467	-0.983427

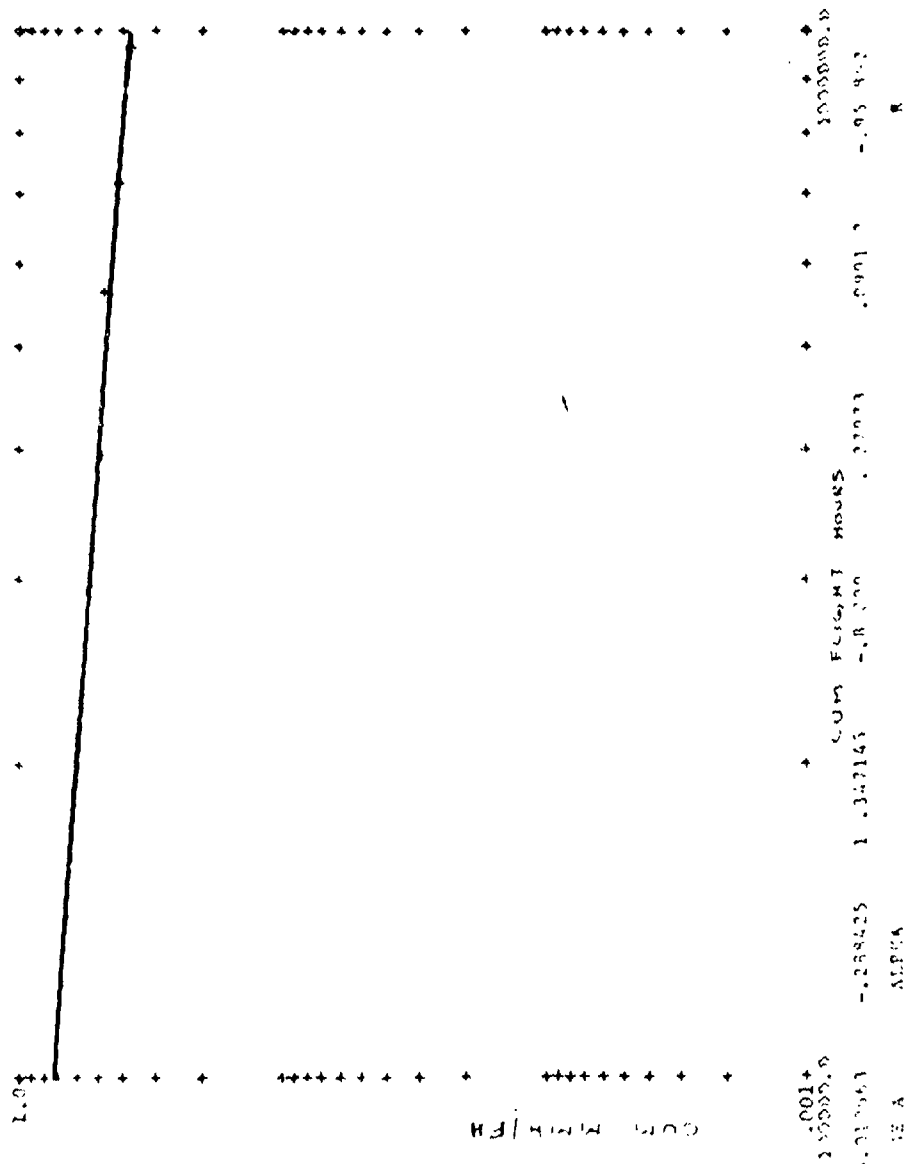
TOTAL
CH-46 MAL./PH - CUM

FIGURE 66

[illegible]

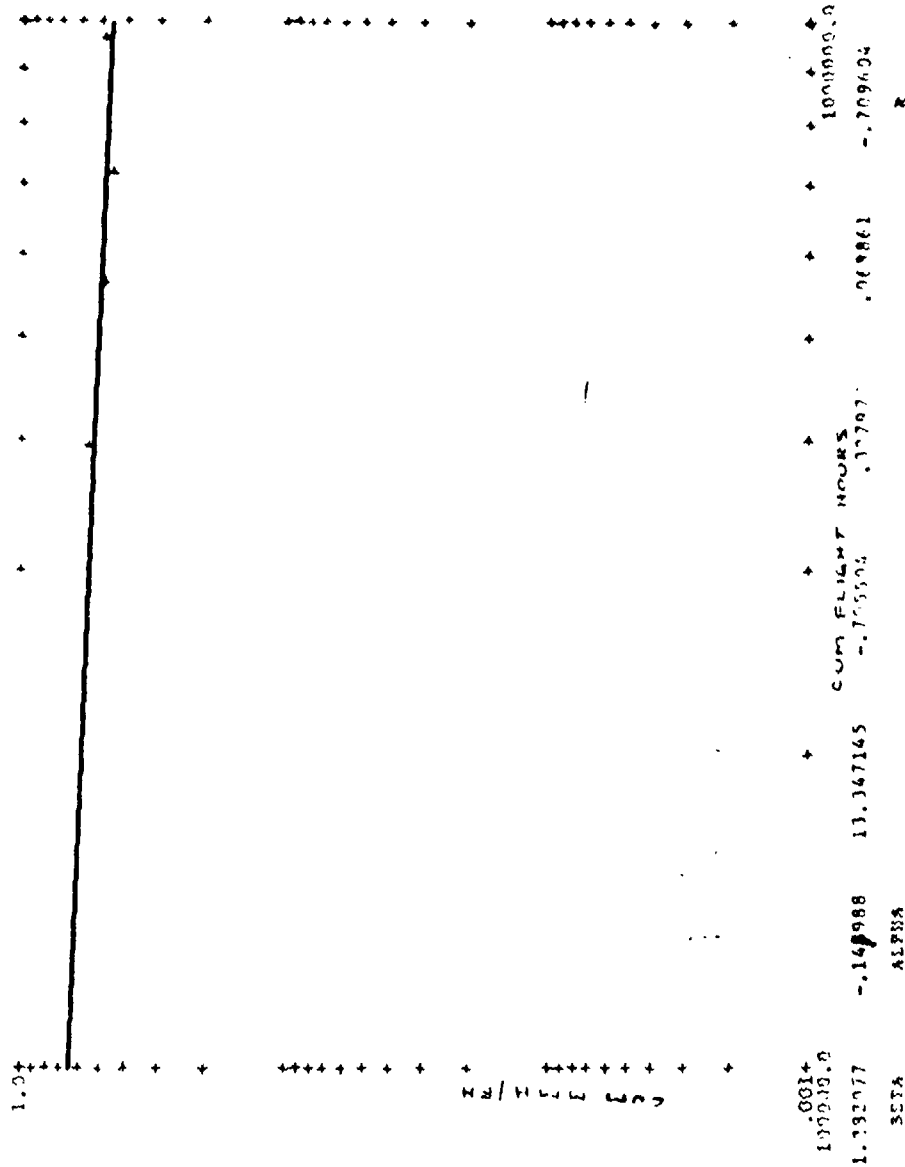
100-443887-100

EV-9,



ATPERS
CH-46 MIN/H - CUM

FIGURE 67



BV-93

CH-46 PPH/FH - CUM

FIGURE 68

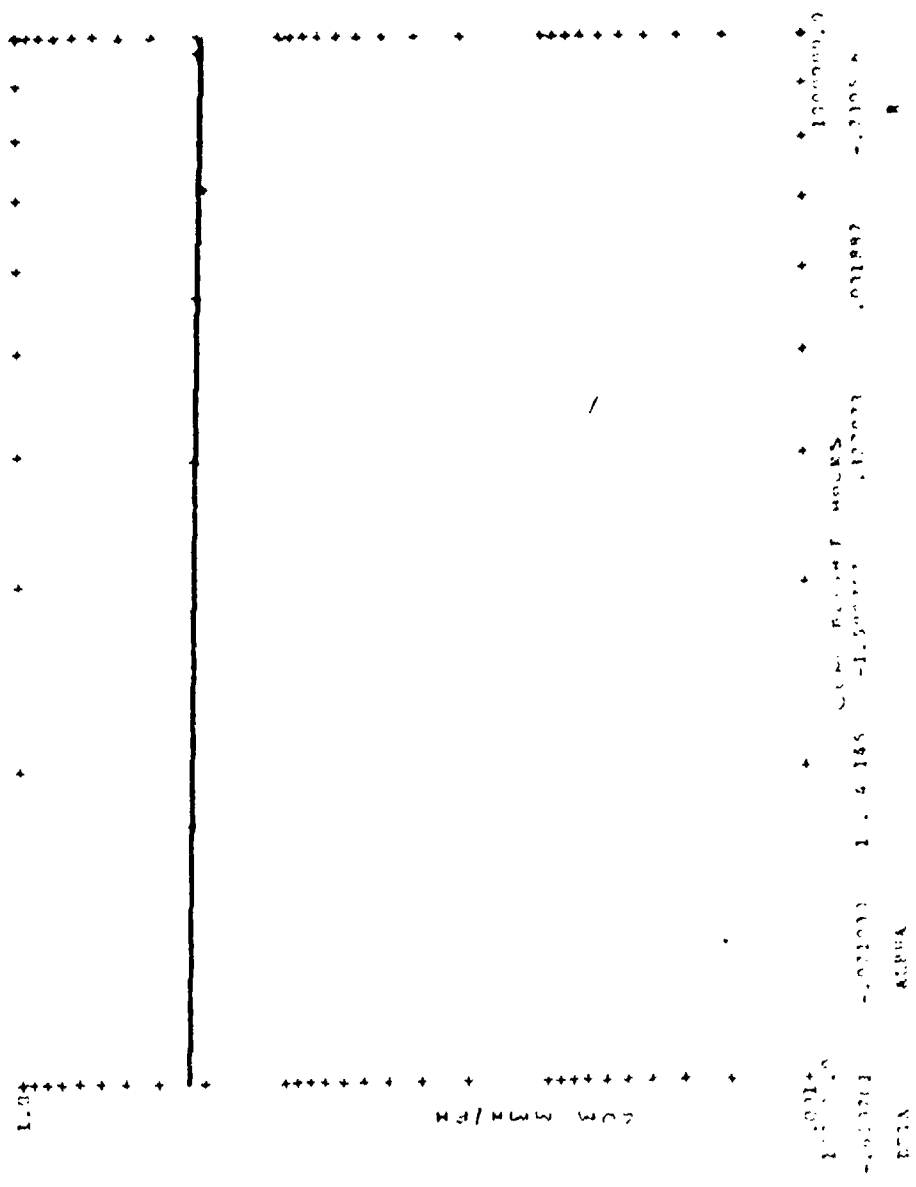
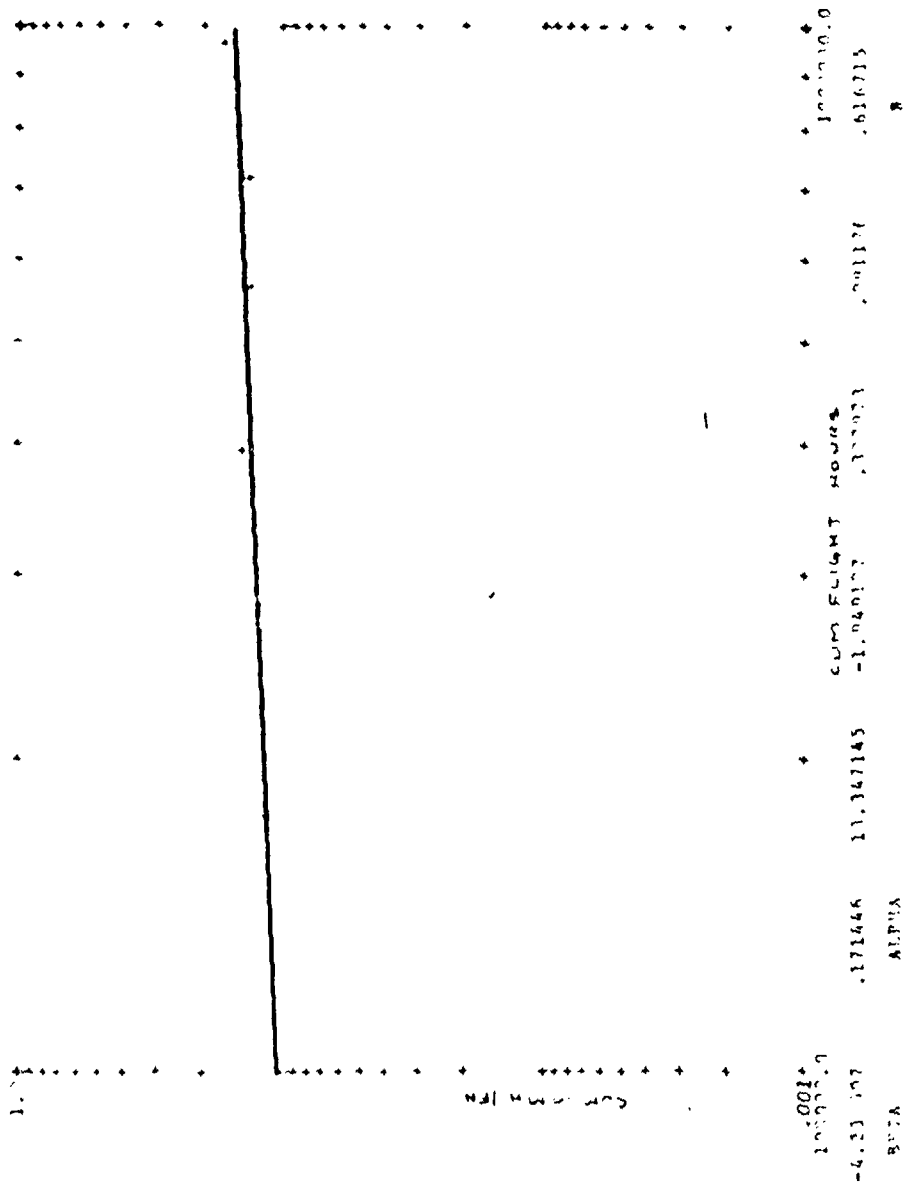


FIGURE 6A
CH-46 MM/PH - CUM



LANDING GEAR
CH-46 1001/FH - CUM

FIGURE 70

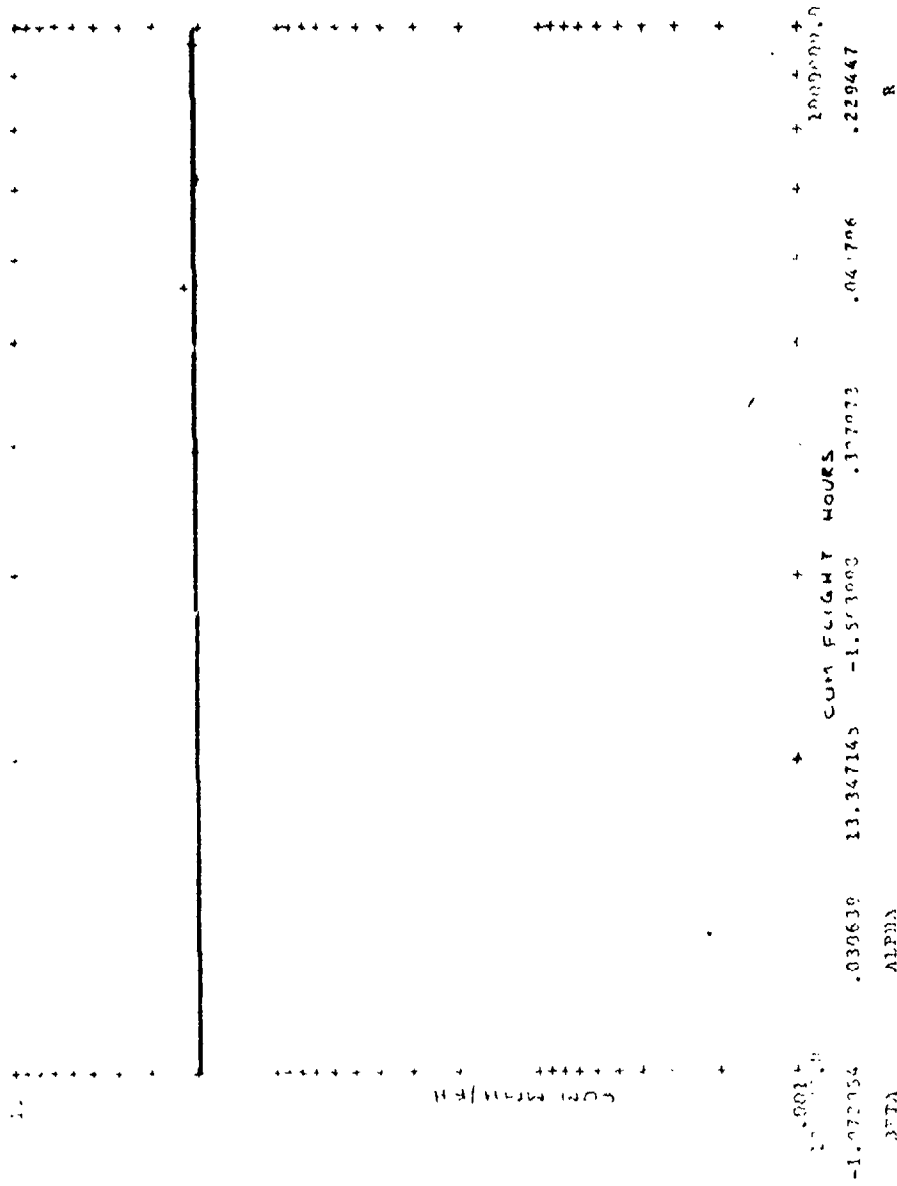
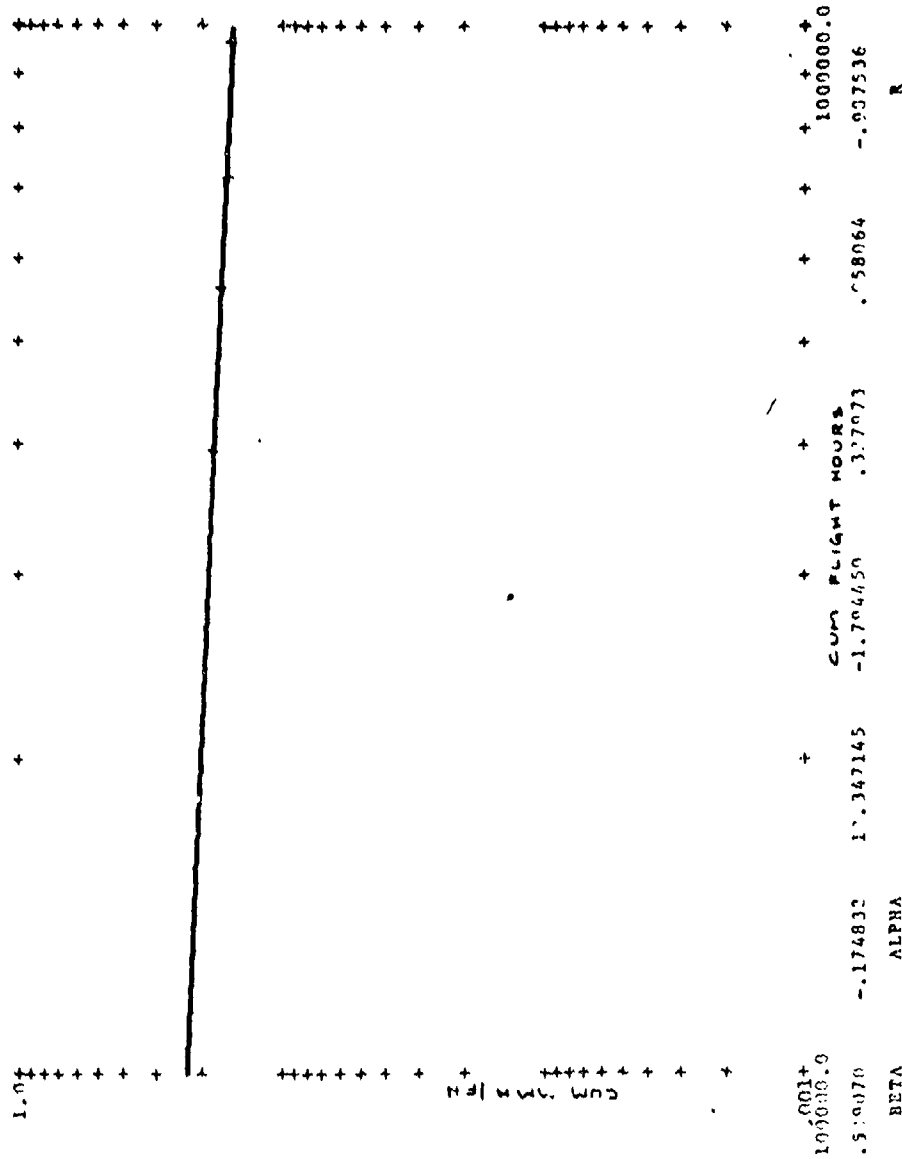


FIGURE 72



HYDRAULIC POWER SUPPLY
CH-46 HPH/PH - CUM

FIGURE 70

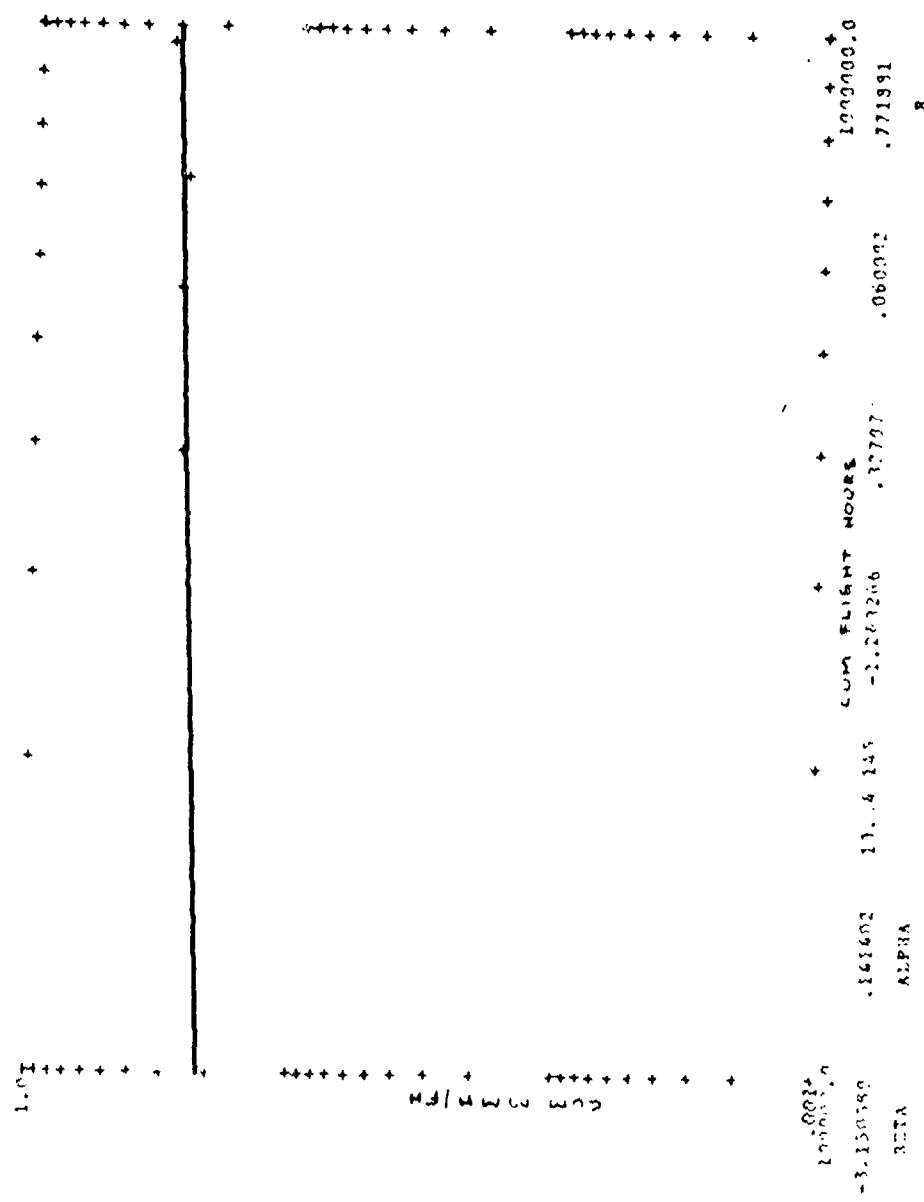
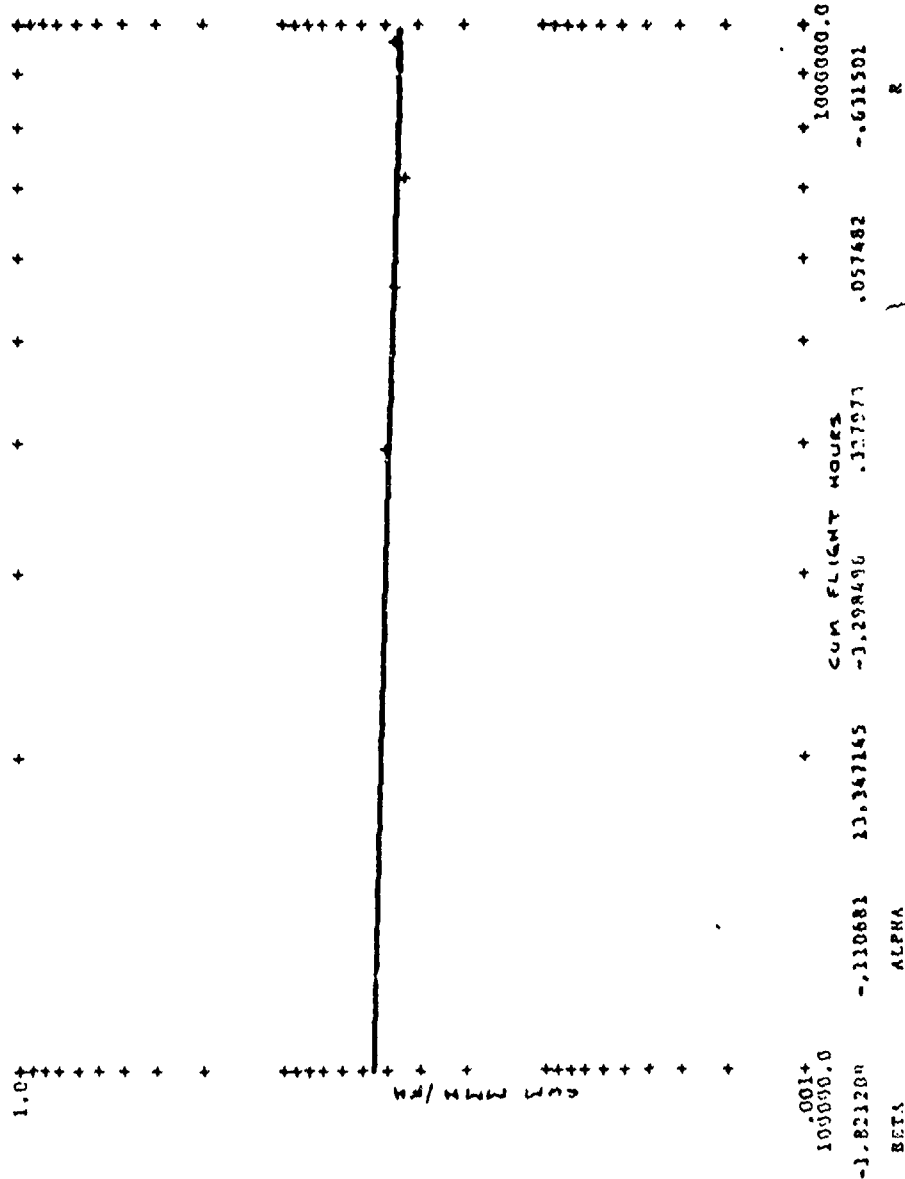


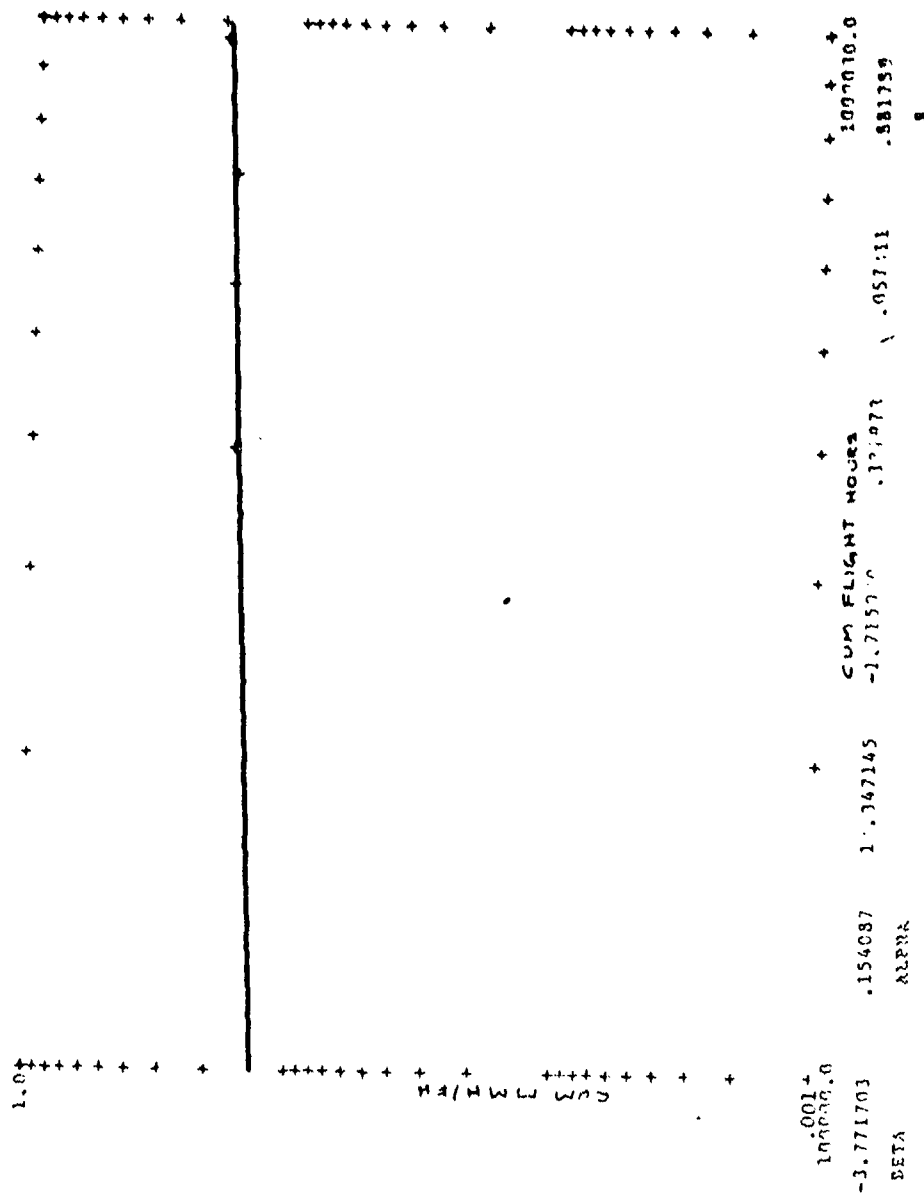
FIGURE 74



BV-100

LIGHTING
CH-46 MMR/TH - CUM

FIGURE 75



RADIO NAVIGATION
CH-46 AMR/PH - CUM

FIGURE 76

BV-101

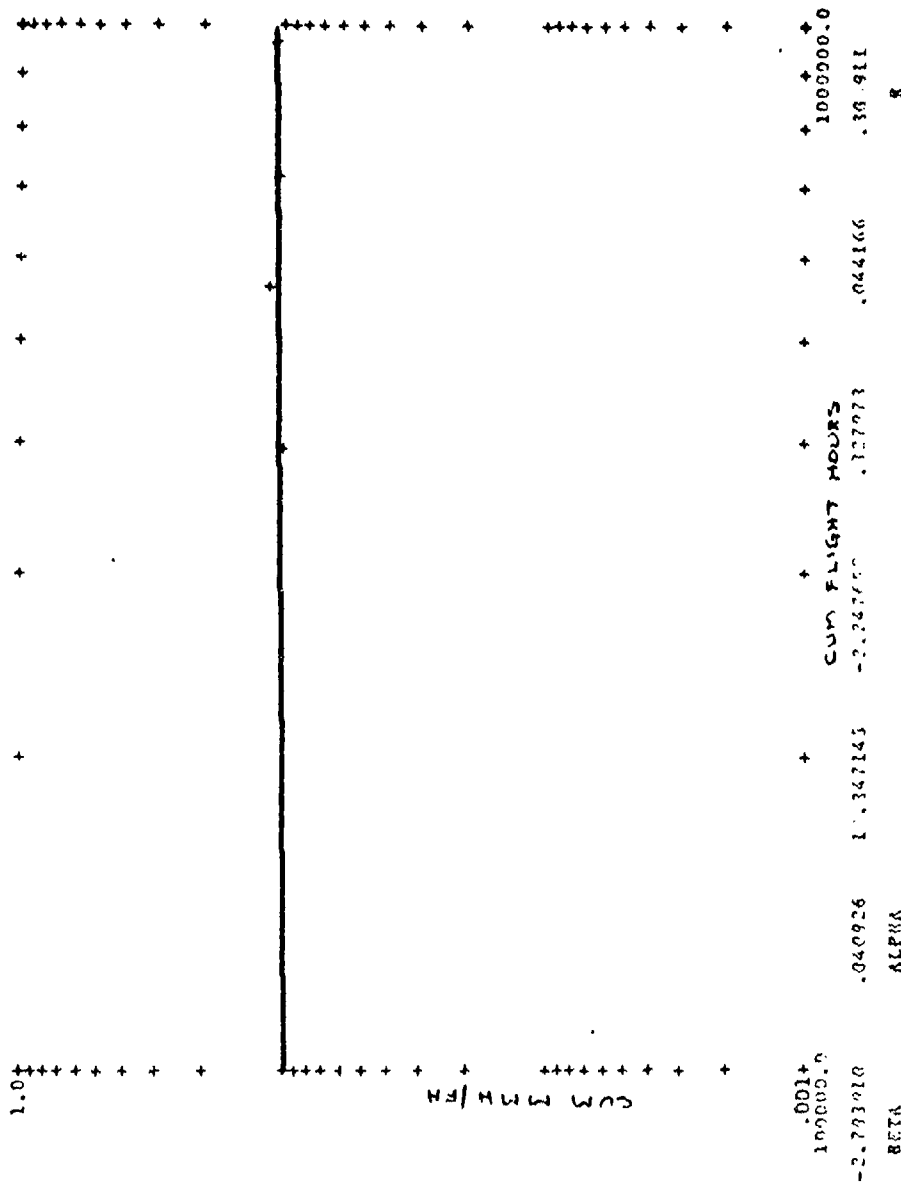
1.001+
100000.0
-6.343071
BETA

0.329663 13.347145
CUM FLIGHT HOURS
-1.941274 .37971
ALPHA

1000000.0
.833705

WJ-46 MCH/PH - CUM

FIGURE 77



POWERPLANT INSTALLATION

CH-46 MHE/FH - CUM

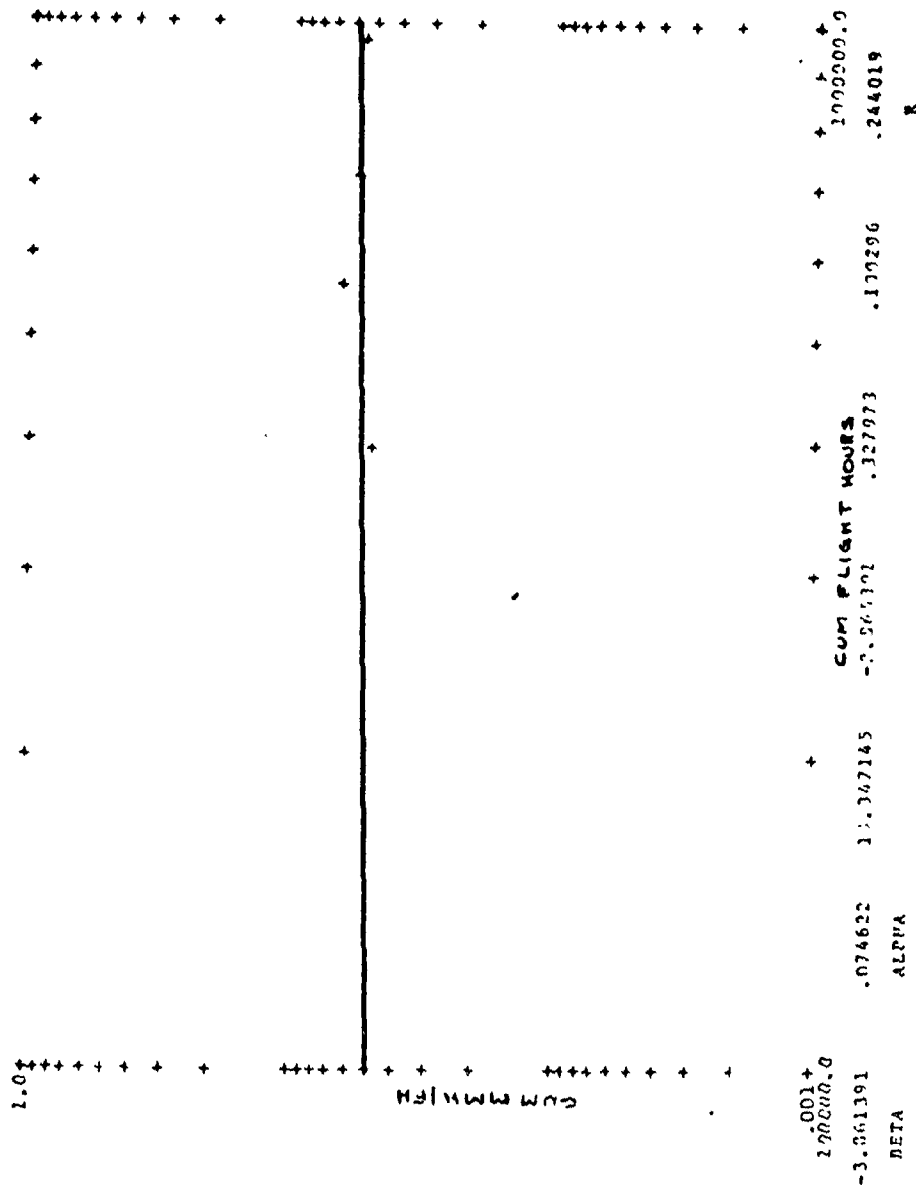
FIGURE 7B

BV-103

[illegible]

CH-46 MCH/FLI - CUM

FIGURE 79



BV-105

INTERPHONE
CH-46 MSG/TH - CUM

FIGURE 80

[illegible]

FOR CON PUBLICATIONS
CH-46 MMH/FH - CUM

FIGURE B1

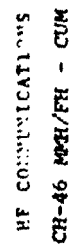


FIGURE 82

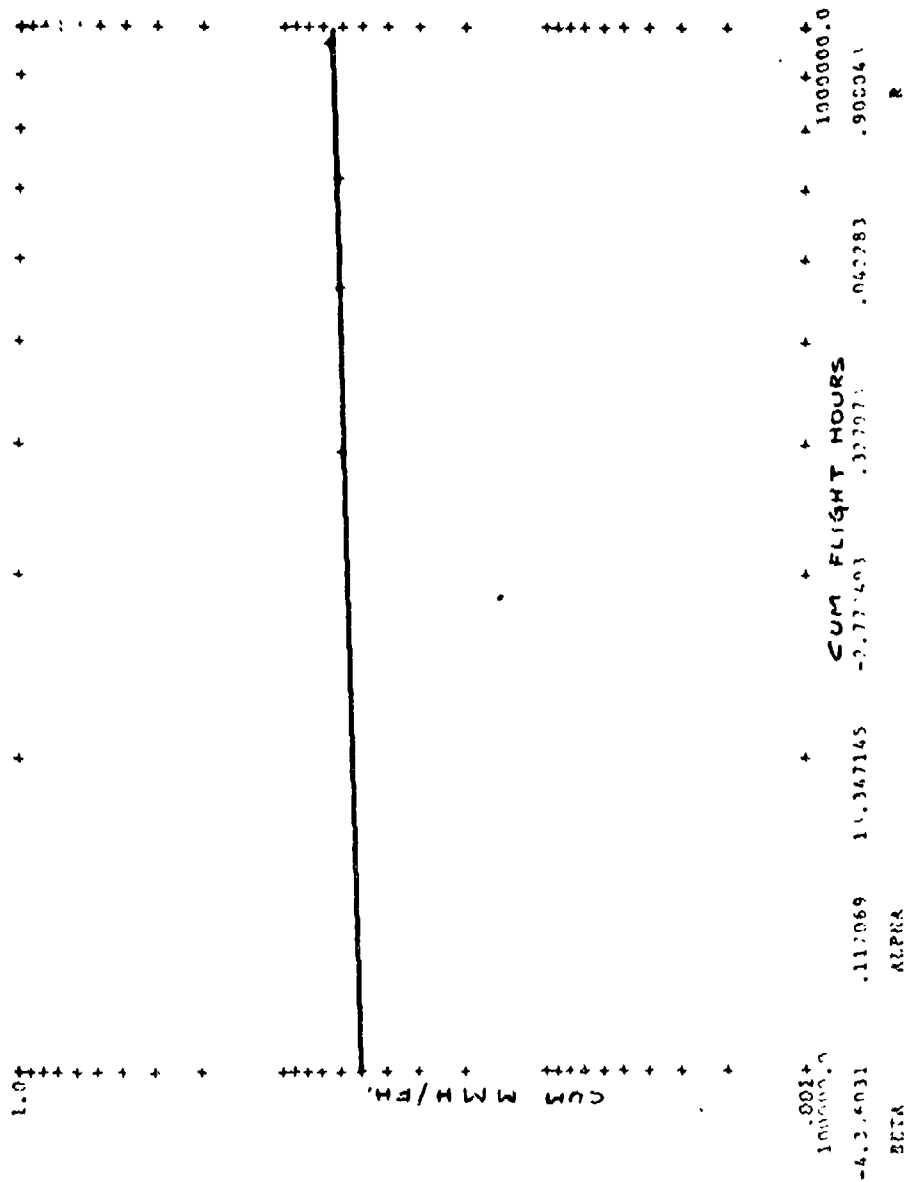
CUM FLIGHT HOURS

CUM FLIGHT HOURS	CUM MM/H
91376	.91376

BTIA ALPHA

WFO - 44-1987 - 214

FIGURE 83



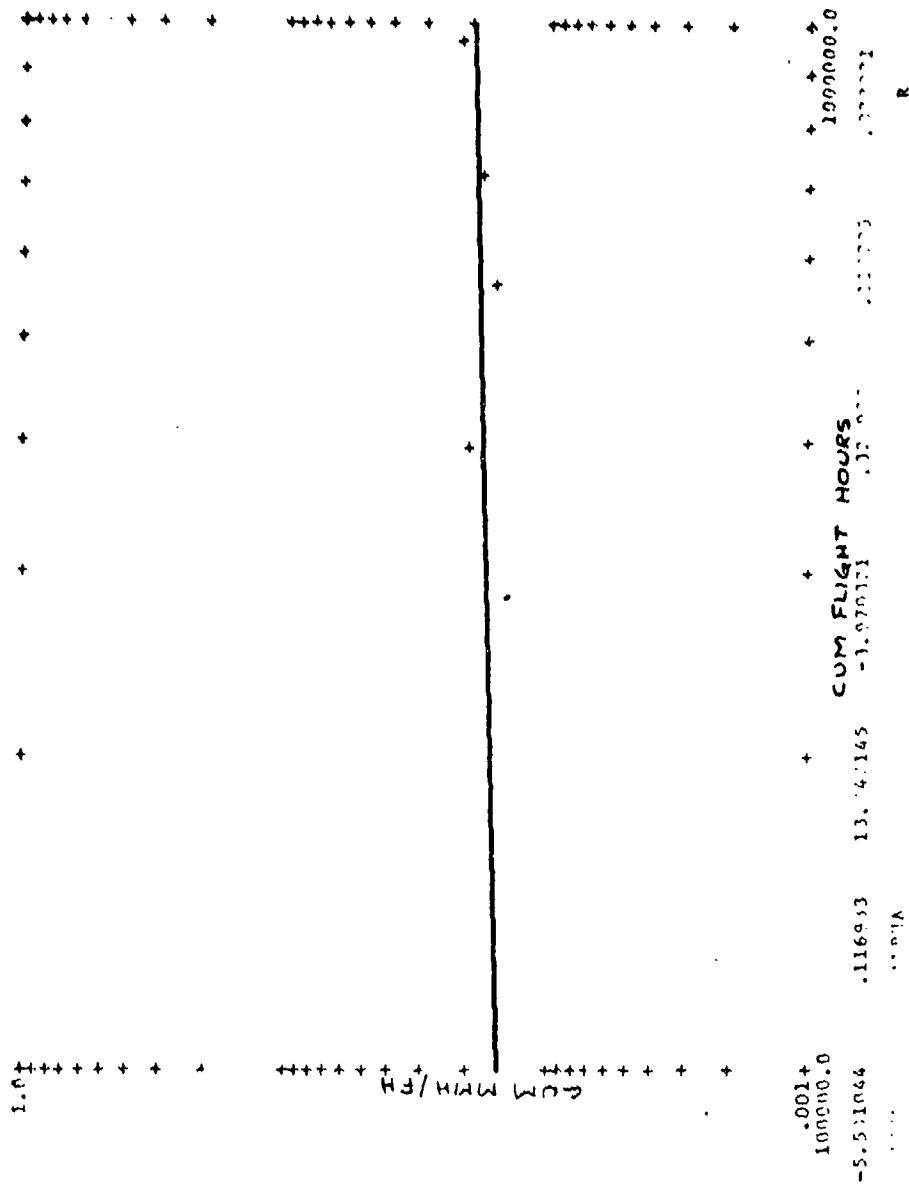
AUX. POUPELANT
CH-46 MCH/FR - CUM

FIGURE 84

[illegible]

CH-46 AMH/FH - CUM

BV-111



BV-112

FIGURE 87

TIME	ALTITUDE	TEMPERATURE	WIND	WAVE	SEA	STATE	REMARKS
100000.0	715145	158182	07707				

CH-46 : MI/FI - CUM

FIGURE A8

[illegible]

CII-46 MCH/EN - CUM

68 380013

NY-216,

100

10000.0
15551
R

100

5-15

•
•
•
•

Reproduced from
best available copy.

TABLE 7 - CH-46 SYSTEM R & M GROWTH PARAMETERS

SYSTEM	MMH/PH - GUM			MAL/PH - GUM		
	R	S	P	R	S	P
AIRFRAME	3.01	-.288	-.354	2.889	-.371	-.920
ROTOR	1.283	-.149	-.710	4.551	-.152	-.708
ENGINE	-.651	-.031	-.731	1.481	-.089	-.771
LANDING GEAR	4.218	-.171	-.617	4.159	-.085	-.470
EXHAUST GEAR	-.046	-.036	-.954	4.754	-.130	-.977
FLIGHT CONTROLS	1.973	-.031	-.229	4.162	-.087	-.604
HYDRAULIC POWER SUPPLY	5.539	-.175	-.988	2.897	-.058	-.413
DRIVE	3.751	-.141	-.772	8.285	-.363	-.843
LIGHTING	1.821	-.111	-.632	1.821	-.115	-.748
RADIO NAVIGATION	3.172	-.114	-.664	2.825	-.478	-.975
ELECTRIC POWER SUPPLY	1.748	-.130	-.814	7.754	-.302	-.728
ENGINE PLANT INSTL	1.748	-.141	-.772	8.285	-.363	-.843
TURBOCHARGER ENGINES	2.931	-.194	-.640	4.118	-.012	-.052
INTERPHONE	2.561	-.175	-.264	1.783	-.209	-.889
HF COMMUNICATIONS	5.72	-.105	-.741	6.354	-.169	-.873
HE COMMUNICATIONS	1.119	-.343	-.706	8.167	-.249	-.567
INFLAME COMBAT	2.187	-.410	-.773	10.898	-.494	-.888
AUX TV EXPLANT	3.756	-.117	-.914	5.649	-.187	-.419
IFF	1.561	-.116	-.572	1.510	-.125	-.859
RADAR NAVIGATION	2.269	-.167	-.246	2.321	-.184	-.875
AIR COND & ICE CONTROL	2.541	-.117	-.223	4.366	-.063	-.194
FUEL	4.421	-.345	-.515	5.208	-.400	-.801
WASH UTILITIES	2.522	-.072	-.497	15.493	-.591	-.873
TOTAL	1087	-.010	-.155	2679	-.218	-.985

PREPARED BY
CHECKED BY
DATE

REV. 1

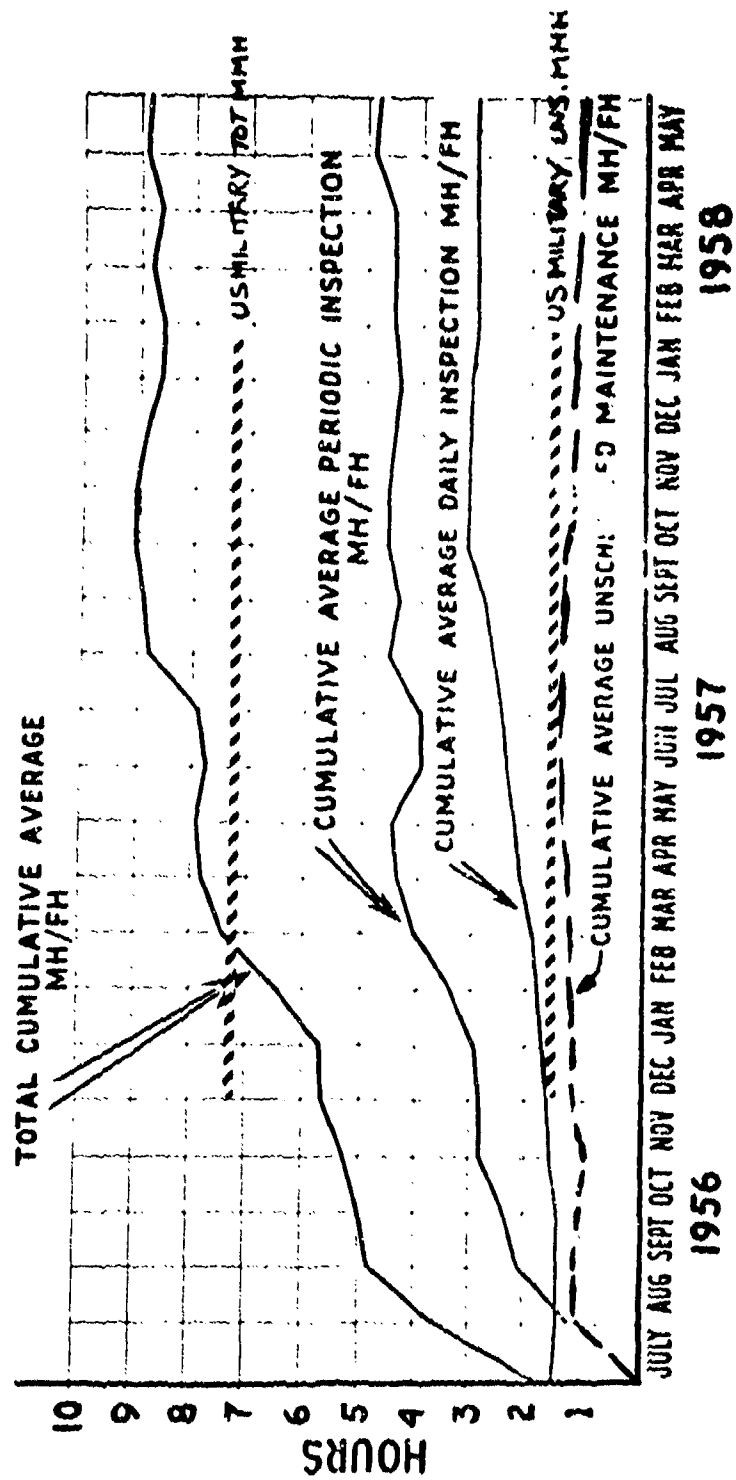
Best Available Copy

NUMBER
REV LTR

BV-116

FIGURE 91

H-21 - BELOW DEPOT MAINTENANCE MAN-HOURS FRENCH ARMY-SETIF, ALGERIA



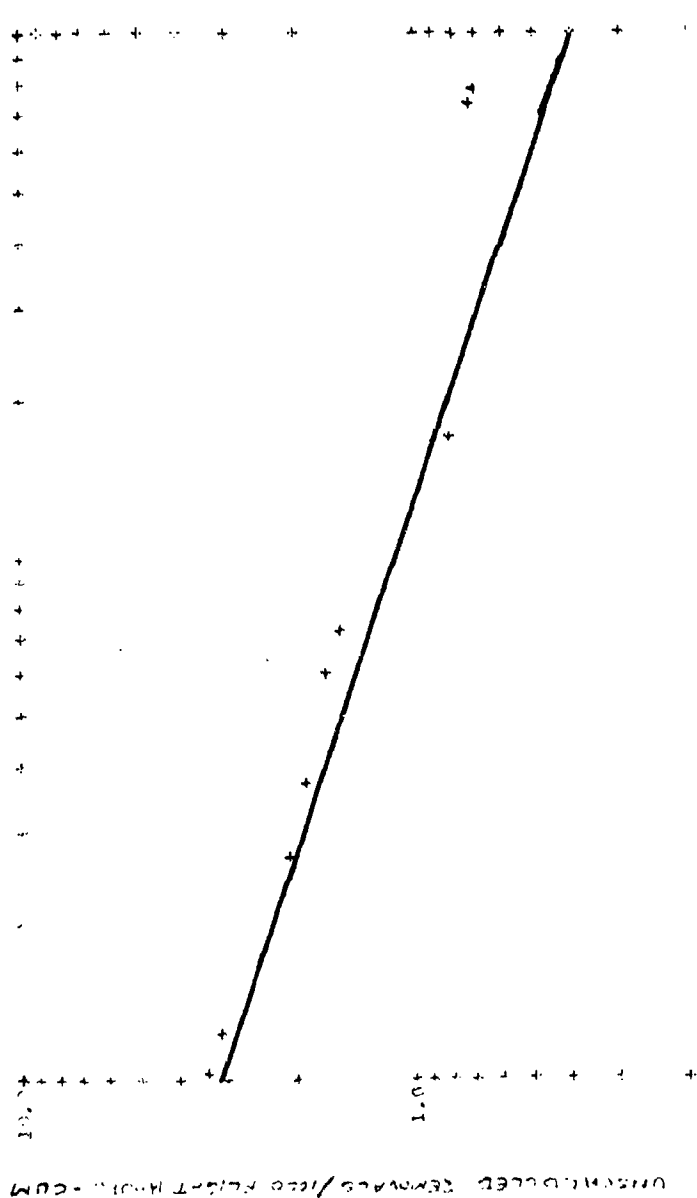


STATISTICS DIVISION

12

TABLE 9 - 4-47 CEMENT & GROWTH STATISTICS

CUM FLIGHT NUMBER	CUM CEREMENT	UN-RECORDED RECORDS PER 1000 FLIGHT HOURS										CUM ACTIVITY				CUM ACTIVITY			
		NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY	NI ACTIVITY
37033	1965	75	75	1.10	1.10	1.80	1.80	1.50	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
72256	1966					4.98	2.17	4.05	2.68	1.45	1.12	.85	.85					.90	.90
102340	1967	70	70	1.10	1.10	1.90	1.90	1.15	1.15	2.42								.60	.60
194200	1967	70	70	1.10	1.10	1.90	1.90	1.15	1.15	2.42								.60	.60
102340	1967	70	70	1.10	1.10	1.90	1.90	1.15	1.15	2.42								.60	.60
202167	1967	70	70	1.10	1.10	1.90	1.90	1.15	1.15	2.42								.60	.60
1164700	1967	70	70	1.10	1.10	1.90	1.90	1.15	1.15	2.42								.60	.60



1.0000.0
5.232694
BETA

-0.449950
ALPHA

11.303819
CUM FLIGHT HOURS

1.458654
1000000.0
-0.75947

FORWARD MSN 1100 001

FIGURE 92

BV-120

[illegible]

FIGURE 93

FIGURE 94

BV-123

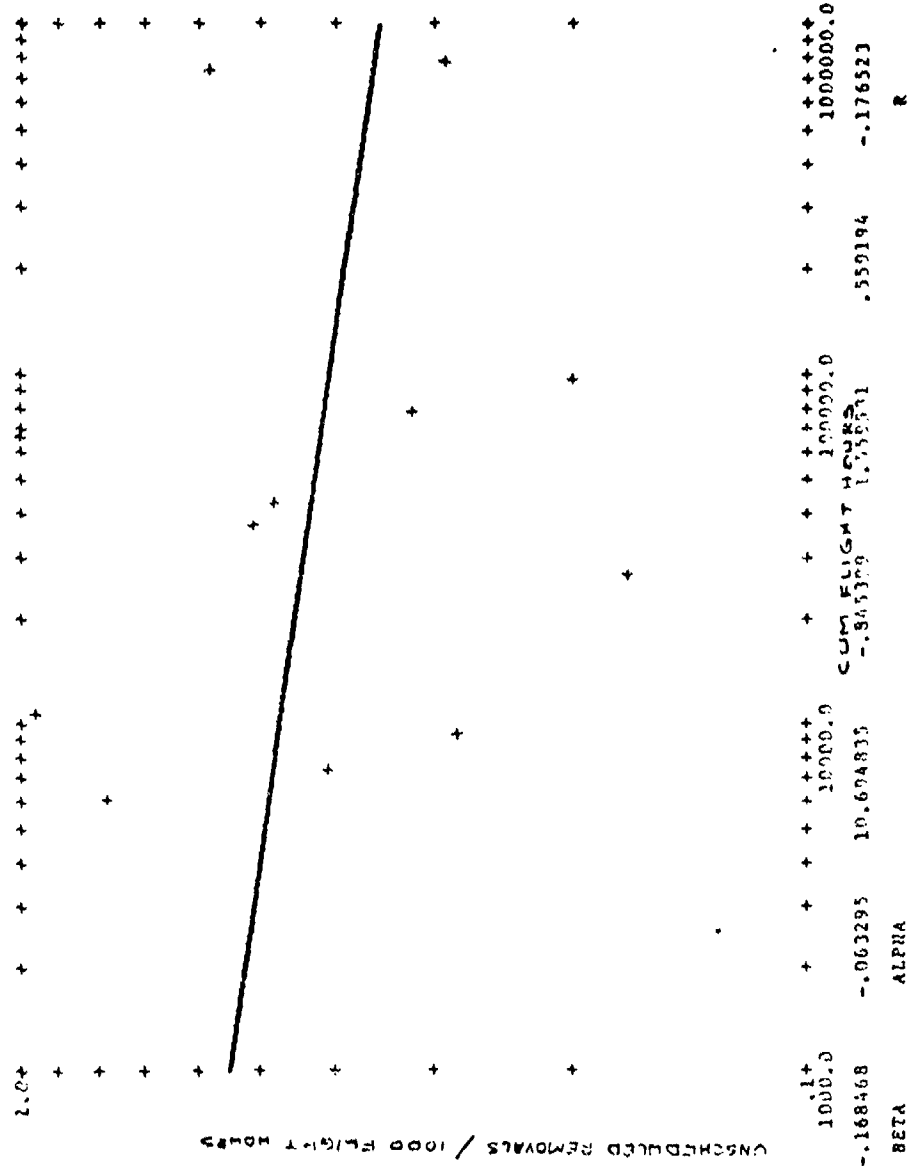


FIGURE 95

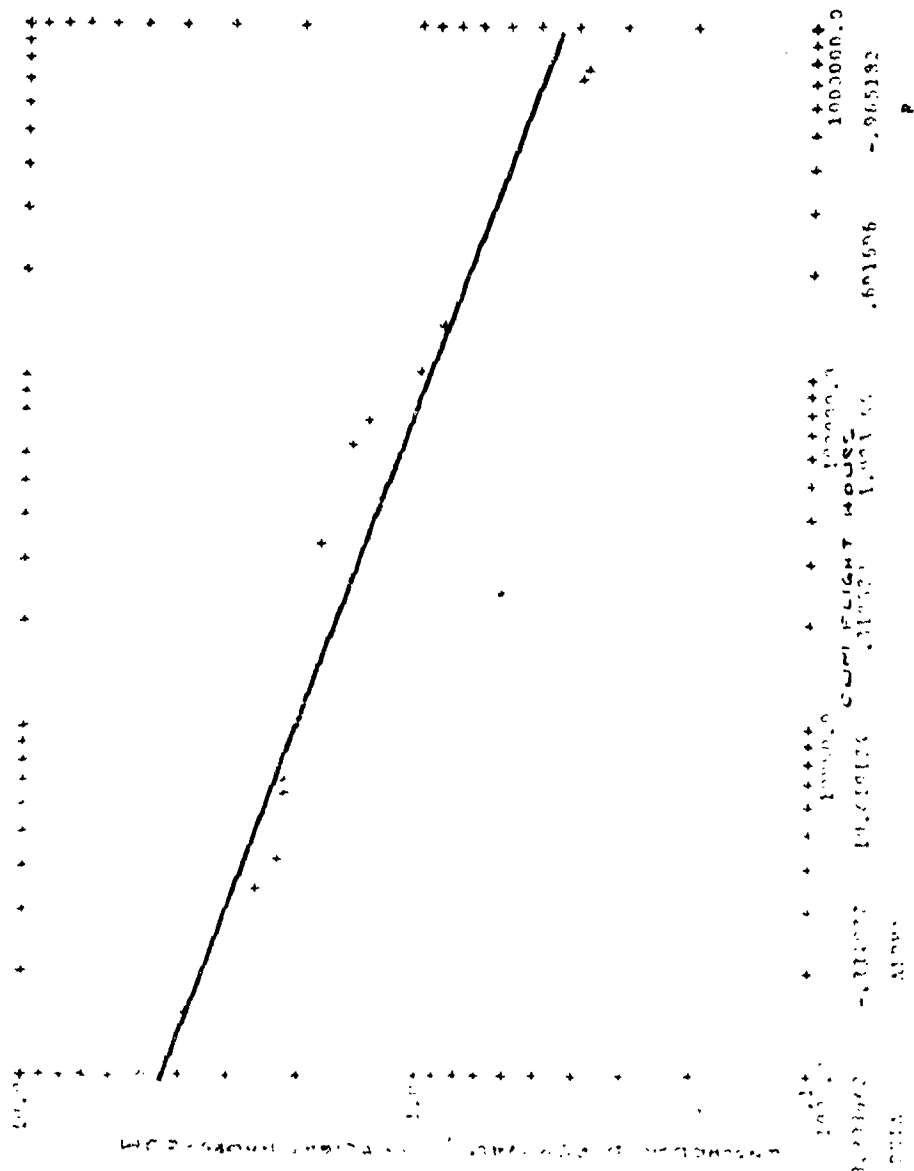


FIGURE '06

BV-125

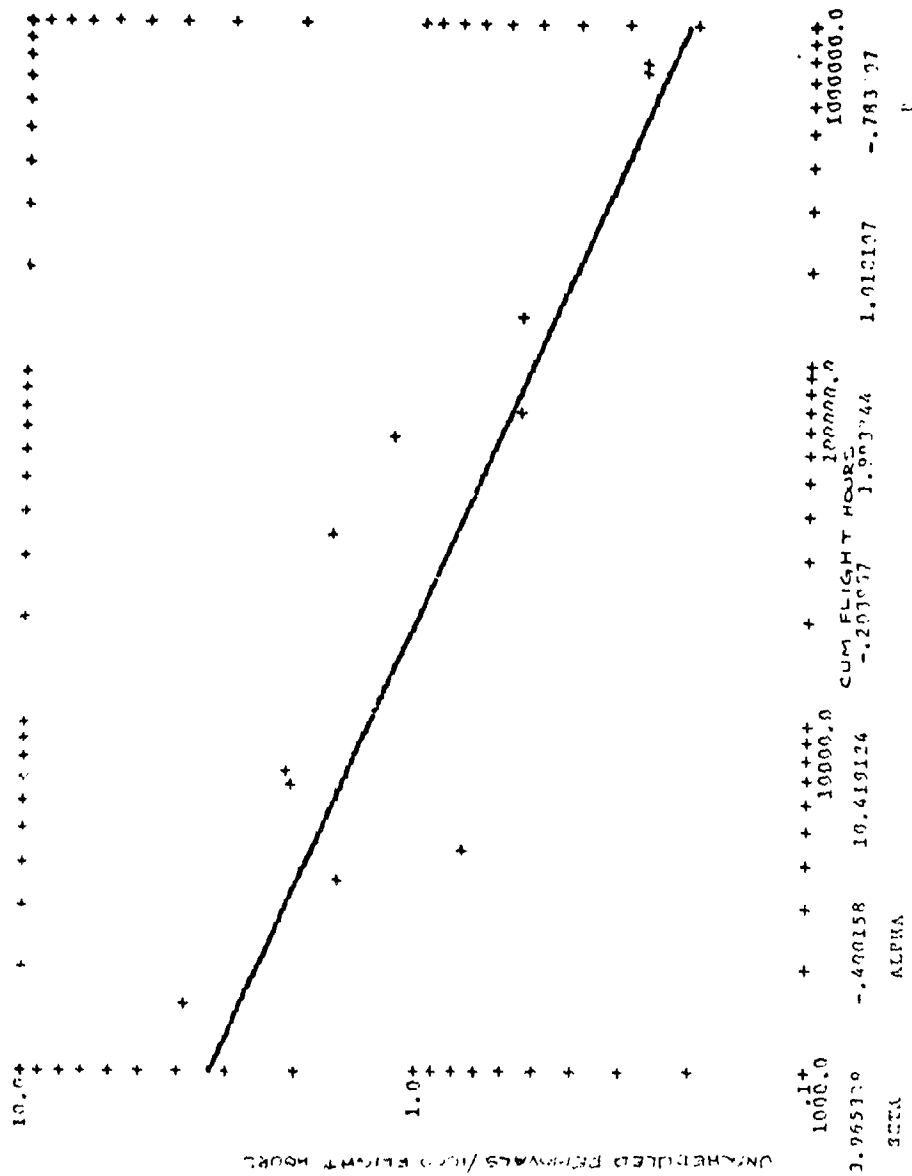


FIGURE 97

BV-12'

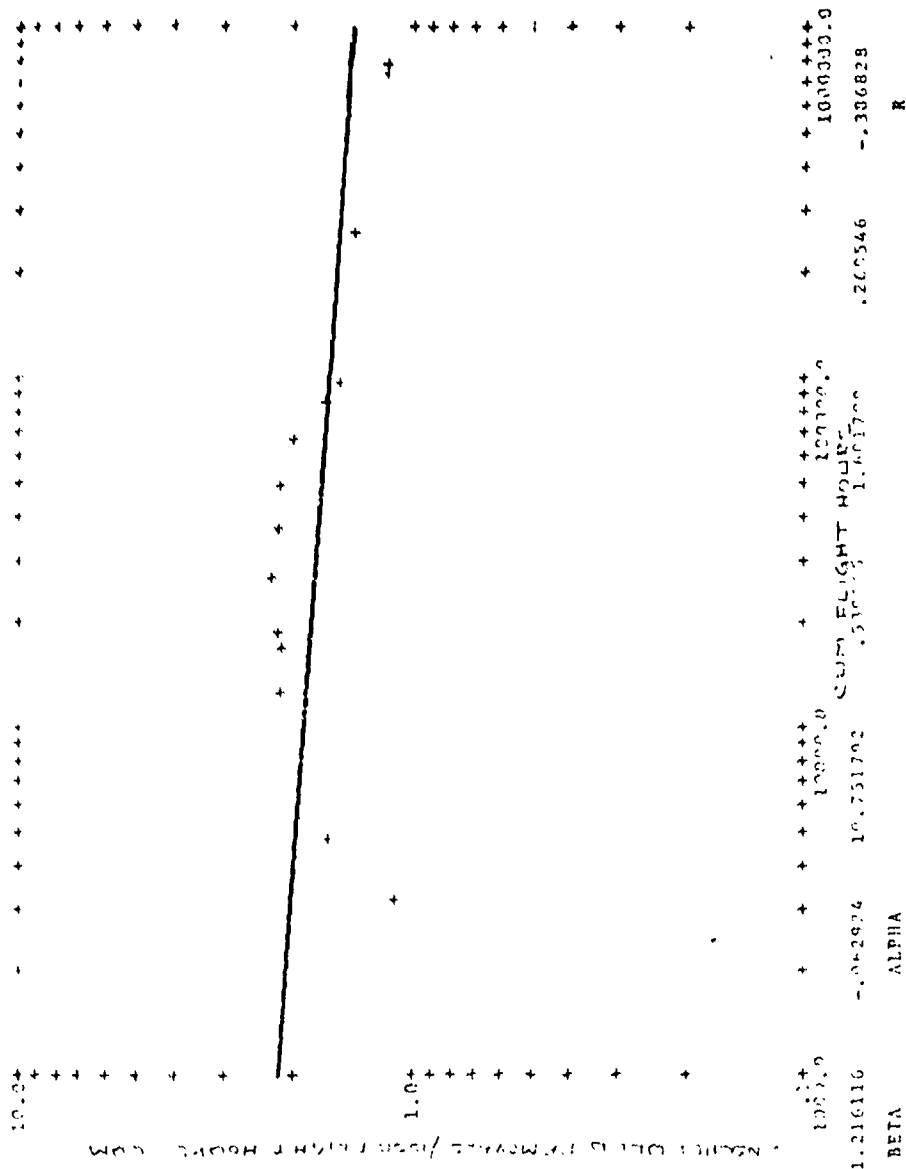
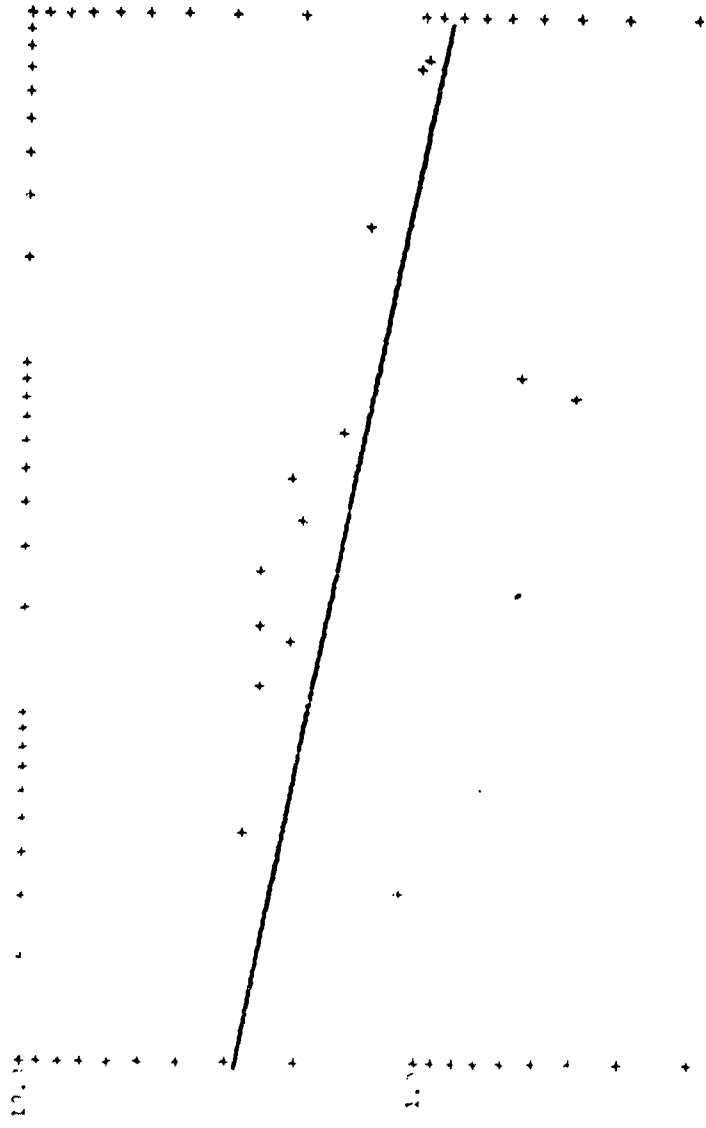


FIGURE 90



ENGINES / COMPUTED FLIGHT HOURS

EN-1.7

100000.0	100000.0	100000.0	100000.0
2.271018	-0.176541	10.751300	10.751300
BETA	ALPHA		
		.575168	-0.401631
			1000000.0

EN INE REF 1140/001

FIGURE 99

Reproduced from
best available copy.

UNSCALED REMAINS/1000 FLIGHT HOURS

LOG10 FLIGHT HOURS

LOG10 FLIGHT HOURS	UNSCALED REMAINS/1000 FLIGHT HOURS
0.0	0.0
0.1	0.1
0.2	0.2
0.3	0.3
0.4	0.4
0.5	0.5
0.6	0.6
0.7	0.7
0.8	0.8
0.9	0.9
1.0	1.0
1.1	1.1
1.2	1.2
1.3	1.3
1.4	1.4
1.5	1.5
1.6	1.6
1.7	1.7
1.8	1.8
1.9	1.9
2.0	2.0
2.1	2.1
2.2	2.2
2.3	2.3
2.4	2.4
2.5	2.5
2.6	2.6
2.7	2.7
2.8	2.8
2.9	2.9
3.0	3.0
3.1	3.1
3.2	3.2
3.3	3.3
3.4	3.4
3.5	3.5
3.6	3.6
3.7	3.7
3.8	3.8
3.9	3.9
4.0	4.0

131

Reproduced from
best available copy.

[illegible]

A. T. ATO.

Fig. 10--

UNSCHEDULED FLIGHT HOURS - 2001

i

[illegible]

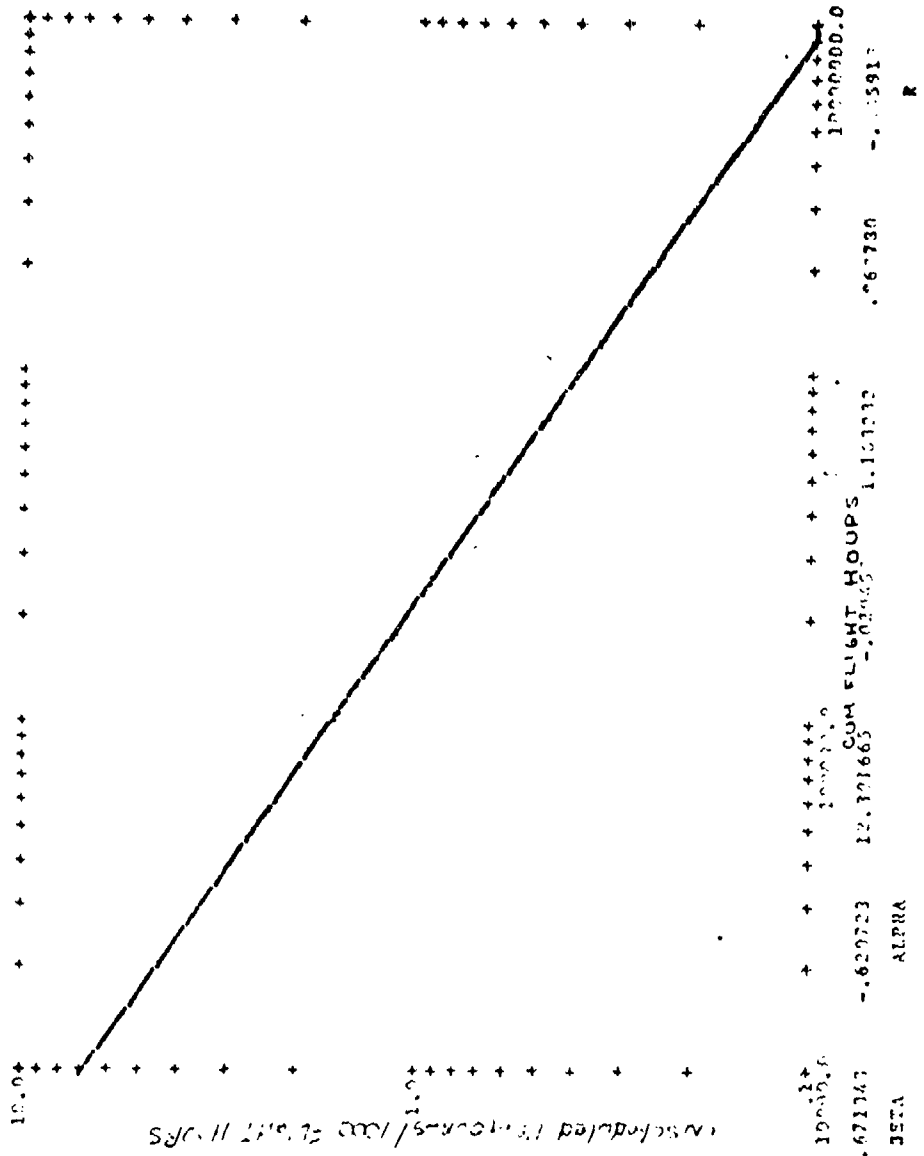
FILE NO. 103
"I" ATT. ATTOR.

Reproduced from
available copy.

	+ + + + +	+ + + + +	+ + + + +	+ + + + +	+ + + + +
1907.6	1907.8	1907.8	1907.8	1907.8	1907.8
4.5627	- .33427	12. 09165	SUN 6:16 MT HOURS 41651	1.16727	.40-367
35TA	ALPHA				R
					-- 88077

PIVOTING ACUATOR

FILE 104



PILOT INC ACTIVATOR
FIGURE 105

Reproduced from
best available copy.

BV-133

The scatter plot displays a strong positive linear relationship between 'MILES PER HOUR - FLIGHT HOURS - GCM' (Y-axis) and 'HOURS' (X-axis). The Y-axis scale is from 0 to 10.0, and the X-axis scale is from 0 to 10.0. A solid line represents the linear regression fit, starting near the origin and extending towards the top right. Data points are marked with '+' symbols, showing a clear upward trend.

SHIP AND ACTUATOR

FIGURE 106

BV-135

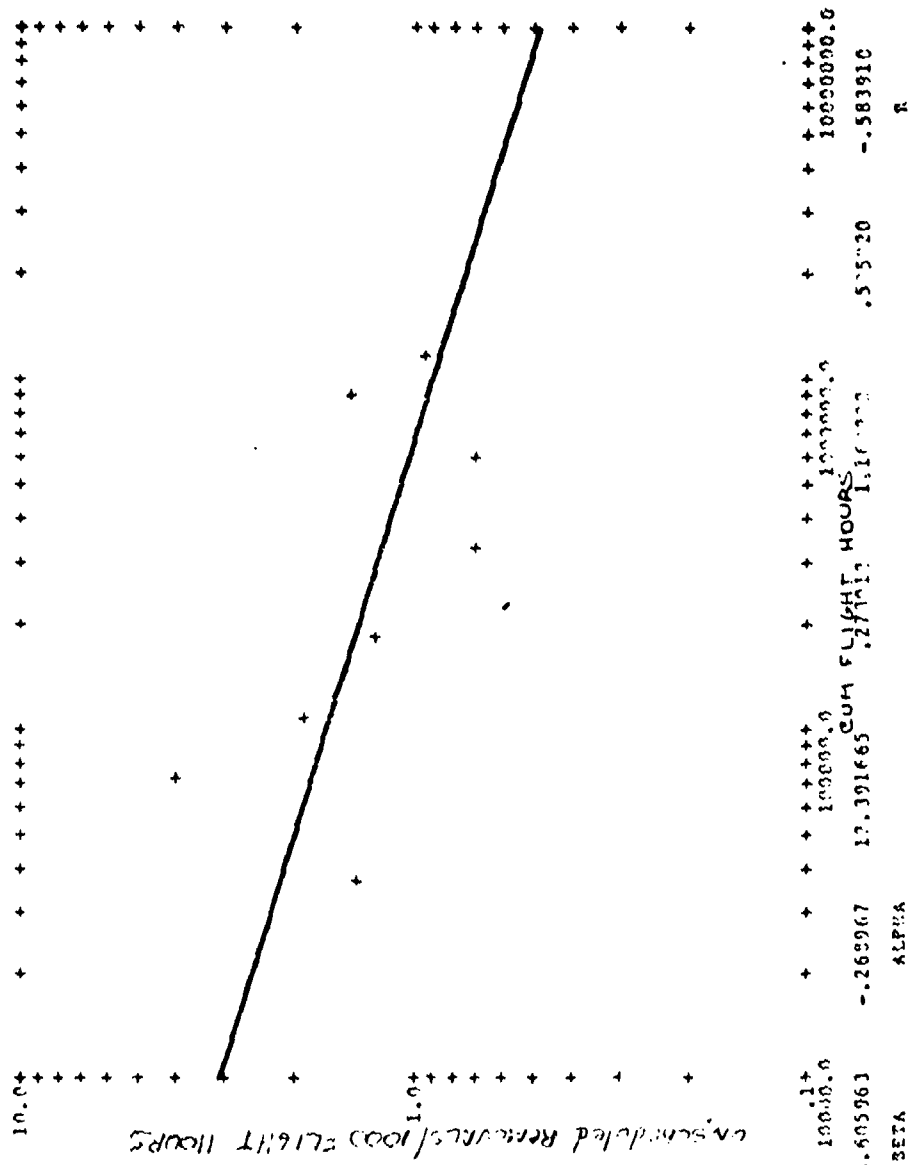
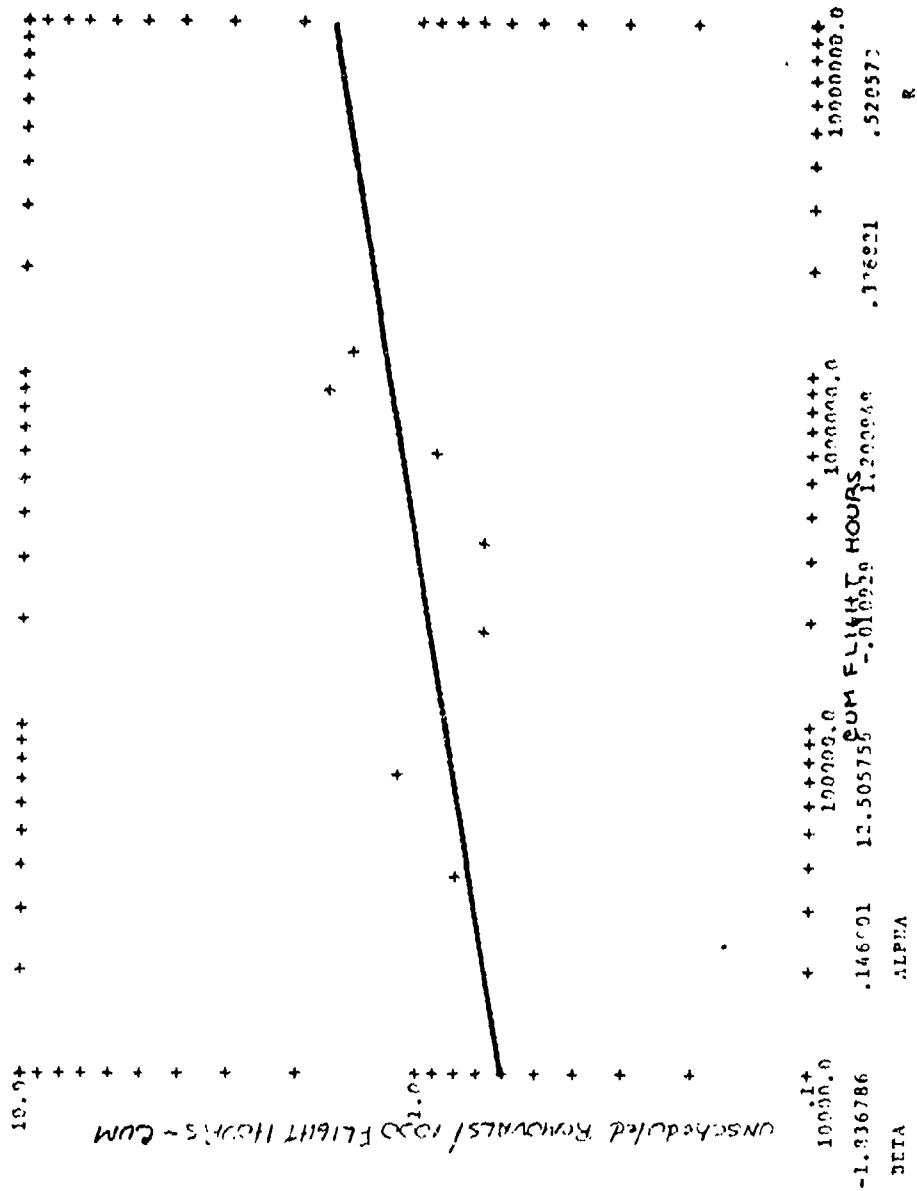


FIGURE 107

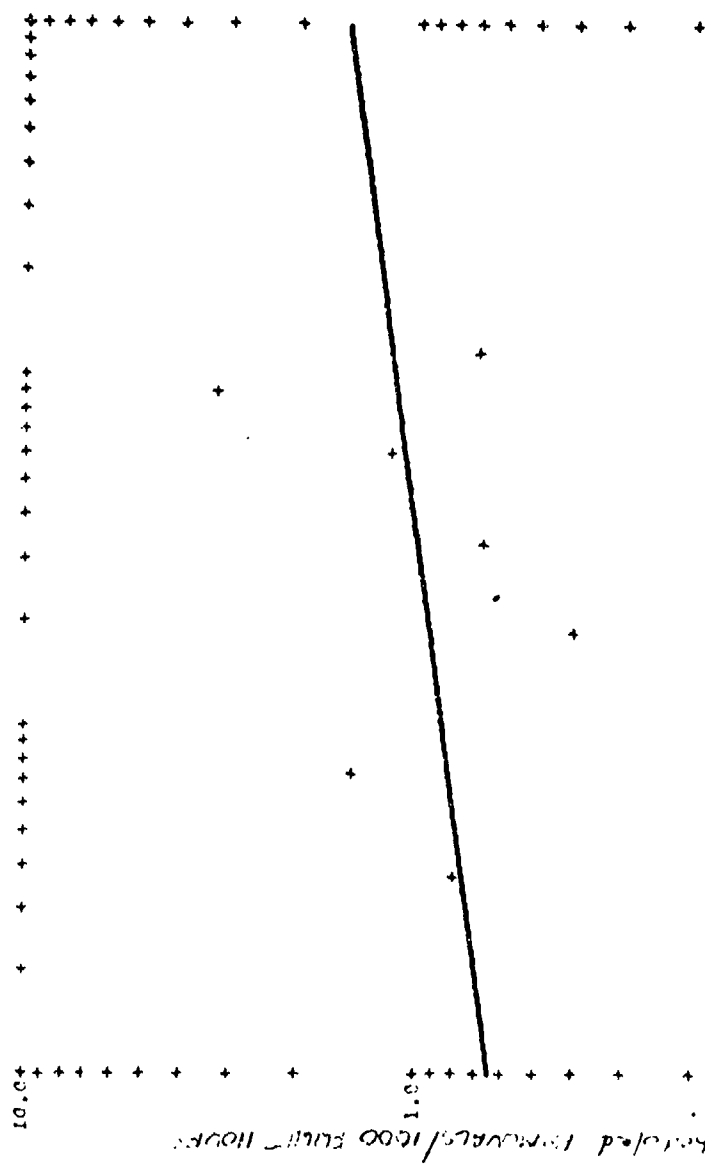
Reproduced from
best available copy.

BV-136



VECTOR ELAS

FIGURE 108



100000.0
-1.578004
BETA

124232
ALPHA

100000.0
12.505756
CUM

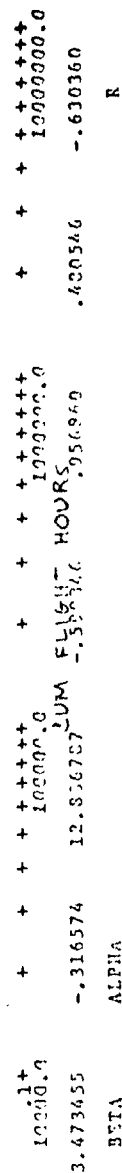
FLIGHT HOURS
100000.0

1000000.0
100000.0
R

ROTOR BLADES
FIGURE KEY

[illegible]

SLIP PLATES
1607-110



15

UNSCHEDED Removal/100 FLIGHT HOURS - CUM

10000.0
17762
-122789
11.0594 2 Cum FL161T HOURS
-685827
ALPHA
BETA
1000000.0
.124 1.
-0.833332

[illegible]

HYDRAULIC PUMP
E11 3007-5
FLURE 11E

Reproduced from
best available copy.

CYCLIC TRIP: ACTIVATOR

FIGURE 114

TABLE 10 - CH-47 XMSN R GROWTH PARAMETERS

TRANSMISSION	UNSL. REM. / 1000 FH		UNSL. REM. / 1000 FH	
	B	α	B	R
FORWARD XMSN	5.293	-.450	4.870	-.446
AFT XMSN	-.158	-.041	-.168	-.064
COMBINING XMSN	3.809	-.335	3.965	-.400
ENGINE XMSN	1.216	-.063	2.271	-.177

TABLE II - CH 17 - R GROWTH PARAMETERS

COMPONENT	UNS.REM./1000 FH-CUM		UNS.REM./1000 FH	
	L	B	NS	I
NO. ACTUATOR	-7.328	.652	.527	.605
NI. ACTUATOR	-8.774	.550	.250	.503
PHOTING ACTUATOR	4.55	-.065	-.621	-.536
SNIPING ACTUATOR	2.820	-.078	-.269	-.584
ROTOR BLADES	-1.927	.521	.124	.239
SWASH PLATES	0.256	-.207	-.317	-.630
HYDRAULIC PUMP	.938	-.122	.139	-.312
CYCLIC TRIM ACT.	.831	-.083	-.191	-.291

PC-185

Best Available Copy



TABLE 12 - CH-46 COMPONENT K GROWTH STATISTICS

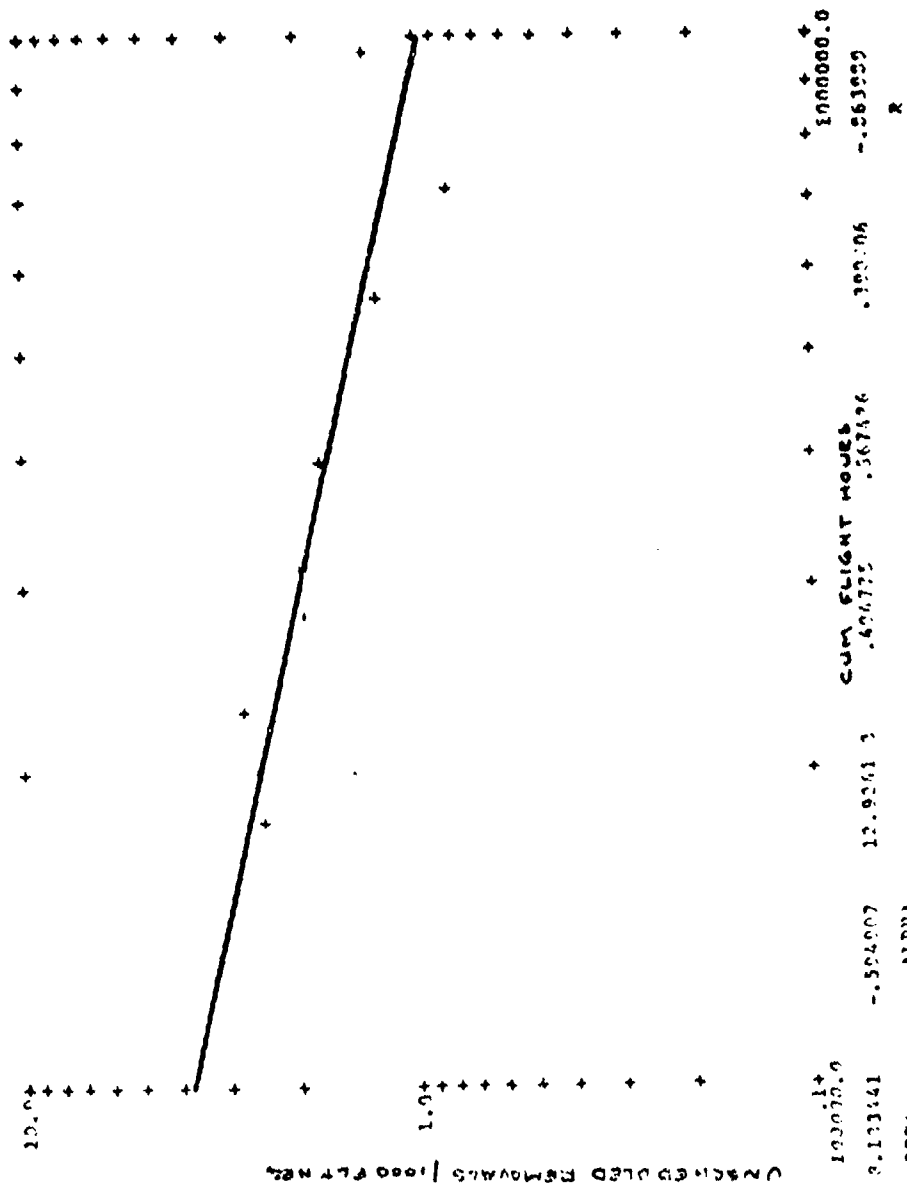
COMPONENT	AT VERTICAL	FEED VERTICAL	NOTCH HEAD, 2	FEED VERTICAL	FEED VERTICAL	FEED VERTICAL	FEED VERTICAL
179020	2.145	2.145	.270	.270	1.412	1.412	1.365
22540	2.762	2.513	.860	.713	1.618	1.456	1.344
311085	1.780	2.371	.185	.352	1.782	1.577	1.244
344129 END 1968	1.748	2.240	.339	.711	1.705	1.619	1.110
563306 END 1969	1.245	1.741	.546	.408			1.152
717639 END 1970	.520	1.700					
964000 END 1972	1.338	1.601	.502	.447			1.170

BV-146

*** - RUCING IOM B-7975-3B-123 ***
 RUCING VERTICAL PROCESSED 3M DATA ***

Best Available Copy

BV-148



CH-46 APT 7.5N

FIGURE 101

100000.0
0.133441
BETA
-0.504007
ALPHA
12.92013
CUM FLIGHT HOURS
0.604722
0.567176
0.300006
-0.563029
1000000.0
R

The diagram shows a rectangular plot with a vertical line drawn near the right edge. The plot is bounded by a horizontal line at the top and bottom, and a vertical line on the left. The right boundary is defined by a vertical line and a series of points marked with '+' and 'x' along the right edge. The vertical line is labeled '1' at the top and '2' at the bottom. The points are labeled with '+' and 'x' and are distributed along the right edge of the plot. The vertical line is labeled '1' at the top and '2' at the bottom. The points are labeled with '+' and 'x' and are distributed along the right edge of the plot.

[illegible]

REF ID: A66555

811 737713

U.S. - 84501 24-33
CH-40 FORMER - 25

FILE 119

PERCENTAGE OF TOTAL POPULATION

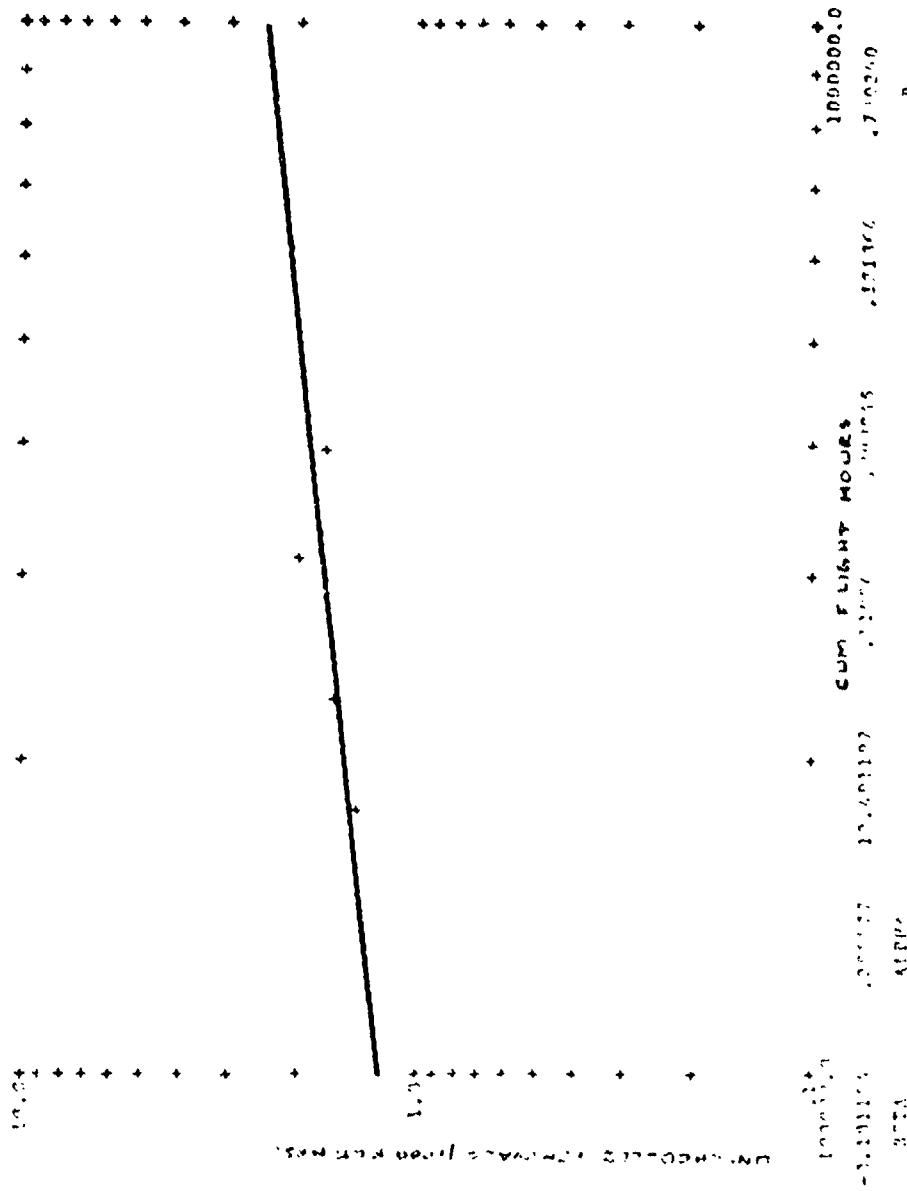
PERCENTAGE OF TOTAL POPULATION

[illegible]

CH-46: 11-0-01 REA. A

Fig. 14. 12.0

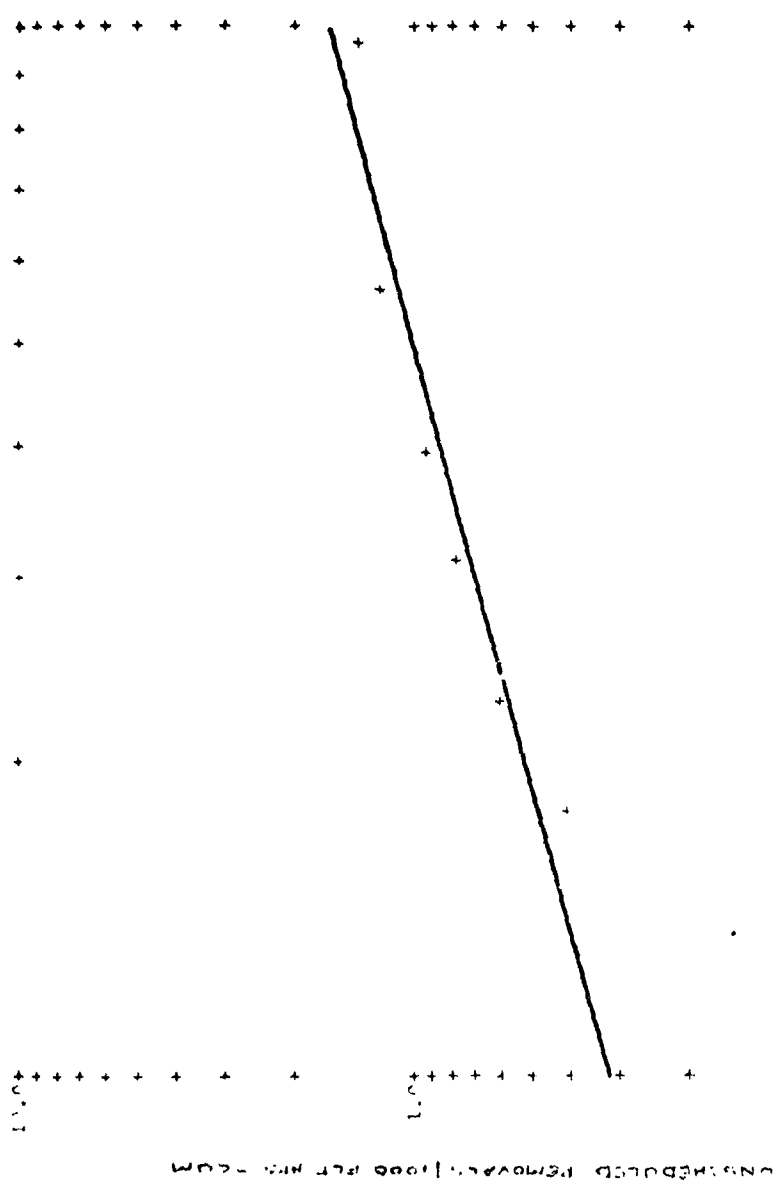
25-150



9-26 800. 0000 0000 0000

FIGURE 121

BV-153

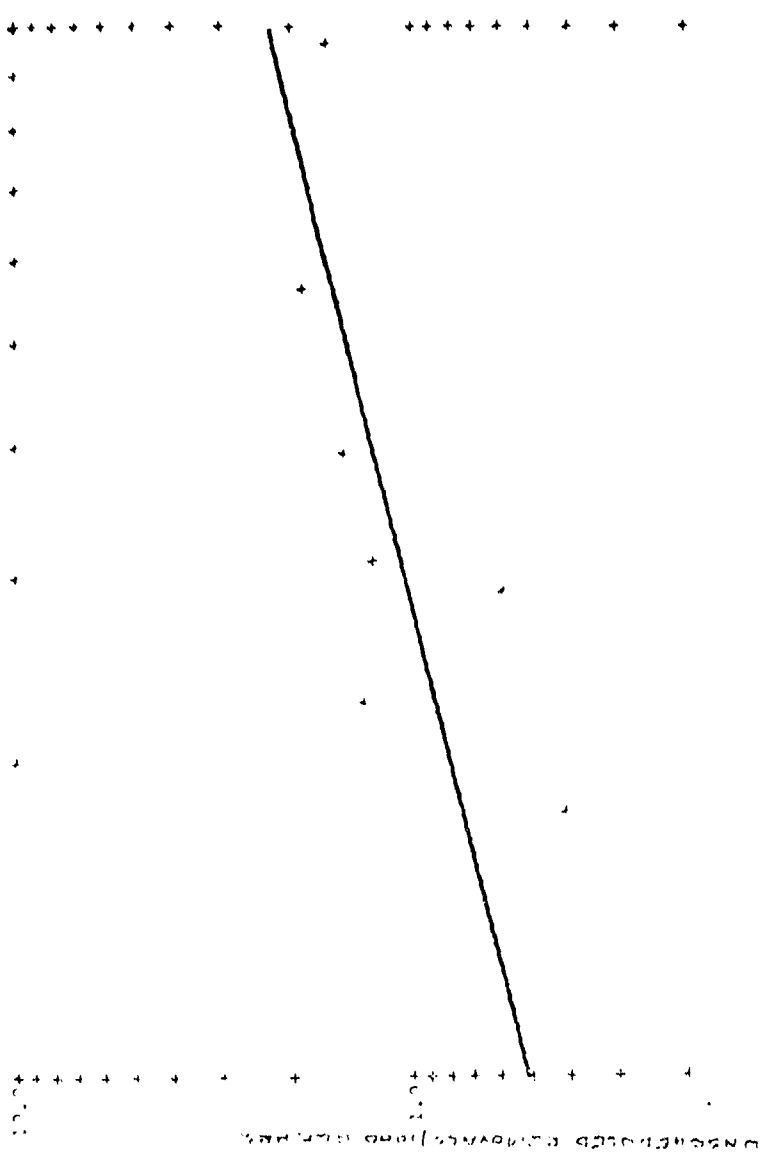


193000.0	12.910000	CUM FLIGHT HOURS	100000.0
1.000000	12.910000	100000.0	1.000000
1.000000	12.910000	100000.0	1.000000

CH-46 FWD. ROTOR HEAD 'D'

WINDSPEED 102

417-AB



100000.0
 0.115127
 ALPHA
 0.646364
 12.8 0010
 CUM FLIGHT HOURS
 100000.0
 0.501101
 100000.0
 0.720752
 R

CH-46 FWD MOTOR MEAN '0'

FIGURE 12B

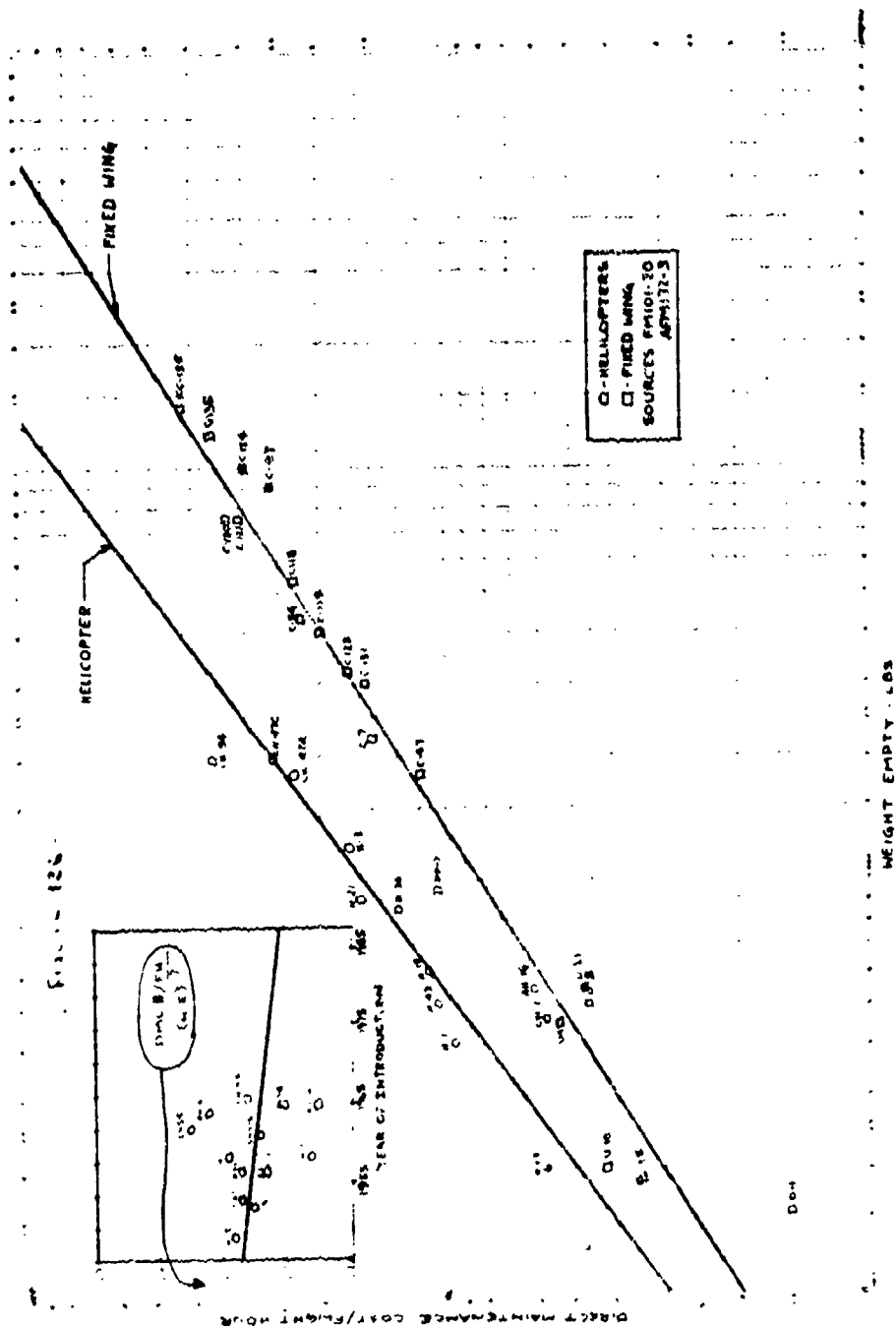
RESEARCHED FOR REMOVAL/1000 FT. HRS - COM

Cir-15 457 0012 "E" A.S.D.

4-5-55

TABLE 13 - CH-46 COMPONENT R GROWTH PARAMETERS

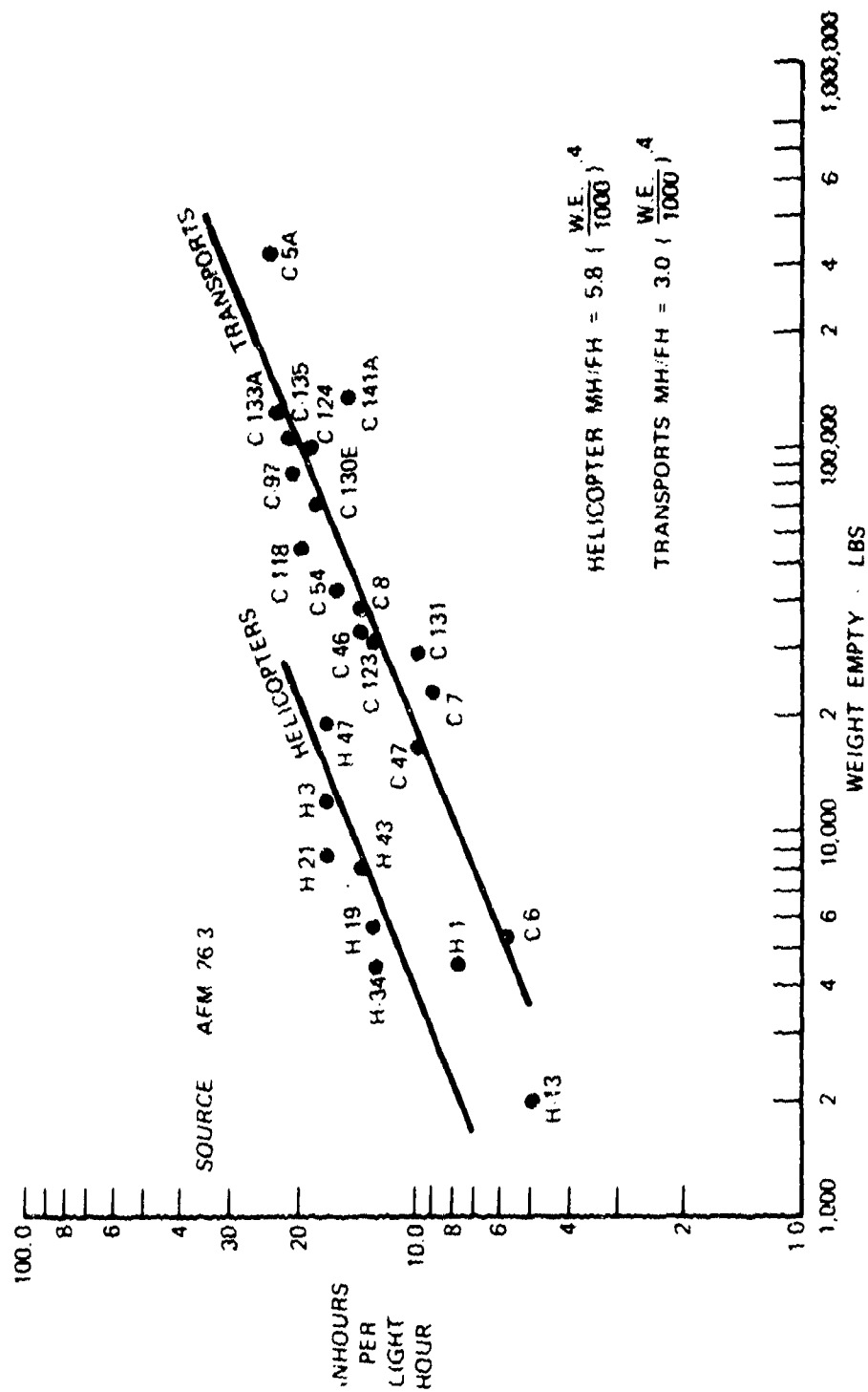
COMPONENT	UN.S. REM/1000 FLT. HRS.		UN.S. REM./1000 FLT. HRS.		UN.S. REM./1000 FLT. HRS.	
	B	α	R	B	α	R
AFT XMSN.	4.403	-.284	-.961	8.183	-.595	-.864
FORWARD XMSN.	-3.367	.186	.729	-3.179	.177	.201
FWD ROTOR HEAD 'A'	-1.957	.190	.974	-3.181	.296	.730
FWD ROTOR HEAD 'D'	-9.294	.709	.961	-8.105	.646	.721
AFT ROTOR HEAD 'A&D'	1.579	-.107	-.774	.791	-.056	-.115



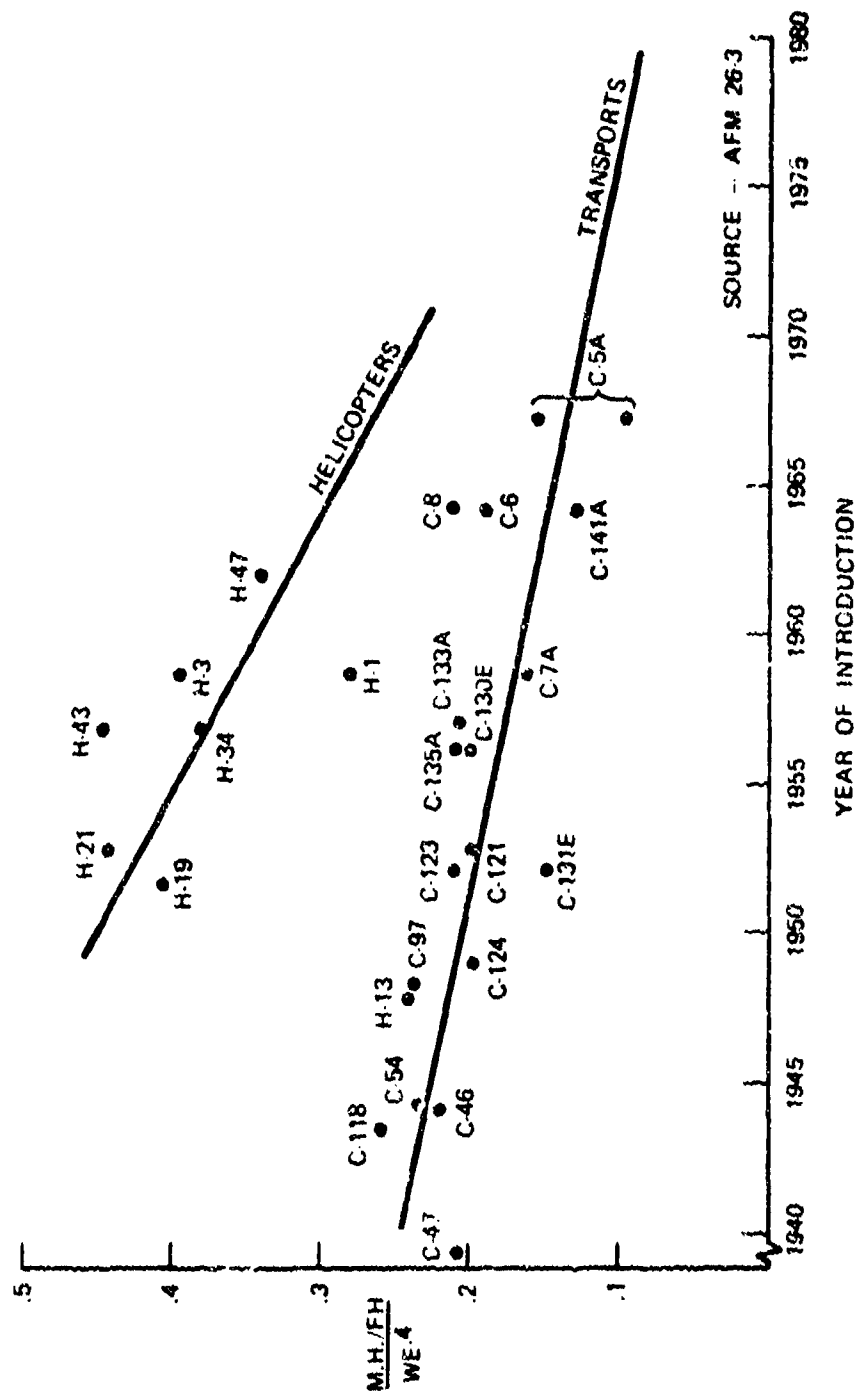
BV-158

Reproduced from
best available copy.

BV-159



USAF HELICOPTER & TRANSPORT MAINTENANCE



BV-160

1000 02

Part B

Data Submitted by Hughes

YOH-6 AND OH-6A
HELICOPTER RELIABILITY STUDY

HUGHES HELICOPTERS
CULVER CITY, CALIFORNIA

PREPARED BY:

P. B. TYONS
P. B. TYONS
RELIABILITY ENGINEER

APPROVED BY:

C. E. DAVIS
C. E. DAVIS
SUPERVISOR
RELIABILITY & MAINTAINABILITY

Best Available Copy

HELICOPTER RELIABILITY STUDY

ARPA TASK ORDER T-105

PURCHASE ORDER NO. 20434 - HUGHES HELICOPTERS

2 December 1974

Best Available Copy

IDA PROJECT T-105

TABLE OF CONTENTS

<u>PARAGRAPH NO.</u>	<u>TITLE</u>	<u>PAGE NO.</u>
1.0	INTRODUCTION	1
2.0	DATA SOURCES	1
2.1	PROTOTYPE YOH-6 IDENTIFICATION	1
2.2	PROTOTYPE DATA SOURCES	1
2.3	PROTOTYPE TRACKING	2
2.4	PRODUCTION OH-6A IDENTIFICATION	3
2.5	PRODUCTION DATA SOURCES	4
3.0	SUBSYSTEM CATEGORIES	6
4.0	CRITERIA AND DEFINITIONS	6
5.0	SUMMARY	7
5.1	PROTOTYPE DATA SUMMARY	7
5.2	R & M DATA SUMMARY (PRODUCTION)	8
5.3	CONFIRMATORY DATA SUMMARY (PRODUCTION)	8
5.4	ADDITIONAL DATA SUMMARY (PRODUCTION)	9
6.0	DETAILED DATA TABLES	9

IDA PROJECT T-105

1.0 INTRODUCTION

This report provides OH-6A Prototype and early Production Helicopter flight test hours and failure data as required under IDA project T-105 (IDA Purchase Order 20434). These data are presented in the following manner:

- a. Failures in each IDA subsystem category.
- b. Failure types in three categories: Mission, Flight Safety and System (Unscheduled Maintenance Actions).
- c. Failure totals and failure rates per flight hour.
- d. A monthly breakdown of flight hours and failures is presented when such information was available.
- e. Maintenance manhours per flight hour data are provided when such information was available.

2.0 DATA SOURCES

2.1 PROTOTYPE YOH-6 IDENTIFICATION

The prototype aircraft are identified in the following table. Note that the flight hours given are from first flight thru May 24, 1966 which is the date of the first flight of production aircraft No. 1 (65-12916).

<u>AIRCRAFT NO.</u>	<u>DATE OF FIRST FLIGHT</u>	<u>TOTAL TIME THRU 5/24/66</u>
1 Static Tests Only		
2 (N9696F)	2/27/63	767*
3 (N9697F)	4/11/63	264
4 (N9698F, 62-12624)	6/2/63	403
5 (N9699F, 62-4216)	9/23/63	720 **
6 (62-4211)	1/20/64	1269
7 (62-4212)	2/25/64	324
8 (62-4213)	3/13/64	810
9 (62-4214)	4/9/64	309
10 (62-4215)	4/30/64	608
TOTAL		5474

* Tie-down endurance vehicle; flown 13 hours prior to start of endurance tests.

** Detailed data provided for 847 hours.

2.2 PROTOTYPE DATA SOURCES

The prototype aircraft were flown in various tests at many scattered locations during the time period in question. The result is that the available historical data regarding maintenance, flight hours, and failure rates is fragmented. The best sources proved to be that for ships maintained at Culver City and for the competitive fly-off tests which were more closely observed and reported. The day-to-day Culver City maintenance and flight records for YOH-6 No. 3 and No. 5 were located and used. Competitive fly-off tests at Fort Rucker

(Logistical Evaluation and Tactical Suitability) provided total flight hour and failure data for YOH-6 No. 6 and No.8. The combined flight time for these four aircraft is 2300 hours and provides a representative sample. The competitive fly-off tests are described in paragraphs following:

2.2.1 Logistical Evaluation Test

Prototype No. 6 was flown to Fort Rucker in Feb. 1964 and began flight test which accumulated 1000 hours by June of that year.

The primary purpose of the test was to evaluate parts failures and replacement requirements when the aircraft was flown on an accelerated program. The flight periods were scheduled for 2½ hours with a 15 minute turnaround. Four mission profiles were used which included nearly every type of flight that can be performed with a helicopter. In all, a total of 3867 landings and takeoffs were made during the 1000 hr. test period. This type of flying quickly brought any subsystem or component deficiencies to light.

Secondary purposes of the test were an evaluation of the preliminary MAC, component replacement schedules, mechanics training, and both standard and special tool requirements.

2.2.2 Tactical Suitability Test

This test was also performed at Fort Rucker using Prototype No. 8 primarily and No. 10 for a short period. The tests were conducted from March thru June of 1964 and were intended to check the OH-6 within the whole tactical environment. An engineering system of ratings was used in making evaluations. Tests included transportability, ground handling and hoisting, ease of maintenance, manhours required for replacement of major components, avionics suitability, flight characteristics and mission suitability. The preliminary MAC was evaluated as was personnel requirements. The flight evaluations required 230 flight hours.

2.3 PROTOTYPE TRACKING

Efforts to locate the YOH-6 aircraft and data were non-productive in general. However, the following history was derived from the memories of Hughes personnel who were present during the period.

No. 1 Static Tests Only

No. 2 (196968) Was flown 13 hours and then tied down in a whirl cage at Culver City for endurance tests. The aircraft was not moved at conclusion of tests and the airframe is still in place.

No. 3 (196978) Underwent general testing at Culver City and armament firing at Camp Pendleton and Twenty-nine Palms. Crashed during low level firing run when the pilot inadvertently flipped a fuel switch instead of a gun safety switch. Aircraft was totaled. Pilot and passenger suffered minor injuries.

Best Available Copy

No. 4 (N9698F, 62-12624) This aircraft is believed to have undergone flight testing at Wright Patterson. Present whereabouts unknown.

No. 5 (N9699F, 62-4216) Underwent extensive testing primarily from the Culver City base. Tests included FAA certification. Present whereabouts unknown.

No. 6 (62-4211) This aircraft was used in log-evaluation (1000 hour) tests at Fort Rucker; was later sent to Fort Bragg and may presently be at Wright Patterson.

No. 7 (62-4212) Underwent tests at Edwards AFB. Tests were primarily of an engineering evaluation type to provide data for the Pilots Flight Handbook. Suffered a tail boom chop during high altitude tests and was rebuilt. Present whereabouts unknown.

No. 8 (62-4213) Flown at Edwards AFB and later was used in Tactical Suitability Tests at Fort Rucker. This aircraft was flown in record breaking speed and endurance runs and is believed to be in a museum at Fort Rucker now.

No. 9 (62-4214) Was flown at Edwards AFB, Bakersfield, and Yuma. Last known location was Aberdeen, Wash.

No. 10 (62-4215) Was used in armament testing at Fort Rucker and Hunter-Liggett. Suffered a blade strike (trees) but was not badly damaged. Later was shipped to Paris for the Airshow. Present location unknown.

2.4 PRODUCTION OH-6A IDENTIFICATION

Production aircraft for which data are provided in this report are identified in the following table. Such history as is available is provided.

<u>HUGHES PROD. NO.</u>	<u>ARMY SER. NO.</u>	<u>DELIVERY DATE</u>	<u>HISTORY</u>
1	65-12916	10/66	Used in Stateside
2	65-12917	10/66	general testing and
3	65-12918	10/66	training. No. 3 & 6
4	65-12919	10/66	later suffered crash
6	65-12921	10/66	damage and were re-
8	65-12923	12/66	paired at HTC. No.
10	65-12925	12/66	2 & 8 are bailed;
11	65-12926	12/66	No. 2 at HTC, No. 4
12	65-12927	12/66	was destroyed in a crash.
14	65-12929	1/67	Used in R&M demo. (ARU).
15	65-12930	2/67	No. 15 later destroyed in a crash.
25	65-12940	2/67	Used in confirmatory
29	65-12944	4/67	tests (AKN). No. 25,
31	65-12946	4/67	29 & 31 later suf-
40	65-12955	4/67	fered crash damage
50	65-12965	5/67	and were repaired at HTC.

2.5 PRODUCTION DATA SOURCES

Data sources for production OH-6A are the R&M Demonstration (Fort Rucker), Confirmatory Tests (Fort Knox) and Hughes Service and Operation Reports from the field. Additional description of source data follows:

2.5.1 R&M Demonstration

The R&M (reliability and maintainability) demonstration tests were performed at Fort Rucker during the period of Feb, 1967 thru Aug, 1967. Production aircraft No. 14 and No. 15 were each flown a total of 500 hours. Close records were kept of all failures which were divided into three categories, Mission, Flight Safety, and System. The failures in each category were charged to the major subsystem (8 total) as appropriate. Nine different mission profiles were flown during this program to provide a representative sample of all expected normal flights of the aircraft.

Maintenance manhour records were kept for all maintenance actions during the program and notations are provided as to the chargeable or non-chargeable nature of the actions. Non-chargeable maintenance actions are those concerning CFE (engine and avionics), actions due to incorrect maintenance practice, and accident or incident damage.

2.5.2 Confirmatory Test Data

Confirmatory tests were conducted at Fort Knox during the period from Sept. 1967 thru June 1968. Five aircraft, (Prod No. 25, 29, 31, 40 and 50) were flown during the tests for a total of 5269 hours.

In these tests, primary concern was the pinpointing of problem subsystems and components, the development of solutions for these problems, and confirmation of the "fix" with resultant increase in reliability.

The data available provides system and component total failures without notation as to which may have been classed as mission failures. An assumption can be made however, on judgement of the nature of the failure. The data are not divided into calendar periods as regards flight hours or maintenance actions.

2.5.3 Additional Production Helicopter Data

Data was extracted from Service and Operation Reports for nine production helicopters listed in Paragraph 2.4. The data for these aircraft covers the period from delivery through October, 1967; a total of over 4000 hours. The cut-off date, and those particular aircraft, were chosen because of their engagement in test or training activities within the United States. Dates

Best Available Copy

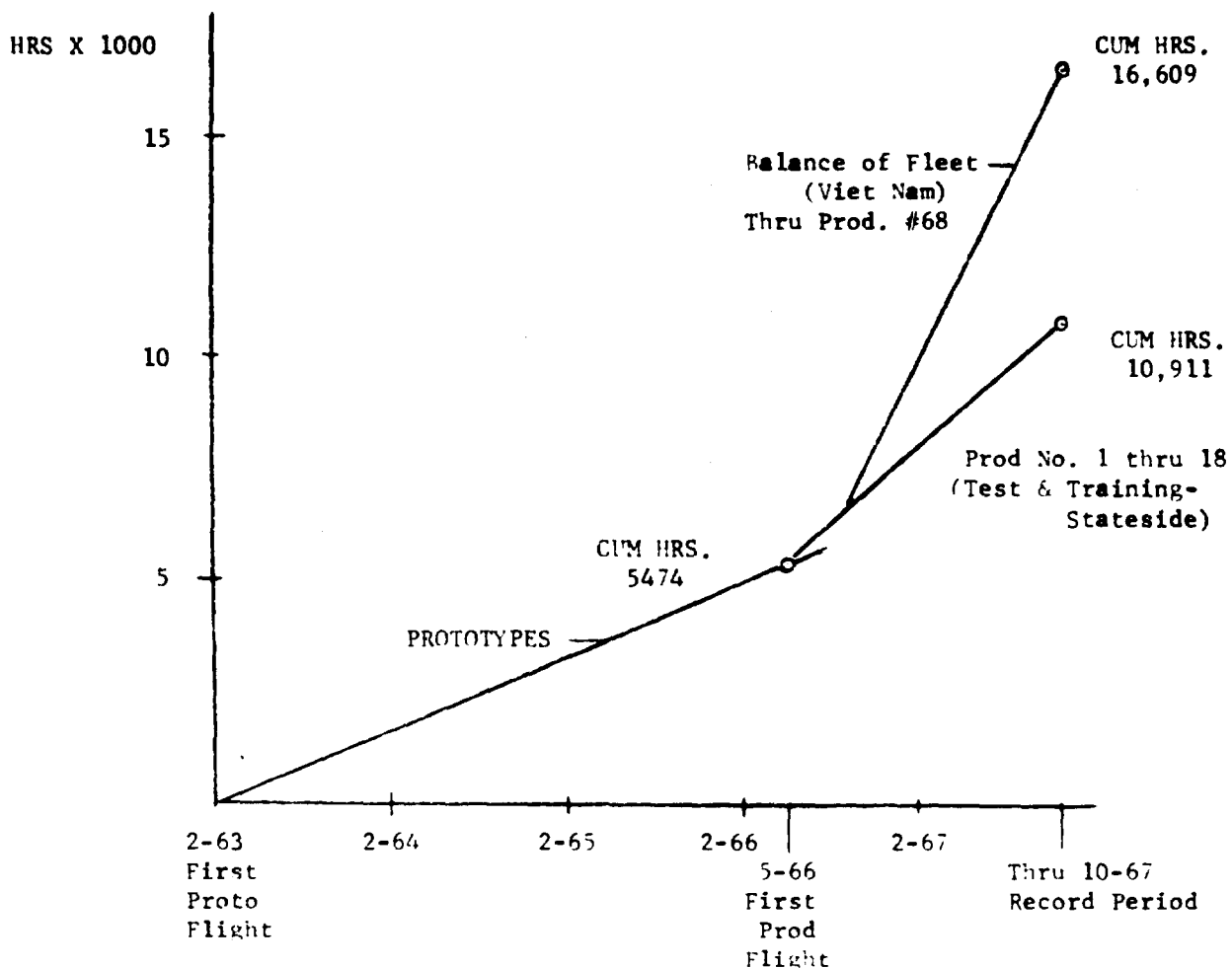


FIGURE 2-1 TOTAL FLEET HOURS FOR RECORD PERIOD

beyond this period, and later aircraft, do not provide a representative sample due to wartime activities. However, a graph of the total OH-6 fleet hours for the record period is provided in figure 2-1. The failure rate data is provided only in terms of total failures and flight hours. Monthly breakdown information is not available.

2-1

Best Available Copy

3.0 SUBSYSTEM CATEGORIES

IDA subsystem categories used in this report include Hughes subsystems as shown in the following chart:

IDA SUBSYSTEM CATEGORY

Complete helicopter

Rotors

Airframe Components

Transmissions and Drives

Power Plant

Instruments

Communications

Weapon Systems

HUGHES SUBSYSTEMS

01 Complete Helicopter

10 Main Rotor

16 Tail Rotor

20 Fuselage

35 Tail Boom

36 Stabilizer

40 Utility Equipment

60 Landing Gear

70 Flight Controls

50 Drive System

77 Engine Controls

80 Power Plant

81 Fuel System

82 Exhaust

83 Oil System

41 Electrical

42 Exterior-Interior Lighting

45 Instruments

44 Radio

47 Armor, Armament

4.0 CRITERIA AND DEFINITIONS

The following criteria were used in preparing this report. Abbreviations used in the tables are also defined.

FS - Flight-Safety failures of the catastrophic type

MSF - Mission failures of the type causing cancelled flight plan, premature return-to-base, or precautionary landing.

SSS - System failures are unscheduled maintenance actions due to pilots squawks or defects found during inspections. Includes items for which maintenance may be deferred without creating a flight safety hazard.

FRH - Failure rate per flight hour.

C - Repairable items are all qualifying failures listed above.

Best Available Copy

NC - Non-chargeable items include parts removed for access to faulty parts, parts removed in error during fault isolation, parts damaged due to incorrect maintenance practices, cannibalization, accident damage, and scheduled (TRO) removals.

CUM - Cumulative

LOC - Location during test period:

AAB - Aberdeen or Phillips AAB
 AKN - Fort Knox
 ARU - Fort Rucker
 EAF - Edwards AFB
 HTC - Hughes, Culver City

5.0 SUMMARY

5.1 PROTOTYPE DATA SUMMARY

SHIP NO.	LOC.	FLT. HRS.	FAILURES				
			MSN	FS	SYS	CUM	FR/FH
3	HTC	264	8	0	105	113	0.4280
5	HTC	807	18	0	331	349	0.4325
6	ARU	1000	17	0	76	93	* 0.0930
8	ARU	230	9	0	93	102	0.4434
TOTALS (all)		2301	52	0	605	657	0.2855
TOTALS (excluding # 6)		1301	35	0	529	564	0.4335

Failure rates for Ship 6 appear low when compared to other prototype aircraft. This is possibly due to the type of testing performed. Records used are for the 1000 hour log evaluation test at Fort Rucker. The flight time there was accumulated as quickly as possible and deferrable type maintenance actions may not have been recorded. CFE failures (engine and communications equipment) were not recorded or charged. Refer to Table 6-5 for system details.

The data for ships No. 3, 5, and 8 were derived from day-to-day records and include all CFE. Some difficulty was experienced in determining which maintenance actions were due to failures and which were work requirements for specific tests. Bias, if any, is toward the high failure rate side. Refer to tables 6-1 through 6-4 and 6-6 for detailed data.

Best Available Copy

5.2 R & M DATA SUMMARY (PRODUCTION)

SHIP NO.	LOC.	FLT HRS.	F A I L U R E S				
			MSN	FS	SYS	CUM	FR/FH
12929	ARU	500	8	0	154	162	0.3240
12930	ARU	500	8	0	190	198	0.3960
TOTALS:		1,000	16		344	360	0.3600

Refer to tables 6-7 through 6-10 for detailed data. GFE failures were not recorded or charged.

5.3 CONFIRMATORY DATA SUMMARY (PRODUCTION)

SHIP NO.	LOC	FLT HRS.	F A I L U R E S				
			MSN	FS	SYS	CUM	FR/FH
12940	AKN	1,032					
12944	AKN	1,068					
12946	AKN	1,037					
12955	AKN	1,053					
12965	AKN	1,077					
TOTALS:		5,269	73	0	972	1,045	0.1983

Refer to table 6-11 for details. The data includes GFE failures. A monthly breakdown for these particular tests is not available.

Best Available Copy

5.4 ADDITIONAL DATA SUMMARY (PRODUCTION)

SHIP NO.	LOC.	FLT HRS.	F A I L U R E S				
			MSN	FS	SYS	CUM	FR/FH
12916	ARU	474	12	0	39	51	0.1075
12917	HTC	183	6	0	13	19	0.1038
12918	ARU	564	10	0	37	47	0.0833
12919	EAF	286	11	0	79	90	* 0.3147
12921	ARU	900	20	0	84	104	0.1156
12923	ARU	352	2	0	15	17	** 0.0483
12925	ARU	483	5	0	16	21	** 0.0435
12926	ARU	652	6	0	16	22	** 0.0352
12927	AAB	132	5	0	19	24	0.1818
TOTALS		4,026	77		318	395	0.0981
(ALL)							

* The failure rate data for this aircraft appears high, placing it in the same category as the prototype and R&M ships. The type of testing undergone at Edwards AFB is unknown, as are the criteria used in defining failures.

** The failure rate data for these aircraft appears low and outside the general pattern. The cause is probably inadequate reporting during the time period. When the questionable data are excluded from the totals (table below) the failure rate per flight hour is lowered. However, the first total including all "good" and "bad" data may be closer to the general average.

FLT HRS.	F A I L U R E S				
	MSN	FS	SYS	CUM	FR/FH
2,905	59	0	208	267	0.0919

Refer to tables 6-12 and 6-13 for details of the data used, GFE failures (Avionics) are not included and a monthly breakdown is not available.

6.0 DETAILED DATA TABLES

Refer to tables 6-1 through 6-13 following.

Best Available Copy

TABLE 6-1 PROTOTYPE DATA (SHIP NO. 3)

<u>MONTH</u>	<u>FLIGHT HOURS</u>	<u>CUM FLIGHT HOURS</u>	<u>FAILURES (CHARGEABLE)</u>				<u>FR/FL</u>
			<u>MSN</u>	<u>FS</u>	<u>SYS</u>	<u>CUM TOTAL</u>	
4/63	9.8	9.8	1	0	9	10	0.9800
5/63	19.9	29.7	2	0	11	23	0.8417
6/63	12.1	41.8	0	0	11	34	0.8612
7/63	33.0	74.8	0	0	11	45	0.6283
8/63	24.5	99.1	2	0	14	61	0.6357
9/63	23.0	122.1	0	0	9	70	0.5896
10/63	6.4	128.5	0	0	2	72	0.5758
11/63	33.8	162.3	2	0	9	83	0.5237
12/63	25.5	187.8	0	0	12	95	0.5165
1/64	20.8	208.6	0	0	4	99	0.4842
2/64	18.1	226.7	0	0	3	102	0.4587
3/64	13.7	240.4	0	0	2	104	0.4409
4/64	17.2	257.6	1	0	8	113	0.4386
5/64	6.8	264.4	0	0	1	114	0.4374

* Crashed during armament tests--Pilot error

TABLE 6-3 PROTOTYPE DATA (SHIP NO. 5)

MONTH	FLIGHT HOURS	CUM FLIGHT HOURS	FAILURES			CUM TOTAL	FR/FH
			MSX	FS	SYS		
9/63	4.5	4.5	0	0	7	7	1.5555
10/63	21.7	26.2	1	0	15	23	0.8778
11/63	26.5	52.7	0	0	8	31	0.5882
12/63	5.0	57.7	2	0	12	45	0.7798
1/64	55.8	113.5	2	0	21	68	0.6017
2/64	33.9	147.4	1	0	13	82	0.4833
3/64	17.0	164.4	1	0	15	98	0.5918
4/64	22.0	186.4	0	0	12	110	0.5863
5/64	49.5	235.9	0	0	17	127	0.5140
6/64	112.7	348.6	2	0	18	147	0.3964
7/64	38.2	386.8	1	0	18	166	0.4090
8/64	24.3	411.1	0	0	9	175	0.4057
9/64	26.6	437.7	1	0	19	195	0.4300
10/64	1.4	439.1	0	0	3	198	0.4354
11/64	18.4	457.5	0	0	7	205	0.4354
12/64	10.9	468.4	0	0	2	207	0.4380
1/65	6.1	474.5	0	0	3	210	0.4387
2/65	1.2	475.7	0	0	2	212	0.4418
3/65	34.0	509.7	1	0	5	218	0.4238
4/65	23.2	532.9	0	0	6	224	0.4166
5/65	3.9	536.8	0	0	3	227	0.4192
6/65	4.1	540.9	0	0	2	229	0.4198
7/65	9.2	550.1	0	0	3	232	0.4182
8/65	15.5	565.6	1	0	8	241	0.4227
9/65	11.1	576.7	0	0	4	245	0.4215
10/65	6.4	583.1	0	0	3	248	0.4220
11/65	9.0	592.1	1	0	5	254	0.4258
12/65	8.8	600.9	0	0	3	257	0.4245
1/66	11.2	612.1	1	0	10	268	0.4349
2/66	28.0	640.1	0	0	4	272	0.4219
3/66	18.8	658.9	1	0	6	279	0.4206
4/66	11.8	670.7	0	0	5	284	0.4205
5/66	25.8	696.5	1	0	6	291	0.4149
6/66	12.2	708.7	0	0	5	296	0.4148
7/66	6.0	714.7	0	0	1	297	0.4127
8/66	4.1	718.8	0	0	3	300	0.4146
9/66	16.8	735.6	0	0	3	303	0.4091
10/66	32.5	768.1	1	0	5	309	0.4127
11/66	0.0	768.1	0	0	7	316	0.4219
12/66	0.0	768.1	0	0	7	323	0.4311
1/67	36.6	804.7	0	0	1	324	0.4125
2/67	1.8	806.5	0	0	1	325	0.4129
3/67	0.0	806.5	0	0	17	342	0.4329
4/67	11.0	817.5	0	0	4	346	0.4320
			18	0	328		

Periodic inspection

Inspection following transfer of aircraft

Conformity inspection

Best Available Copy

TABLE 6-2 PROTOTYPE DATA (SHIP NO. 3)
TOTAL FAILURES PER SUBSYSTEM

SUBSYSTEM	CALENDAR YEAR												MONTH												TOTAL
	1/63	2/63	3/63	4/63	5/63	6/63	7/63	8/63	9/63	10/63	11/63	12/63	1/64	2/64	3/64	4/64	5/64								
COMPLETION OF HELICOPTER	10	13	11	11	16	9	2	11	12	4	3	2	9	1	114										
	1	2	2	2	2	0	0	2	0	0	0	0	0	0	11										
ROTORS	1	3	3	3	1	1	1	0	1	0	0	0	1	0	15										
	1	2	2	2	1	0	0	0	0	0	0	0	0	0	8										
AIRFRAME	1	1	0	3	2	3	0	6	5	1	1	2	3	0	33										
COMPS	0	0	0	0	1	0	0	2	0	0	0	0	0	0	3										
ENGINE DRIVES	0	1	1	2	3	0	0	1	0	1	0	0	1	1	11										
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
POWER PLANT	6	4	4	2	3	2	1	3	3	0	1	0	3	0	32										
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
TESTING FLTC.	0	4	3	1	2	3	0	0	3	2	0	0	1	0	19										
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
COMMUNICATIONS	2	0	0	0	0	0	0	1	0	0	0	0	0	0	3										
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
WEAPON SYSTEMS	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1										
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
TOTAL REMOVALS	5	6	7	5	6	6	1	8	10	3	0	2	7	1	67										
	1	2	2	2	2	0	0	0	1	0	2	0	0	0	12										

TABLE 6-4 PROTOTYPE DATA (SHIP NO. 5) Sheet 1 of 3
TOTAL FAILURES PER SUBSYSTEM

SUB SYS. CATEGORY	C = CHARGEABLE NC = NON CHARGEABLE	MONTH																	
		9/63	10/63	11/63	12/63	1/64	2/64	3/64	4/64	5/64	6/64	7/64	8/64	9/64	10/64	11/64	12/64	1/65	
COMPLETE HELICOPTER	C	7	16	8	14	23	14	5	16	12	17	20	19	9	20	3	7	2	3
	NC	5	8	8	5	7	5	5	4	5	6	5	5	0	5	0	2	1	0
ROTORS	C	0	3	3	3	5	3	2	2	4	3	2	2	2	3	1	2	0	0
	NC	1	6	2	2	3	0	0	1	1	1	0	0	0	0	0	1	1	0
AIRFRAME COMPS.	C	4	5	2	5	12	5	5	6	5	3	6	6	6	9	1	2	1	1
	NC	1	0	1	2	4	2	2	2	2	1	1	0	4	0	0	0	0	0
XMSN & DRIVES	C	2	4	0	1	0	1	1	0	1	0	0	0	0	2	0	1	1	0
	NC	1	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
POWER PLANT	C	0	0	2	3	2	2	4	4	4	10	6	1	2	2	1	2	0	1
	NC	0	0	3	0	0	0	1	1	2	4	2	0	1	0	0	1	0	0
INST. & ELEC.	C	1	2	1	2	4	2	4	0	1	4	5	0	4	0	0	0	0	1
	NC	2	0	1	0	0	2	2	0	0	0	2	0	0	0	0	0	0	0
COMMUN- ICATIONS	C	0	2	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0
	NC	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WEAPON SYSTEMS	C	NO WEAPONS INSTALLED																	
	NC																		
TOTAL REMOVALS	C	0	7	7	11	11	9	9	5	12	14	12	4	7	1	3	1	0	0
	NC	2	4	3	6	3	3	2	1	2	4	3	0	2	0	1	0	0	0

Best Available Copy

TABLE 6-4 PROTOTYPE DATA (SHIP NO. 5) Sheet 2 of 3
TOTAL FAILURES PER SUBSYSTEM

SUB SYS. CATEGORY	C = CHARGEABLE NC = NON CHARGEABLE	MONTH																	6/66
		2/65	3/65	4/65	5/65	6/65	7/65	8/65	9/65	10/65	11/65	12/65	1/66	2/66	3/66	4/66	5/66		
COMPLETE HELICOPTER	C	2	6	6	3	2	3	9	4	3	6	3	11	4	7	5	7	5	
	NC	0	0	0	0	0	0	1	0	0	1	3	3	0	0	1	3	3	
ROTORS	C	0	1	0	1	0	2	2	1	1	1	1	2	2	1	1	1	0	
	NC	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	3	
AIRFRAME COMPS.	C	2	2	3	0	0	1	3	1	1	3	0	6	1	2	1	1	2	
	NC	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
XMSVS DRIVES	C	0	0	0	1	0	0	1	1	0	1	1	1	1	2	0	0	0	
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
POWER PLANT	C	0	1	1	0	0	0	1	0	0	1	0	1	0	1	2	4	2	
	NC	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	
INSTS. ELEC.	C	0	2	1	1	1	0	2	1	1	0	1	1	0	1	1	1	1	
	NC	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	
COMMUN- ICATIONS	C	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NO WEAPONS INSTALLED																			
WEAPON SYSTEMS	C																		
	NC																		
TOTAL REMOVALS	C	1	2	2	3	0	1	4	2	0	3	1	3	2	5	2	5	2	
	NC	0	0	0	0	0	0	1	0	0	1	1	1	0	0	1	2	3	

TABLE 6-4 PROTOTYPE DATA (SHIP NO. 5) Sheet 3 of 3
TOTAL FAILURES PER SUBSYSTEM

SUB SYS. CATEGORY	C = CHARGED NC = NO CHARGED		MONTH												TOTAL
	7/66	8/66	9/66	10/66	11/66	12/66	1/67	2/67	3/67	4/67	GFE INCLUDED				
COMPLETE HELICOPTER	C	1	3	3	7	7	1	1	17	4	346				
	NC	1	0	0	1	0	0	0	0	0	88				
ROTORS	C	0	0	1	1	0	1	0	1	1	61				
	NC	1	0	0	0	0	0	0	0	0	28				
AIRFRAME COMPS.	C	1	1	2	1	5	7	0	8	1	133				
	NC	0	0	0	1	0	0	0	0	0	24				
XMSN & DRIVES	C	0	0	0	0	0	0	0	0	0	23				
	NC	0	0	0	0	0	0	0	0	0	5				
POWER PLANT	C	0	1	0	1	0	0	0	3	0	63				
	NC	0	0	0	0	0	0	0	0	0	18				
INSTS. & ELEC.	C	0	1	0	2	1	0	1	4	2	57				
	NC	0	0	0	0	0	0	0	0	0	12				
COMMUN- ICATIONS	C	0	0	0	1	0	0	0	1	0	9				
	NC	0	0	0	0	0	0	0	0	0	1				
WEAPON SYSTEMS	C	NO WEAPONS INSTALLED													
NC															
TOTAL REMOVALS	C	0	0	3	3	1	0	0	5	1	164				
	NC	0	0	0	0	0	0	0	0	0	46				

Best Available Copy

TABLE 6-5 PROTOTYPE DATA (SHIP NO. 6)
TOTAL FAILURES PER SUBSYSTEM

SYSTEMS CATEGORY	C = CHARGEABLE NC = NON-CHARGEABLE	RECORD PERIOD - FEB. 1964 THRU JUNE 1964 - 1000 FLIGHT HRS.			
		Unsched. MH	Sched. MH	Total	MH/FL
COMPLETE HELICOPTER	C 93	342.5	186.8	529.3	0.529
ROTORS	C 28	24.6	48.4	73.0	0.073
AIRFRAME COMPS.	C 29	186.4	65.7	252.0	0.252
XMEN & DRIVES	C 8	54.8	25.8	80.6	0.081
POWER PLANT	C 8 EXCLUDES G F E	17.1	24.0	41.1	0.041
INSTS & ELEC.	C 20	59.5	22.8	82.3	0.083
COMMUN-ICATIONS	C F - NOT REPORTED				
WEAPON SYSTEMS	- NOT REPORTED				
TOTAL REMOVALS	UNKNOWN				

TABLE 6-6 PROTOTYPE DATA (SHIP NO. 8)
TOTAL FAILURES PER SUBSYSTEM

SUB SYS. CATEGORY	C = CHARGEABLE NC = NON CHARGEABLE	RECORD PERIOD - 3/64 thru 6/64	
		C	NC
COMPLETE HELICOPTER	C NC	102 20	
ROTORS	C NC	19 6	
AIRFRAME COMPS	C NC	23 5	
XMSN & DRIVES	C NC	4 2	
POWER PLANT	C NC	20 4	
INSTS. & ELEC.	C NC	28 3	
COMMUN- ICATIONS	C NC	8 0	
WEAPON SYSTEMS	NOT REPORTED		
TOTAL REMOVALS	C NC	41 16	

TABLE 6-7 R&M DATA (65-12929)

<u>MONTH</u>	<u>FLIGHT HOURS</u>	<u>CUM FLIGHT HOURS</u>	<u>FAILURES</u>				<u>FR/FH</u>
			<u>MSN</u>	<u>FS</u>	<u>SYS</u>	<u>CUM TOTAL</u>	
2/67	18.8	18.8	0	0	0	0	
3/67	146.2	165.0	2	0	13	15	0.0909
4/67	33.3	198.3	1	0	3	19	0.0958
5/67	104.1	302.4	2	0	55	76	0.1818
6/67	142.6	445.0	2	0	51	129	* 0.2898
7/67	0.0	445.0	-	-	13	142	0.3191
8/67	55.0	500.0	1	0	19	162	0.3240

* Periodic Inspection

Total man hours = Scheduled + Unscheduled = 308.2

Maint. man hours per flight hours = $308.2/500 = 0.616$ Hr.

TABLE 6-8 R&M DATA (65-12929)
TOTAL FAILURES PER SUBSYSTEM

SUBSYS. CATEGORY	C = CHARGEABLE NC = NON CHARGEABLE	MONTH						TOTAL
		2/67	3/67	4/67	5/67	6/67	7/67	8/67
COMPLETE	C	0	15	4	57	53	13	20
HELICOPTER	NC	0	3	1	7	9	0	1
								162
								21
ROTORS	C	0	4	1	9	8	0	2
	NC	0	1	0	2	2	0	0
								24
								5
AIRFRAME	C	0	7	1	23	21	5	7
COMPS	NC	0	2	0	4	5	0	0
								64
								11
XMEN & DRIVES	C	0	0	0	3	1	2	3
	NC	0	0	0	0	1	0	1
								9
								2
POWER PLANT	C	0	1	1	7	11	3	2
	NC	0	0	1	1	1	0	0
								25 EXCLUDES G F E
								3
INSTS. & ELFC.	C	0	3	2	15	12	3	6
	NC	0	0	0	0	0	0	0
								40
								0
COMMUN- ICATIONS								
WEAPON SYSTEMS								
TOTAL	C	0	2	4	15	18	5	6
REMOVALS	NC	0	0	1	4	6	0	1
								50
								12

61-1

TABLE 6-9 R&M DATA (65-12930)

<u>MONTH</u>	<u>FLIGHT HOURS</u>	<u>CUM FLIGHT HOURS</u>	<u>FAILURES</u>				<u>FR/FH</u>
			<u>MSN</u>	<u>FS</u>	<u>SYS</u>	<u>CUM TOTAL</u>	
2/67	17.3	17.3	0	0	0	0	
3/67	116.2	133.5	2	0	15	17	0.1273
4/67	74.7	208.2	2	0	20	39	0.1873
5/67	27.5	235.7	1	0	14	54	0.2291
6/67	112.4	348.1	2	0	92	148	0.4251
7/67	96.6	444.7	1	0	23	172	0.3867
8/67	55.6	500.3	0	0	26	198	0.3960

* Periodic Inspection

Total Manhours = Scheduled + Unscheduled = 374.8

Maint. Manhours per flight hour = $374.8/500 = 0.749$ Hr.

TABLE 6-10 R&M DATA (65-12930)
TOTAL FAILURES PER SUBSYSTEM

SUB SYS. CATEGORY	C = CHARGEABLE NC = NON CHARGEABLE	MONTH						TOTAL	
		2/67	3/67	4/67	5/67	6/67	7/67		8/67
COMPLETE	C	0	17	22	15	94	24	26	198
HELICOPTER	NC	0	2	0	0	0	0	0	2
ROTORS	C	0	3	4	3	17	2	2	31
	NC	0	0	0	0	0	0	0	0
AIRFRAME COMPS.	C	0	5	8	7	38	13	15	86
	NC	0	0	0	0	0	0	0	0
XMSN & DRIVES	C	0	0	1	0	8	2	3	14
	NC	0	0	0	0	0	0	0	0
POWER PLANT	C	0	4	5	3	12	4	2	30 EXCLUDES G F E
	NC	0	1	0	0	0	0	0	1
INSTS. & ELEC.	C	0	5	4	2	19	3	4	37
	NC	0	1	0	0	0	0	0	1
COMMUN- ICATIONS	C	G F E NOT REPORTED							
WEAPON SYSTEMS	NC	NONE INSTALLED							
TOTAL	C	0	10	5	12	34	13	10	84
REMOVALS	NC	0	2	4	0	8	2	0	16

TABLE 6-11 CONFIRMATORY DATA (PRODUCTION)
TOTAL FAILURES PER SUBSYSTEM

SUB SYS CATEGORY	C = CHARGEABLE NC = NON CHARGEABLE		RECORD PERIOD FROM 9/67 thru 5/68	
	C	NC		
COMPLETE HELICOPTER	1045	155		FIVE AIRCRAFT FAILURE TOTALS FOR 5269 FLT. HRS.
ROTORS	83	23		MAINTENANCE MANHOURS PER FLIGHT HOUR 0.877
AIRFRAME COMPS.	283	15		AVAILABILITY - ACTUAL - 83.4%
XMSN & DRIVES	9	13		
POWER PLANT	220	18		INCLUDES G F E
INSTS. & ELEC.	222	83		
COMMUN- ICATIONS	62	3		INCLUDES G F E
WEAPON SYSTEMS	166	0		
TOTAL REMOVALS	446	83		

TABLE 6-11

TABLE 6-12 ADDITIONAL PRODUCTION DATA

SERIAL NO. 65-	FLIGHT HOURS	CUM FLIGHT HOURS	FAILURES				
			MSN	FS	SYS	CUM TOTAL	FR/FH
Period of Record from 1966 delivery to 11/1/67							
21916		474	12	0	39	51	0.1075
21917		183	6	0	13	19	0.1038
21918		564	10	0	37	47	0.0833
21919		286	11	0	79	90	0.3147
21921		900	20	0	84	104	0.1156
21923		352	2	0	15	17	0.0483
21925		483	5	0	16	21	0.0435
21926		652	6	0	16	22	0.0352
21927		132	5	0	19	24	0.1818

TABLE 6-13 ADDITIONAL PRODUCTION DATA
TOTAL FAILURES PER SUBSYSTEM

SUB SYS CATEGORY	Ser. No. 65-	(RECORD PERIOD FROM 1966 DELIVERY TO 11/1/67)											TOTAL
		C = CHARGEABLE NC = NON CHARGEABLE											
		12916	12917	12918	12919	12921	12923	12925	12926	12927			
COMPLETE HELICOPTER	C	51	19	47	90	104	17	21	22	24		395	
	NC	3	4	1	4	12	1	1	2	2		30	
ROTORS	C	5	6	4	7	20	1	2	2	6		53	
	NC	0	0	0	0	4	0	0	0	0		4	
AIRFRAME COMPS.	C	16	5	15	35	41	8	10	11	10		151	
	NC	2	1	1	4	6	0	1	1	1		17	
XMSN & DRIVES	C	3	2	6	5	10	3	4	3	1		37	
	NC	1	2	0	0	0	0	0	0	0		3	
POWER PLANT	C	11	1	11	33	11	3	2	4	2		78	
	NC	0	0	0	0	0	0	0	0	1		1	
INSTS. & ELEC.	C	16	5	11	10	22	1	3	2	5		75	
	NC	0	0	0	0	2	1	0	1	0		4	
C F E NOT REPORTED													
NOT REPORTED													
UNKNOWN													

Part C

Data Submitted by Sikorsky

5-1

Sikorsky Aircraft



TITLE Operations Reliability Maintainability Engineering
Program Quarterly Evaluation Report

REPORT NUMBER REP-04276

PREPARED UNDER Contract No. DAA-J01-68C-0512 (31 Mod P008

REPORT DATE May 10, 1968

REPORT PERIOD

This report is applicable to the following aircraft model(s) and contract(s):

MODEL

CH-53A

CONTRACT

DAA-J01-68C-0512 (31) P008

Prepared by

E. Holbert
E. Holbert

Checked by

M. A. Wachs
M. A. Wachs

Approved by

E. S. Jenney
E. S. Jenney

REV.	CHANGED BY	REVISED PAGE(S)	ADDED PAGE(S)	DELETED PAGE(S)	DESCRIPTION	DATE	APPROVAL
1	<i>h</i>				9th Quarterly Cumulative Report	15 May 70	
2	<i>h</i>				10th Quarterly Cumulative Report	15 Aug 70	
3	<i>h</i>				11th Quarterly Cumulative Report	15 Dec 70	

REVISIONS CONTINUED ON NEXT PAGE

ABSTRACT

The quarterly Evaluation Report is submitted for the eleventh quarterly period of field data collection as part of the Operations Reliability/Maintainability Engineering Program, defined in Contract DAA-J01-68C-0512 (31), Data Item 08-010, DA Form 3149-F. The data is cumulative for the 33 month period and all information not compiled in the prior reports has been included as part of up-dating for this report.

CH-54A Operations Reliability data accumulated a total of 47,993 flight hours for the 33 month period. The reliability levels for a one-hour mission based on this data are:

Total Reliability	.7845
Mission Reliability	.9875

Analysis of maintainability data shows the following derivations.

Average Active Maintenance Downtime/Flight Hour	2.3 hrs
Elapsed Mean Time to Repair	1.9 hrs
Average Manhours/Down Hour	2.8 MH
Active Maintenance Manhour/Flight	6.4 MMH/FH
Operational Availability	54.3%

The stable nature of the 2.8 manhours per down hour and 6.4 manhours per flight hour values may reflect the maturing of the program and the continuing effort to improve our computer program.

The increase in operational availability from 54.1% to 54.3% is the direct result of a decrease in reported administrative down time.

Sikorsky Aircraft

DIVISION OF UNITED AIRCRAFT CORPORATION

U
A.

REPORT NO. DA-64276-Part 1
MODEL CH-54A

RELIABILITY

ANALYSIS

SUMMARY

U. S. Army CH-54A operations in the 33 months of ORME data reporting have accumulated 47,993 flight hours and exhibit the following MTBF's (Mean Time Between Failures):

All Failures 4.12 hours

Mission Aborts 60.1 hours

These MTBF's convert to the following reliability levels for a one-hour mission:

Total Reliability* (1 hour) .754-

Mission Reliability** (1 hour) .9575

Hardware discrepancies required 37,663 maintenance man-hours for local corrective maintenance.

Relatively few components contribute to a high percentage of the total aircraft unreliability. At the system level, powerplant, rotors and blades, transmission, instruments, hydraulics and communications account for 67.3% of all primary failures. Powerplant, APF, hydraulics and transmission account for 73% of all mission abort failures.

The "top ten" components in each of the following categories account for more than:

11% of all failures

15% of all mission abort failures

26% of all local corrective maintenance time to repair primary failures

31% of all local corrective maintenance manhours to repair primary failures

* Total Reliability - Probability of no failure in the specified time. This category applies to all classes of failure regardless of degree of severity and includes aborts, downs, minors, and malfunctions with no effect.

**Mission Reliability - Probability that a CH-54A will experience no mission aborting failure in a one-hour mission.

SUMMARY (Cont)

The 33 month cumulative reliability statistics show a slight change in reliability relative to the 30 month figures submitted in the last quarterly report as shown:

	<u>30 Month Cumulative</u>	<u>33 Month Cumulative</u>
CH-54A Total Reliability (1 hour)	.7850	.7845
CH-54A Mission Reliability (1 hour)	.9870	.9875

The distribution of failure rate among systems has changed slightly since the last report. Powerplant, rotors and blades, and transmission remain the top three failure rate systems. Lower MTHF's for instruments, hydraulics and communications now rank these three systems as the fourth, fifth and sixth major sources of unreliability. These six major areas account for 67% of the total aircraft failure rate. Powerplant, APP, hydraulics and transmission still rank as the top four major contributors of mission aborts and are responsible for 73% of the abort rate.

The "top ten" lists of components, R-1, R-2, and R-3, show slightly less impact on total aircraft reliability from top ten components.

Top ten components' contribution to aircraft unreliability have changed only slightly from that of the previous report:

	<u>30 Month Cumulative</u>	<u>33 Month Cumulative</u>
based on failure rate	15%	15%
based on number of failures	22%	21%
based on abort rate	27%	25%

SUMMARY (cont)

New Components in top ten lists and the components they replace from the last quarterly are as follows:

<u>Top Ten Category</u>	<u>New Components In Top Ten List</u>	<u>Components Deleted From Top Ten List</u>
Number of Failure (List R-2)	Rotor Brake Package Assembly P/N 71428	MGB Oil Cooler V Belt P/N 3V600
Abort Rate (List R-3)	Cargo Hoist UP Pressure Generator Tube P/N 6465-62051-061	P/N 28B139-33A
Unscheduled Maintenance Manhours (List R-5)	Turbo shaft Engine Exhaust Duct P/N 571076	AFCS Servo Assembly P/N S6265-62551-10

SUMMARY (Cont)

Projections of component MTBR's (Mean Time Between Removals) based on 33 month cumulative data show slight deterioration from the 30 month cumulative figures submitted in the last report. Higher rates of failure and damage beyond local repair yield generally lower MTBR's. (Note that MTBR's continue to consider overhauls and scrappage arising from both primary failures and damage.)

COMPONENT	MTBR	MTBR
	Based on 30 Month Cumulative Data	Based on 33 Month Cumulative Data
Main Rotor Head Assembly	322 hr	291 hr
APP Clutch Assembly	309 hr	311 hr
Tail Rotor Blade	374 hr	345 hr
Main Rotor Damper Assembly	391 hr	395 hr

DISCUSSIONTotal Reliability

Figure A-1, the total reliability block diagram covering all major systems shows a 4.12 hour total mean time between failures and .7845 total aircraft reliability for a one-hour mission. The system code digits shown in the block diagram define system boundaries and the hardware included. They are defined in Appendix A2-1 of the ORE Handbook.

There were no changes in the total MTBF or the Reliability covering major systems from the last quarterly report.

	<u>30 Month Cumulative</u>	<u>33 Month Cumulative</u>
MTBF	4.12 hr	4.12 hr
Reliability (1 hour)	.785	.785

Figure A-1 shows powerplant, rotors and blades, transmission, instruments, hydraulics and communications as the major contributors to unreliability. Taken together these major systems account for 67.4% of all failures observed in the reporting period. Figures A-2 through A-7 show the breakout of total reliability among the individual system codes within these areas.

- Powerplant - Figure A-2 highlights the engine and engine exhaust areas. Major problem items are tailpipes, flex shafts, fuel controls and exhaust ducts.
- Rotors & Blades - Figure A-3 shows both tail and main rotor blades and the main rotor head to be major contributors to unreliability. Major problem items are tail rotor blade erosion, main rotor blade tip caps, and main rotor head droop restrainers.
- Transmission - Figure A-4 highlights the rotor brake, main transmission and MGB oil cooler. Rotor brake pucks & support brackets are large contributors to unreliability. Main transmission failures are distributed among many component parts. Oil cooler V belts are the highest single contributors to MGB oil cooler unreliability.

Instruments - Figure A-5 highlights the instruments (from detector to indicator). The generator tachometer, servo network and the fuel flow transmitter are the major sources of unreliability.

Hydraulics - Figure A-6 highlights the cargo hoist and flight control hydraulics. Hoist up pressure tube, hoist pump, 1st stage hydraulic pump and the 2nd stage hydraulic manifold are the major sources of unreliability.

Communications - Figure A-7 highlights the ARC-54 VHF radio sets.
Corrective action procedures for increasing the reliability of various components and systems are discussed in detail in SER-64272-1 Monthly Progress Accomplishment Report.

Mission Reliability

Figure A-8, the total mission reliability block diagram, shows an 89.12 hour total mean time between failures for mission aborts and .9875 one-hour mission reliability.

These levels represent a 5% improvement in mission abort MTBF from the last quarterly report.

	<u>30 Month Cumulative</u>	<u>33 Month Cumulative</u>
MTBF, aborts	76.6 hr	89.2 hr
Mission Reliability (1 hour)	.9870	.9875

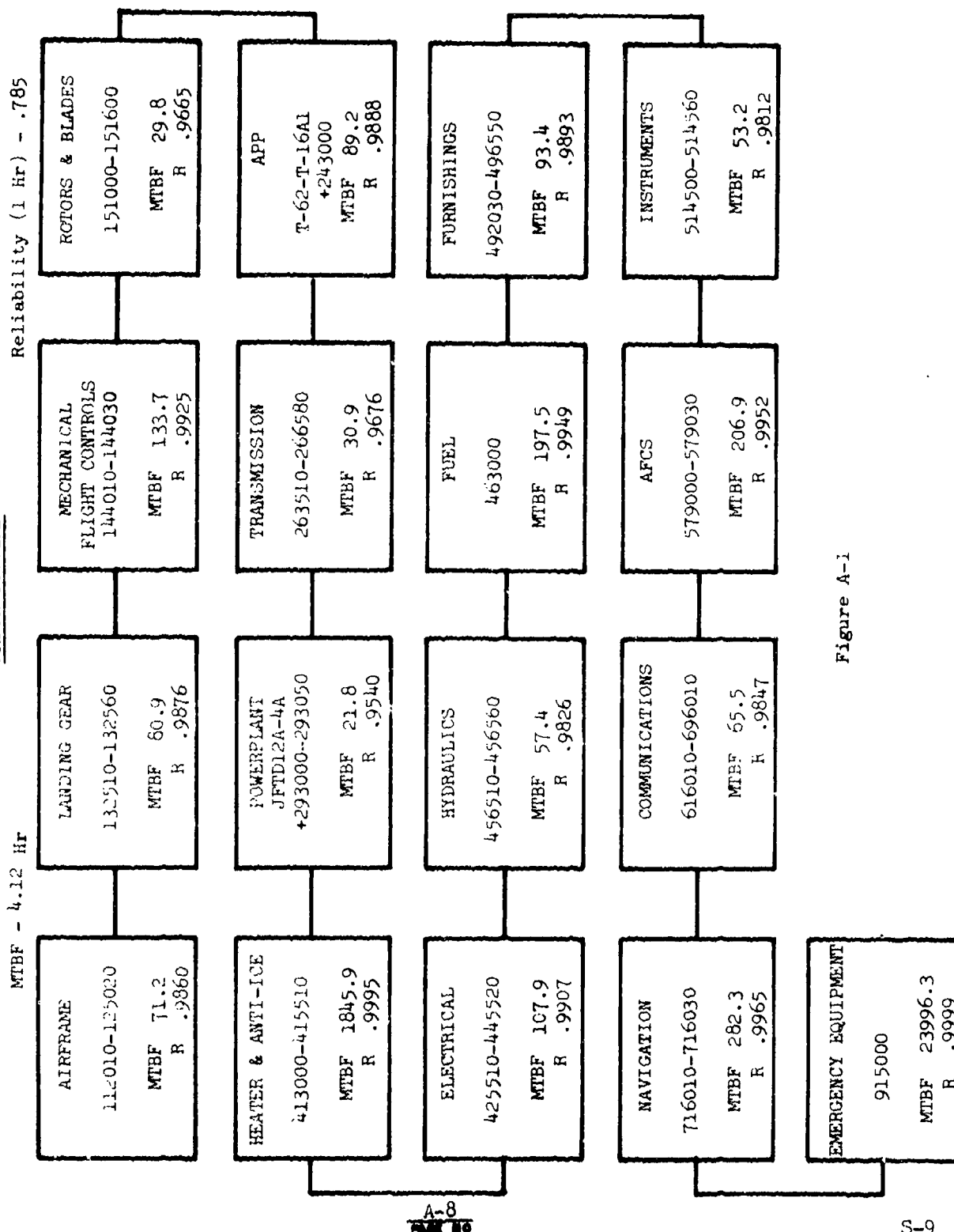
Figure A-8 shows powerplant, APP, hydraulics and transmission continue to be the major contributors to the mission abort rate. Taken together these four major systems account for 73.5% of all mission aborts observed in the reporting period. Figures A-9 through A-12 show the breakout of mission reliability among the individual system codes within these four areas.

Powerplant - Figure A-9 highlights the engine and engine hydraulic start. Fuel controls, engine start hydraulic lines, fuel pumps & flex shafts are important mission abort items.

- APP - Figure A-10 highlights the APP itself. The APP fuel pressure switch and the APP fuel control are significant abort items.
- Hydraulics - Figure A-11 shows cargo hoist hydraulics account for 55.8% of all hydraulic aborts. Pressure lines are a significant source of mission aborts.
- Transmission - Figure A-12 shows the main transmission and the main gear box oil cooler to be major contributors among transmission systems. The oil cooler V belt is a large single source of aborts.



TOTAL RELIABILITY BLOCK DIAGRAM MAJOR SYSTEMS



TOTAL RELIABILITY BLOCK DIAGRAM - POWERPLANT SYSTEMS

MTBF - 41.8 Hr Reliability (1 Hr) - .9540

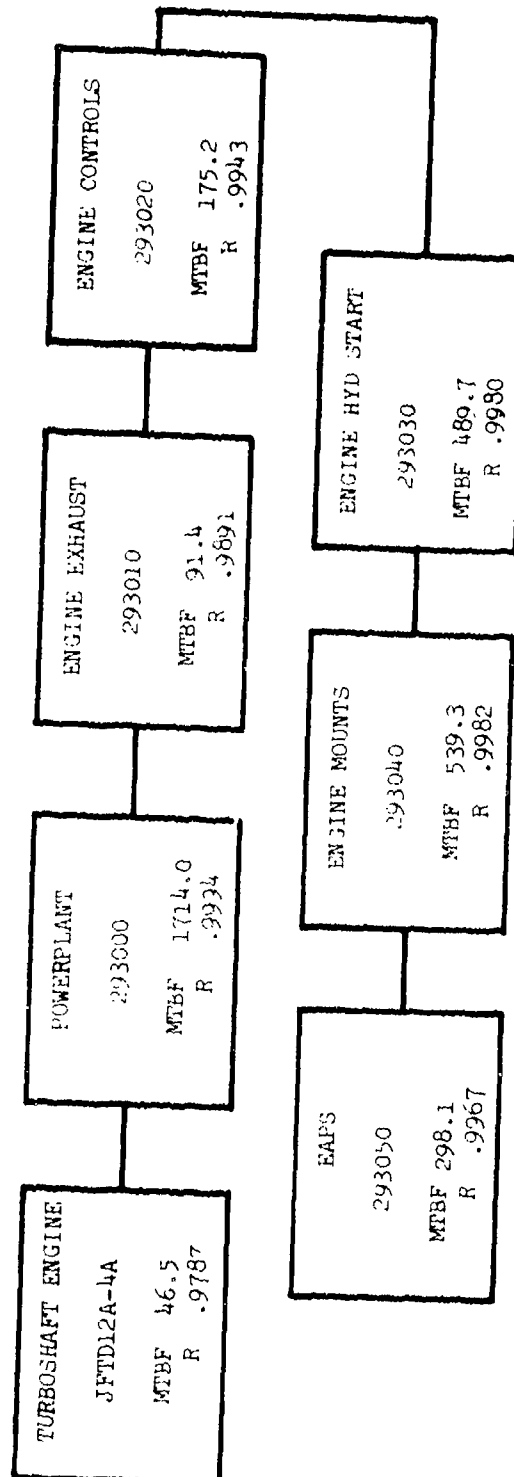


Figure A-2

TOTAL RELIABILITY BLOCK DIAGRAM - ROTOR AND BLADE SYSTEM

MTBF - 29.8 Reliability (1 Hr) - .9665

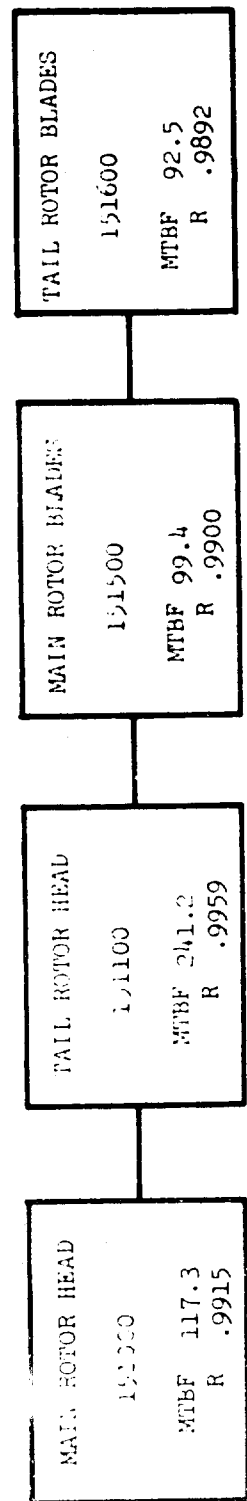


Figure A-3

TOTAL RELIABILITY BLOCK DIAGRAM - TRANSMISSION SYSTEMS

MTBF - 30.9 hr Reliability (1 Hr) - .9676

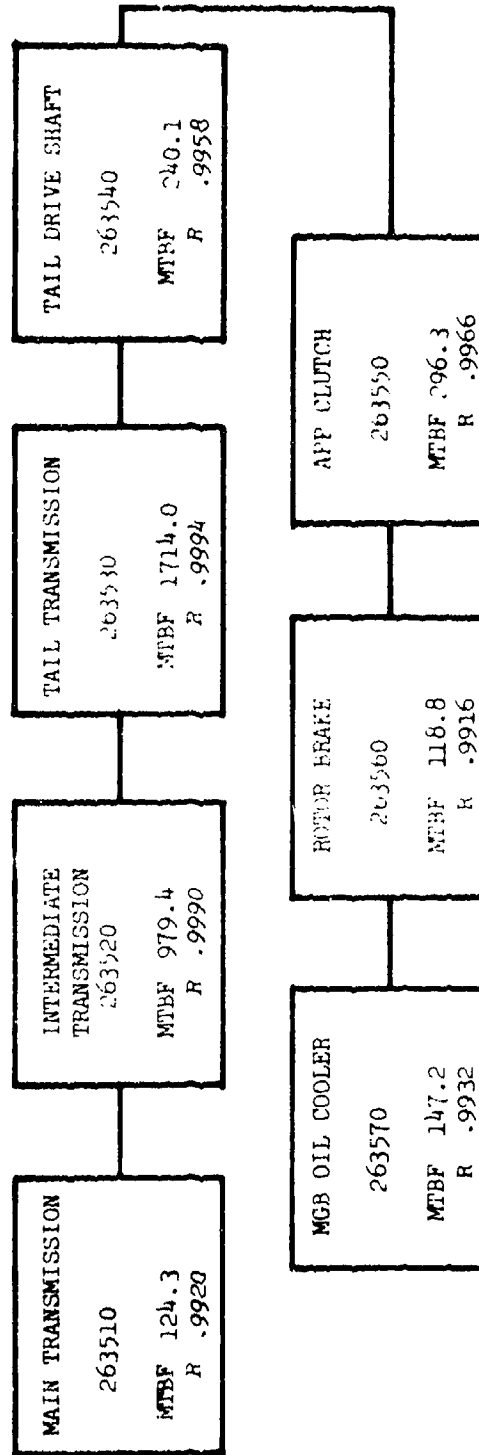


Figure A-4

TOTAL RELIABILITY BLOCK DIAGRAM - INSTRUMENTS SYSTEM

MTBF - 53.0 Hr Reliability (1 Hr) - .9812

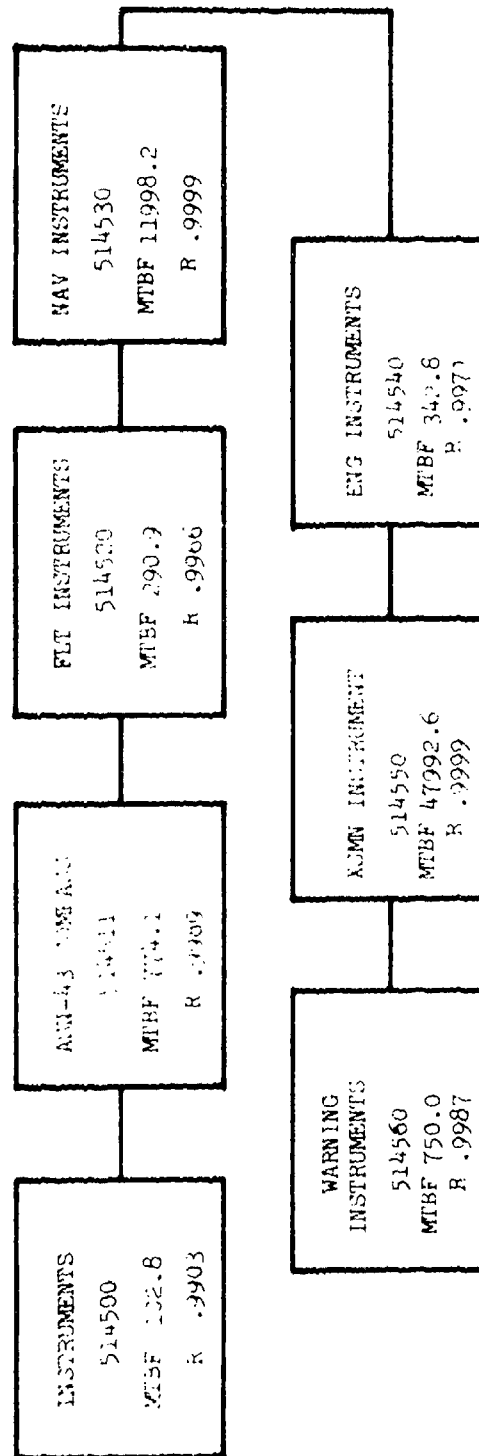


Figure A-5

TOTAL RELIABILITY BLOCK DIAGRAM - HYDRAULICS SYSTEM

MTBF - 57.4 Hr Reliability (1 Hr) - .9826

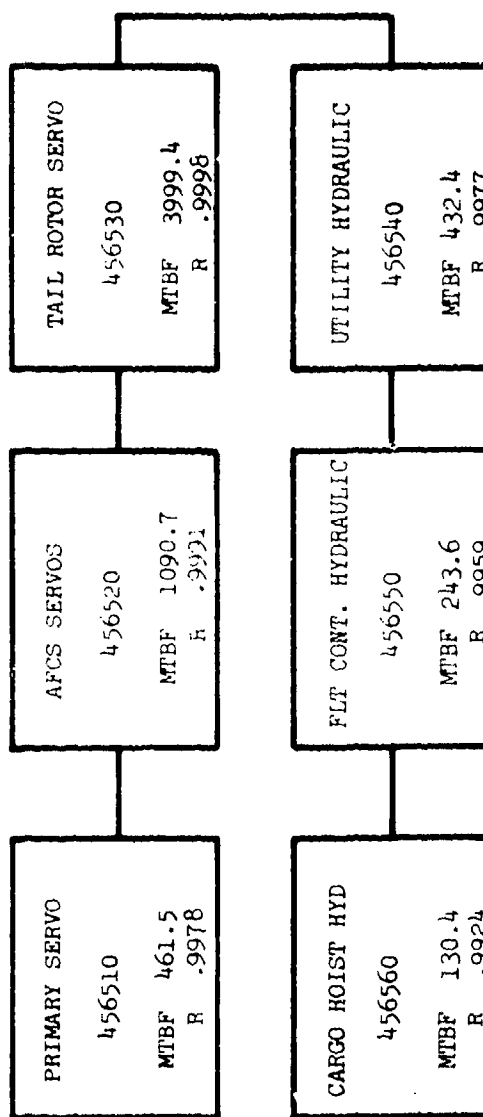


Figure A-6

TOTAL RELIABILITY BLOCK DIAGRAM - COMMUNICATION SYSTEM

MTBF - 65.5 Hr

Reliability (1 Hr) - .9847

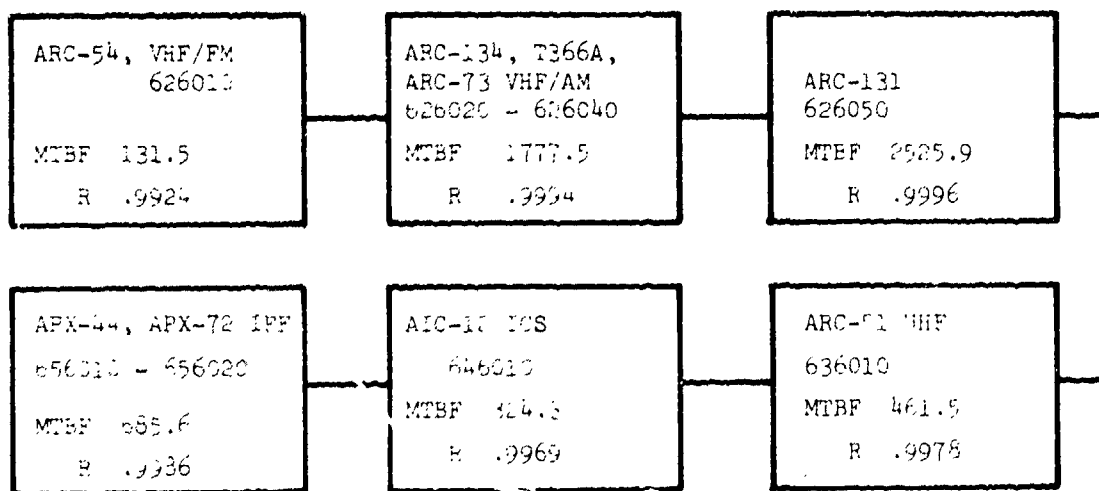
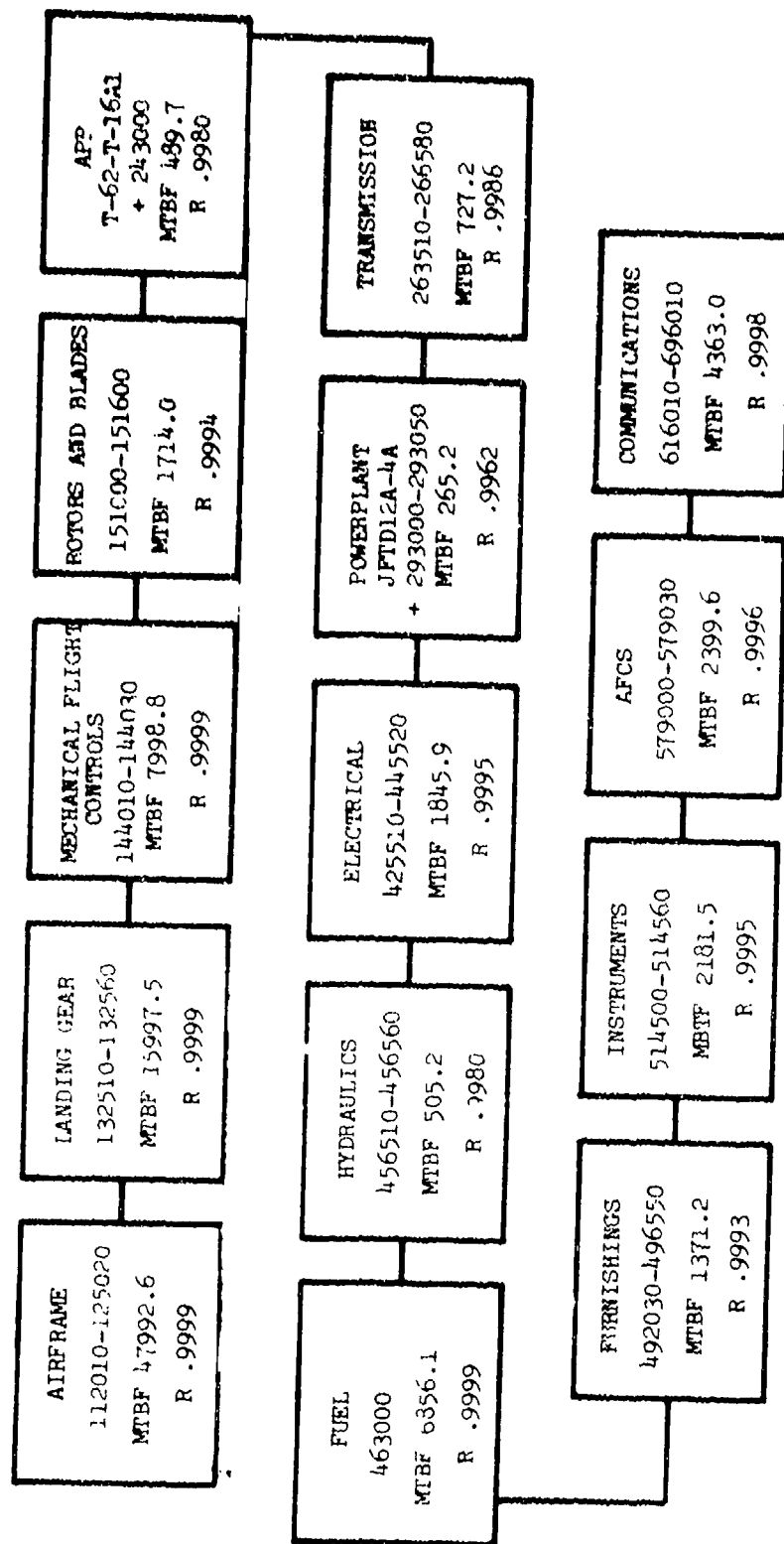


Figure A-7

MISSION RELIABILITY BLOCK DIAGRAM - MAJOR SYSTEMS

MTBF - 60.12 Reliability (1 Hr.) - .9875

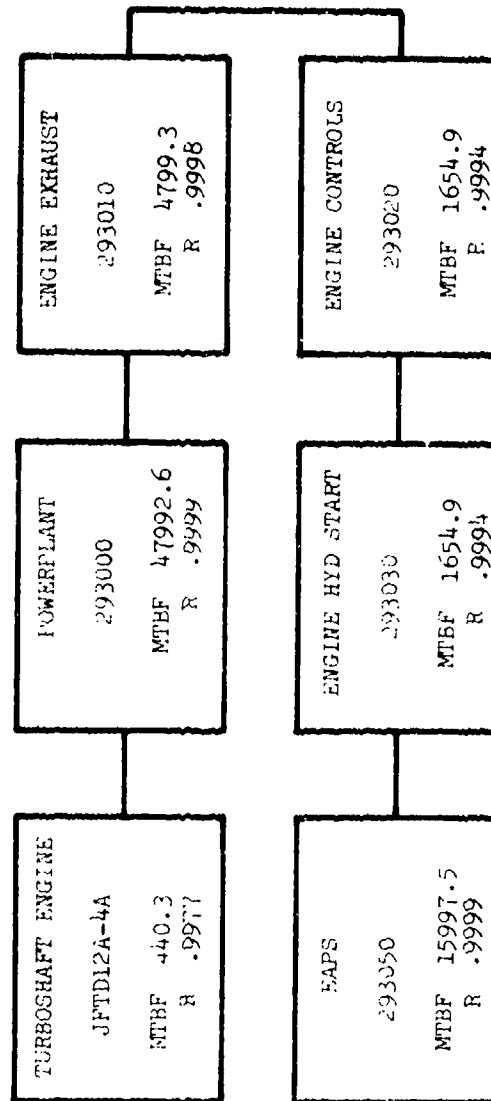


No Aborts Reported in Heater and Anti-Ice, Navigation, and Emergency Equipment.

Figure A-8

MISSION RELIABILITY BLOCK DIAGRAM - POWERPLANT SYSTEMS

MTBF - 365.3 Hr Reliability (1 Hr) - .9962



No Aborts in Other Powerplant System Codes

Figure A-9

MISSION RELIABILITY BLOCK DIAGRAM - APP
MTBF - 499.7 Hr Reliability (1 Hr) - .9980

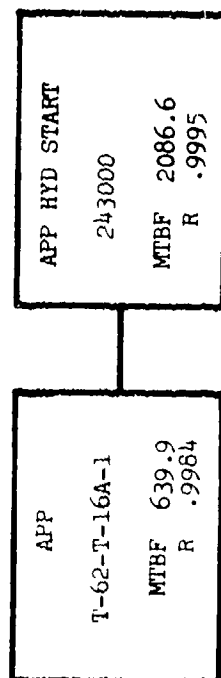
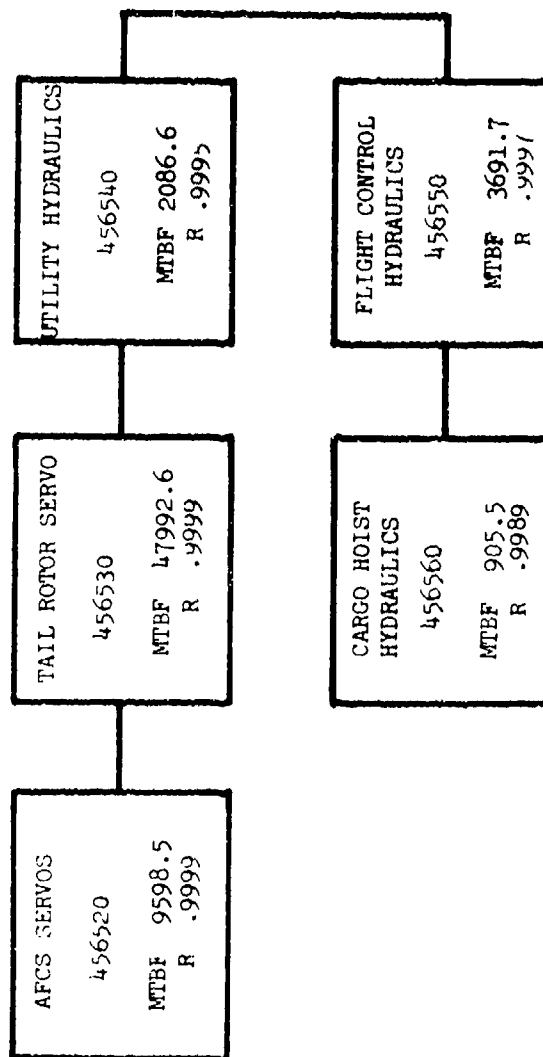


Figure A-10

MISSION RELIABILITY BLOCK DIAGRAM - HYDRAULIC SYSTEMS

MTBF - 505.2 Hr Reliability (1 Hr) - .9980



No Aborts in Other Hydraulic System Codes

Figure A-11

MISSION RELIABILITY BLOCK DIAGRAM - TRANSMISSION SYSTEMS

MTBF - 727.2 Reliability (1 Hr) - .9986

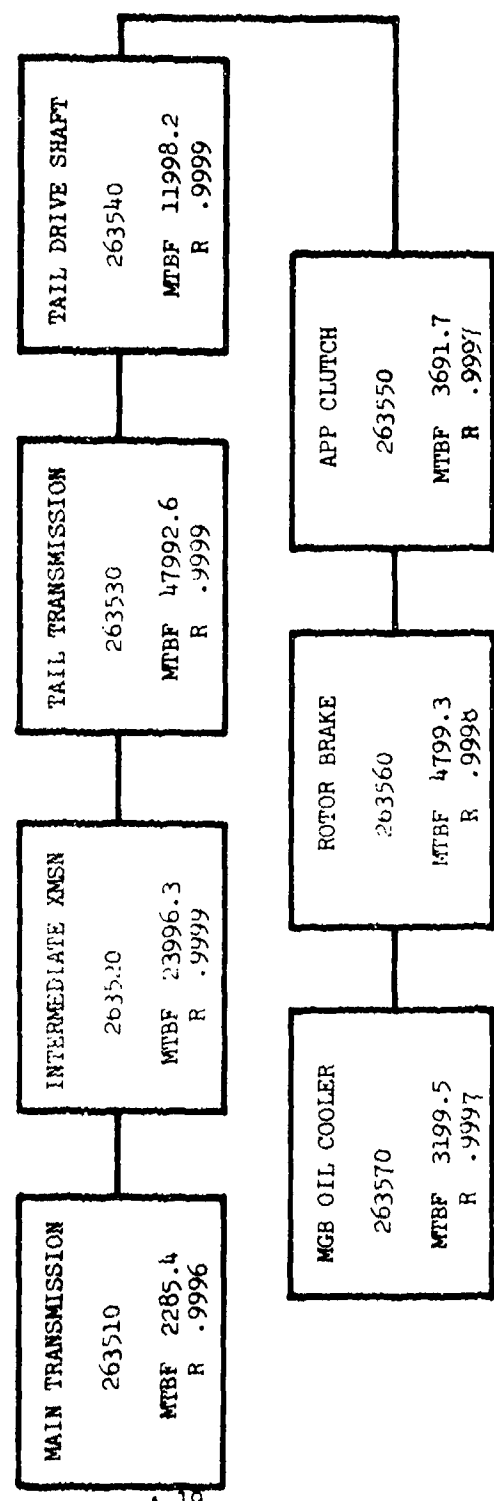


Figure A-12

Failure Rates and Reliabilities
(Data Item 08-010-1)SYSTEMS

Table A-1, Section D of this report, provides the failure rates, reliabilities, and abort rates observed in this reporting period by system.

Thirty-three month cumulative behavior shows an increase in the reliability in a number of the systems relative to the 30 month cumulative behavior documented in the previous quarterly report.

Table A-1 shows a high concentration of primary failures in the following areas: powerplant, rotors and blades, transmission, instruments, hydraulics and communications. Taken together the systems in these major groupings account for an observed .163 failures per flight hour, 6 7% of the total .243 failures per flight hour for the overall aircraft.

The ten individual system codes with the highest observed failure rates are as follows:

<u>System Code</u>	<u>Nomenclature</u>	<u>Failure Rate</u> (Failures per hr)	<u>Reliability</u> (1 hour)
0FTD12A-4A	Turboshaft Engines	.021503	.9787
293010	Engine Exhaust	.010939	.9891
151600	Tail Rotor Blade	.010814	.9892
151500	Main Rotor Blade	.010064	.9900
514500	Instruments	.009731	.9903
151000	Main Rotor Head	.008522	.9915
263560	Rotor Brake	.008418	.9916
263510	Main Transmission	.008043	.9920
456560	Cargo Hoist Hydraulics	.007668	.9924
626010	ARC-54 VHF/FM	.007605	.9924

Sikorsky Aircraft

DIVISION OF UNITED AIRCRAFT CORPORATION

U
A.

REPORT NO. SER 64276 Rev J

Taken together these ten system codes account for .103 failures per flight hour, 43% of the aircraft total.

Table A-1 shows a continued high concentration of mission abort failures in four areas: powerplant, APP, hydraulics, and transmission. Taken together the systems in these four major groupings account for an observed .0092 aborts per flight hour, 74% of the total .0125 aborts per flight hour for the overall aircraft.

The ten individual system codes with the highest observed abort rates are as follows:

<u>System Code</u>	<u>Nomenclature</u>	<u>Failure Rate</u> (Failures per hour)	<u>Reliability</u> (1 hour)
JFTD12A-4A	Turboshaft Engines	.002271	.9977
T-62-T-16A1	APP	.001563	.9984
456560	Cargo Hoist Hydraulics	.001104	.9989
495020	Cargo Winch	.000667	.9993
{ 293020	Engine Controls	.000604	.9994
{ 293030	Engine Hydraulic Start	.000604	.9994
243900	APP Hydraulic Start	.000479	.9995
263510	Main Transmission	.000438	.9996
514500	Instruments	.000396	.9996
425520	Generator	.000354	.9997
263570	MGB Oil Cooler	.000313	.9997

Taken together these ten system codes account for .0088 abort failures per flight hour, 71% of the aircraft total.

The MGB Oil Cooler System code is a new entry in this list replacing the Utility Hydraulic system code present in the previous 30 month cumulative list. The Engine Controls and Engine Hydraulic Start system codes have tied with the fifth highest abort rate.

Table A-1 shows a continued high concentration of maintenance man-hours to repair primary failures in four areas: powerplant, transmission, rotors and blades, and hydraulics. Taken together the systems in these four major groupings account for an observed 25,290.8 maintenance manhours to repair primary failures, 67% of the total 37,662.2 manhours to repair all primary failures in all aircraft systems.

The ten individual system codes with the most maintenance manhours for primary failure repair are as follows:

<u>System Code</u>	<u>Nomenclature</u>	<u>Maintenance Manhours to Repair Primary Failures</u>
5FTD12A-4A	Turboshaft Engines	6359.2
151000	Main Rotor Head	3249.7
203510	Main Transmission	3139.5
450500	Cargo Hoist Hydraulics	1490.4
495020	Cargo Winch	1382.6
151500	Main Rotor Blade	1172.4
203500	Hel.	1168.8
151510-10A	APB	1087.9
151510	Tail Rotor Blade	1075.1
151510	Engine Exhausts	1045.6

Taken together these ten system codes account for 21,179.2 maintenance manhours, 56% of the total required to repair all primary failures observed on the aircraft.

Table A-1 shows a continued high concentration of elapsed maintenance time to repair primary failures in five areas: powerplant, transmission, rotors and blades, hydraulics and airframe. Taken together the systems in these five major groupings account for an observed 15,526.3 elapsed hours for maintenance to repair primary failures, 69% of the total 22,530.9 hours to repair all primary failures in all aircraft systems.

The ten individual system codes with the most elapsed time for primary failure repair are as follows:

<u>System Code</u>	<u>Nomenclature</u>	<u>Elapsed Time for Primary Failure Repair Active Maintenance</u>
JFTDLRA-4A	Turboshaft Engines	3158.9
203510	Main Transmission	1628.4
151000	Main Rotor Head	1310.5
450560	Cargo Hoist Hydraulics	949.9
151600	Tail Rotor Blade	732.2
*293010	Engine Exhaust	715.7
45020	Cargo Winch	711.8
450500	Fuel	710.8
151500	Main Rotor Blade	663.3
T-62 LT-16A1	APF	650.9
203560	Rotor Brake	637.4

Taken together these system codes account for 11869.8 elapsed hours, 53% of the total required to repair all primary failures observed on the aircraft.

*The system codes present in the previous 30 month cumulative list have remained virtually the same, except the order has changed.

COMPONENTS

Table A-2, Section D of this report, provides the failure rates, reliabilities, and abort rates observed in this reporting period by component.

Within each system code Table A-2 arranges components alpha-numerically by Sikorsky and vendor part number of three levels of hardware, assembly, subassembly, and component. Corresponding federal stock numbers are also shown.

List R-1 in this section shows the ten assembly part numbers with the highest reported failure rates. Taken together they contribute 15% the total aircraft failure rate. There are no new additions or deletions to List R-1 for the last quarter.

R-1 printout entries correspond to the part numbers shown. In some cases Table A-2 reports additional failures of the same hardware against alternate part numbers so that the actual number of failures, component failure rates, and percentages are higher.

In general, the R-1 printout reflects the hardware level at which component replacement was performed on the aircraft. Major components such as the main transmission, for which Table A-1 shows a total .038043 failures per hour, do not appear since these failures are distributed among 101 separate lower level assemblies, each of which is repairable or replaceable on the aircraft.

R-1 entries for the engine exhaust tailpipe, tail rotor blade, and rotor brake support bracket identify the failed hardware meaningfully, in sufficient detail to show where reliability improvement at the component level can provide a relatively high yield in total failure rate reduction.

Other entries require additional explanation. Table A-2 in Section 2 shows that:

Approximately 18% of all APP clutch malfunctions were traced to SB1125-1 bearings. An increase in failures in other subsystems has diluted the effect of the clutch problem relative to the total system.

Approximately 41% of all engine malfunctions diagnosed below the assembly level are attributable to exhaust ducts, fuel controls, fuel pumps, and shafts. Note that Table A-1 shows 1032 failures against the engine system code, more than four times the number shown in R-1. The remaining 784 are distributed among alternate part numbers and engine component parts accessible for on-aircraft repair or replacement.

Approximately one-quarter of all rotor brake malfunctions diagnosed below the assembly level are attributable to brake pucks. Puck failures together with rotor brake support bracket failures account for almost one half of all diagnosed failures. Note that Table A-1 shows 404 failures against the rotor brake system code, more than four times the number shown in R-1. The remaining 319 are distributed among alternate part numbers and rotor brake component parts accessible for on-aircraft repair or replacement.

Approximately 20% of all anti-collision light failures are attributable to MIL-B338-7079 incandescent light failures. Table A-1 shows 313 failures against the exterior light system code, more than twice the number shown in R-1. The remaining 172 are distributed among alternate part numbers and various components accessible for on-aircraft repair or replacement.

Approximately 30% of all MGB oil cooler malfunctions below the assembly level are attributable to the upper, lower and idler pulleys. Table A-1 shows 326 failures against the MGB oil cooler system code, more than twice the amount shown in R-1. The remaining 194 are distributed among various components accessible for on-aircraft repair or replacement.

A complete evaluation of ARC-54 failures is impossible because it requires additional data that is not currently available to ORE's. Meaningful identification of failure phenomenon requires electronic diagnosis within the receiver-transmitter to the component level. Current maintenance facilities at CH-54A operation sites do not permit such diagnosis. (The ARC-54 is being replaced by the ARC-131.)

The ARC-54 UHF receiver-transmitter is similar to the ARC-54 receiver-transmitter in that additional electronic diagnosis within these units is necessary for true component level reporting. Its failure rate is substantially lower and the effects of its failures upon mission reliability, maintenance manhours and elapsed maintenance downtime is substantially less. Depending upon the exact nature of the failure modes, failure rates may be reasonable and justified in light of the complexity inherent in this unit. Table A-1 shows an observed 461.3 hr MTBF for the ARC-54 system, - a level more than four times higher than the 100 hr specified by procurement specification MIL-R-22659B (A3).

S-27

In order to identify problem areas and possible future problems, additional top ten lists are included for the first time. These new lists are identified by the suffix A, and include only the data received during the past 3 month period. In this way we can better determine what are the current problem areas and if a potential fix has been made, whether or not it is effective.

List R-2 in this section shows the ten part numbers with the highest reported number of failures. This criterion spotlights cases where component failure rates below R-1's top ten combine with high quantities-per-aircraft to yield significant contributions to the total aircraft failure rate. Note that List R-2 accounts for approximately 21% of the total aircraft failure rate while List R-1 accounts for only 15%. Specifically List R-2 shows that:

6415-20209-041	Main Rotor Blade Tip Cap
6415-20201-041	Main Rotor Blade Assembly
65160-00001-045	Tail Rotor Blade Assembly
6435-60028-010	Tail Drive Shaft Support Assembly
71428	Rotor Brake Package Assembly

fall below List R-1's top ten on the basis of failure rates but contribute substantially to aircraft unreliability.

The Rotor Brake Package P/N 71428 is a new entry in R-2 replacing the WGB Oil Cooler V Belt P/N 3V600 present in the previous 30-month cumulative list.

List R-2A shows those items with the highest number of failures which have occurred during the past quarter. A review of the Monthly Accomplishment Report SER 64276-1, will describe the corrective action taken.

Best Available Copy

TOP TL - FAILURE RATE

930

LIST R-1 REV J

FROM: 090101 TO 700930

LOCATION - ALL

FLIGHT TIME - 47992.6

AIRCRAFT SERIAL NO. RANGE - ALL

COMPONENT P/N	NOMENCLATURE	NO. OF FAILURES	COMP. FAILURE RATE	QTY PER A/C	TOTAL FAILURE RATE	PERCENT OF A/C FAIL. RATE
626010 RT-348/ARC-54	ARC-54 VHF REC-TRANS.	312	.006501	1	.006501	2.7
293010 6430-80601-082	ENGINE EXHAUST TAIL PIPE ASSY	431	.004490	2	.008981	3.7
263550 S6137-91000-015	APP CLUTCH APP CLUTCH	140	.002917	1	.002917	1.2
4FD12A-4A 572200	TURBO-SHAFT ENG ENGINE	248	.002584	2	.005167	2.1
636010 RT-742/ARC-518X	ARC-51 UHF REC-TRANS	86	.001792	1	.001792	.7
263560 6465-28016-012	ROTOR BRAKE SPY ROTOR BRAKE	85	.001771	1	.001771	.7
579010 6490-60105-101	AFC5 AMPLIFIER AMPLIFIER CONTR	72	.001500	1	.001500	.6
445510 WS25277-2	EXTERIOR LIGHTS LIGHT ANTI COLL	141	.001469	2	.002938	1.2
579030 6490-60131-011	REMOTE STICK REMOTE STICK	67	.001396	1	.001396	.6
263570 3V600	MGB OIL COOLER V BELT	132	.001375	2	.002750	1.1

PAGE A-29

TOP TEN - FAILURE RATE List R-1A REV 3 FROM: 700701 TO 700930 LOCATION - ALL

FLIGHT TIME - 3001.2		AIRCRAFT SERIAL NO. RANGE -		REL		
COMPONENT P/N	NOMENCLATURE	NO. OF FAILURES	COMP. FAILURE RATE	QTY PER A/C	TOTAL FAILURE RATE	PERCENT OF A/C FAIL. RATE
293010	ENGINE EXHAUST 6430-80601-082 TAIL PIPE ASSY	30	.004996	2	.009996	4.5
8280210	ARC-84 VHF RT-348/ARC-54 REC-TRANS.	13	.004332	1	.004332	1.9
283539	APP CLUTCH 56137-91000-015 APP CLUTCH	12	.003998	1	.003998	1.8
579010	MCS AMPLIFIER 6490-0108-101 AMPLIFIER CONTR	8	.002666	1	.002666	1.2
283510	MAIN TRANSMISSION 6435-20400-047 MAIN GEAR BOX	5	.001666	1	.001666	.7
828030	ARC-131 RT-023/ARC-131 REC-TRANS	5	.001666	1	.001666	.7
293020	ENGINE CONTROLS 6430-80326-101 ACTUATOR SPEED	9	.001999	2	.002999	1.3
JPTD12A-6A 571078	TURBO-SHAFT ENG FUEL CONTROL	9	.001999	2	.002999	1.3
979030	REMOTE STICK 6490-00131-011 REMOTE STICK	4	.001333	1	.001333	.6
975010	WINDSHIELD WIPER XW20403490-20 WIPER ASSY	8	.001333	2	.002666	1.2

TOP TEN - NUMBER OF FAILURES

LIST R-2 REV 3

FROM: 680101 TO 700930

LOCATION - ALL

FLIGHT TIME - 47992.6

AIRCRAFT SERIAL NO. RANGE - ALL

COMPONENT P/N	DESCRIPTION	NO. OF FAILURES	COMP. FAILURE RATE	QTY PER A/C	TOTAL FAILURE RATE	PERCENT OF TOTAL NO. FAILURES
151600	TAIL ROTOR BLADE	477	.000000	-0	.000000	4.1
65160-00001-045	BLADE ASSY T/R					
293010	ENGINE EXHAUST	431	.004490	2	.008981	3.7
6430-00601-082	TAIL PIPE ASSY					
626910	ARC-54 VHF	312	.006501	1	.006501	2.7
RT-3487ARC-54	REC-TRANS.					
JFT012A-4A	TURBO-SHAFT ENG	248	.002504	2	.005167	2.1
572200	ENGINE					
151500	MAIN ROTOR BLADE	225	.000781	6	.004686	1.9
6415-20209-041	CAP TIP					
151500	MAIN ROTOR BLADE	212	.000736	6	.004417	1.8
6415-20201-041	BLADE ASSYS/H/R					
263540	TAIL DRIVE SHAFT	149	.000621	5	.003105	1.3
6435-60028-010	SUPPORT ASSY					
445510	EXTERIOR LIGHTS	141	.001469	2	.002936	1.2
MS23277-2	LIGHT ANTI COLL					
263550	APP CLUTCH	140	.002917	1	.002917	1.2
56137-91000-015	APP CLUTCH					
263560	ROTOR BRAKE	134	.000000	-0	.000000	1.2
71428	BRAKEPACKAGE/SSY					

Page A-31

TOP TEN - NUMBER OF FAILURES **LUT R-2A REV 3** FROM: 700701 TO 700930 LOCATION - ALL

FLIGHT TIME - 3001.2 AIRCRAFT SERVICE NO. RANGE - ALL

COMPONENT P/N	NO. OF FAILURES	COMP. FAILURE RATE	QTY PER 17C	TOTAL FAILURE RATE	PERCENT OF TOTAL NO. FAILURES
29301C	30	.004998	2	.009996	4.5
6430-80601-688					
ENGINE EXHAUST TAIL PIPE ASSY					
263940	10	.001200	5	.005996	2.7
6435-60020-010					
TAIL DRIVE SHAFT SUPPORT ASSY					
191900	17	.000944	6	.005604	2.5
6415-20201-041					
MAIN ROTOR BLADE BLADE ASSY NR					
620010	13	.005332	1	.004332	1.9
RT-340/ARC-34					
ARC-34 VAP REC-TRANS.					
263880	12	.003996	1	.003996	1.8
56137-91000-015					
APP CLUTCH APP CLUTCH					
263000	12	.000000	-0	.000000	1.8
71420					
ROTOR BRACE BRACKET/ASSY					
191000	12	.001000	0	.003996	1.8
65161-00001-041					
TAIL ROTOR BLADE TAIL ROTOR BLADE					
191000	12	.000000	-0	.000000	1.8
65160-00001-045					
TAIL ROTOR BLADE BLADE ASSY T/R					
191000	10	.000555	6	.003332	1.5
6415-20209-041					
MAIN ROTOR BLADE CAP TIP					
293020	9	.001999	2	.002999	1.3
6430-80320-101					
ENGINE CONTROLS ACTUATOR SPEED					

List R-3 in this section shows the ten component part numbers with the highest reported mission abort rates. Taken together they contribute 25% of the total mission abort rate.

The Cargo Hoist Up Pressure tube, P/N 6465-62051-061, is a new entry in R-3 replacing the Generator, P/N 28B139-33A, present in the previous 30 month cumulative list.

R-3 printout entries correspond to the part numbers shown. In some cases Table A-2 reports additional aborts of the same hardware against alternate part numbers so that the actual number of aborts, component abort rates, and percentages are higher.

R-3 shows 22% of the total mission abort rate concentrated in engine, APP, powerplant and engine control components necessary for the engine start cycle.

Virtually all R-3 entries are well defined. Components are identified meaningfully - in sufficient detail to show where reliability improvement at the component level can provide a reduction in the total abort rate. List R-3A shows those components with the highest report mission abort rates during the last quarter.

List R-4 shows the ten component part numbers with the most reported elapsed active maintenance time required to repair primary failures. R-4 highlights cases where the combined effects of high failure rates and lengthy times to repair have an overall large impact on the total maintenance required to support the aircraft. Taken together these ten components are responsible for approximately 26% of the total time required to repair all observed primary failures.

There has been virtually no change in List R-4 from the previous 30 month cumulative list.

List R-4A shows those components with the most reported elapsed active maintenance time required to repair primary failures during the last quarter.

TOP TEN - ABORT RATE

LIST R-3 REV J

FROM: 680101 TO 700930

LOCATION - ALL

FLIGHT TIME - 47992.6

AIRCRAFT SERIAL NO, RANGE - ALL

COMPONENT P/N	NOMENCLATURE	NO. OF ABORTS	COMP. RATE	QTY PER A/C	TOTAL ABORT RATE	PERCENT OF A/C ABORT RATE
293030	ENGINE HYD START	17	.000354	1	.000354	2.8
5545C3E214000	HOSE ASSY PRESS					
JFT012A-4A	TURBO-SHAFT ENG	32	.000333	2	.000667	5.3
571078	FUEL CONTROL					
I-62-I-16A1	APP	14	.000292	1	.000292	2.3
44936-0	FUEL CONTROL APP					
I-62-I-16A1	APP	13	.000271	1	.000271	2.2
37697-0	SW FUEL PRESS					
I-62-I-16A1	APP	12	.000250	1	.000250	2.0
37747-100	APP					
263550	APP CLUTCH	11	.000229	1	.000229	1.8
50157-91000-015	APP CLUTCH					
JFT012A-4A	TURBO-SHAFT ENG	21	.000219	2	.000438	3.5
572200	ENGINE					
243000	APP HYD START	10	.000208	1	.000208	1.7
530604001	STARTER APP					
495020	CARGO WINCH	10	.000208	1	.000208	1.7
6450-62100-102	RELEASE CARGO					
456560	CARGO HOIST HYD.	9	.000168	1	.000168	1.5
6465-62051-061	TUBE P HOIST UP					

36

TOP TEN - ABORT RATE LIST R-2A REV 3 FROM: 700701 TO 700930 LOCATION - ALL

FLIGHT TIME - 3001.2		AIRCRAFT SERIAL NO. RANGE - ALL				
COMPONENT P/N	NOMENCLATURE	NO. OF ABORTS	COMP. ABORT RATE	QTY PER A/C	TOTAL ABORT RATE	PERCENT OF A/C ABORT RATE
JTD12A-4A 571078	TURBO-SHAFT ENG FUEL CONTROL	3	.000500	2	.001000	10.7
131008 51505-2469	MAIN ROTOR HEAD FLUID TANK COVER	1	.000333	1	.000333	3.6
263510 35016C	MAIN TRANSMISSION SEAL	1	.000333	1	.000333	3.6
263510 6435-20140-100	MAIN TRANSMISSION COUPLING SPLINED	1	.000333	1	.000333	3.6
263510 6435-20400-047	MAIN TRANSMISSION MAIN GEAR BOX	1	.000333	1	.000333	3.6
233226 6430-00326-101	ENGINE CONTROLS ACTUATOR SPEED	2	.000333	2	.000666	7.1
496500 6465-62051-061	CARGO HOIST HYD. TUBE P HOIST UP	1	.000333	1	.000333	3.6
496020 PT06SP22-21P	CARGO WINCH CONNECTOR PLUG	1	.000333	1	.000333	3.6
495020 6450-62352-104	CARGO WINCH DECOUPLER	1	.000333	1	.000333	3.6
495500 6490-60220-011	FIRE DETECTION PANEL ASSY, FIRE	1	.000333	1	.000333	3.6

TOP TEN - ACTIVE ELAPSED MAINTENANCE TIME

FROM: 680101 TO 700930

LOCATION - ALL

FLIGHT TIME - 47992.6 AIRCRAFT SERIAL NO. RANGE - ALL

List R-4 Rev 3

COMPONENT P/N	NOMENCLATURE	ACTIVE ENT	PERCENT OF A/C TOTAL
JFTD12A-4A	TURBO-SHAFT ENG	1352.	6.0
263510	MAIN TRANSMISSION	754.	3.3
6435-20500-047	MAIN GEAR BOX		
JFTD12A-4A	TURBO-SHAFT ENG	703.	3.1
571078	FUEL CONTROL		
151600	TAIL ROTOR BLADE	685.	3.0
65160-00001-045	BLADE ASSY 1/R		
293010	ENGINE EXHAUST	646.	2.9
6430-80601-082	TAIL PIPE ASSY		
626010	ARC-54 VHF	424.	1.9
61-003/ARC-54	REC-TRANS.		
263540	TAIL DRIVE SHAFT	370.	1.6
6435-60028-010	SUPPORT ASSY		
263550	APP CLUTCH	329.	1.5
56137-91000-015	APP CLUTCH		
151500	MAIN ROTOR BLADE	308.	1.4
6415-20201-041	BLADE ASSY 5/H/R		
151500	MAIN ROTOR BLADE	296.	1.3
6415-20209-041	CAP TIP		

LOCATION - ALL

FROM: 700701 TO 700930

TOP TEN - ACTIVE ELAPSED MAINTENANCE TIME

FLIGHT TIME - 3001.2 AIRCRAFT SERIAL NO. RANGE - ALL

LIST R-4A REV J

COMPONENT P/N Nomenclature ACTIVE EMT PERCENT OF A/C TOTAL

263510 MAIN TRANSMISSION 102. 6.1

263540 TAIL DRIVE SHAFT 68. 5.3

JFT012A-4A TURBO-SHAFT ENG 67. 5.3

JFT012A-4A TURBO-SHAFT ENG 59. 4.7

293010 ENGINE EXHAUST 45. 3.6

263550 APP CLUTCH 29. 2.3

463000 FUEL 24. 1.9

496810 PRIMARY SERVO 20. 1.6

131900 MAIN ROTOR BLADE 19. 1.5

JFT012A-4A TURBO-SHAFT ENG 19. 1.5

PAGE A-37

List R-5 shows the ten component part numbers with the most reported maintenance manhours required to repair primary failures. R-5 highlights cases where the combined effects of high failure rates, lengthy times to repair, and required large complements of maintenance personnel have an overall large impact on the total aircraft maintenance burden. Taken together these ten components are responsible for 31% of the total maintenance manhour work load required to repair all primary failures.

The Turbo Shaft Engine Exhaust Duct, P/N 571076, is a new entry in R-5 replacing the AFCS Servo Assembly, P/N 86265-62551-10 present in the previous 30 month cumulative list.

R-5 printout entries correspond to the part numbers shown. In some cases Table A-2 shows additional maintenance required to repair primary failures of the same hardware against alternate part numbers so that the actual maintenance times and percentages are higher.

List R-5A shows those components with the most reported maintenance manhours required to repair primary failures, during the last quarter.

TOP TEN - UNSCHEDULED MAINTENANCE MANHOURS

FROM: 680101 TO 700930

LOCATION - ALL

FLIGHT TIME - 47992.6 AIRCRAFT SERIAL NO. RANGE - ALL

LIST R-5 REV J

COMPONENT P/N	NONENCLATURE	UNSCHE. MANHOURS	PERCENT OF A/C TOTAL
JFTD12A-4A 572200	TURBO-SHAFT ENG ENGINE	3175.	8.4
263510 6435-20000-047	MAIN TRANSMISSION MAIN GEAR BOX	1854.	4.9
JFTD12A-4A 571076	TURBO-SHAFT ENG FUEL CONTROL	1466.	3.9
151600 65160-00001-045	TAIL ROTOR BLADE BLADE ASSY 1/R	1005.	2.7
293010 6430-00601-082	ENGINE EXHAUST TAIL PIPE ASSY	954.	2.5
151000 6410-20004-023	MAIN ROTOR HEAD HEAD ASSY MR	746.	2.0
263580 6435-60028-010	TAIL DRIVE SHAFT SUPPORT ASSY	724.	1.9
151500 6415-20201-041	MAIN ROTOR BLADE BLADE ASSYS, B/R	659.	1.8
151000 6410-20004-015	MAIN ROTOR HEAD HEAD ASSY MR	657.	1.7
JFTD12A-4A 571076	TURBO-SHAFT ENG DUCT EXH TURBINE	551.	1.5

TOP TEN - UNSCHEDULED MAINTENANCE MANHOURS

FROM: 700701 TO 700930

LOCATION - ALL

FLIGHT TIME - 3001:2

AIRCRAFT SERIAL NO. RANGE - ALL

LIST R-SA REV 3

COMPONENT P/N	DESCRIPTION	UNSCHE- D MANHOURS	PERCENT OF A/C TOTAL
263510	MAIN TRANSMISSION	268.	11.9
6435-20400-047	MAIN GEAR BOX		
JFTD12A-4A	TURBO-SHAFT ENG	162.	7.2
572208	ENGINE		
263290	TAIL DRIVE SHAFT	135.	6.0
6435-00028-010	SUPPORT ASSY		
JFTD12A-4A	TURBO-SHAFT ENG	105.	4.7
571076	FUEL CONTROL		
293010	ENGINE EXHAUST	68.	2.7
6438-00601-082	TAIL PIPE ASSY		
101590	MAIN ROTOR BLADE	57.	2.5
6415-23281-041	BLADE ASSY NR		
132530	MAIN LANDING GEAR	55.	2.4
6425-50102-014F	STRUT ASSY		
243010	MAIN TRANSMISSION	51.	2.3
6435-20400-027	MAIN GEAR BOX		
945000	FUEL		
6430-62094-013	CELL FUEL	51.	2.3
JFTD12A-4A	TURBO-SHAFT ENG	50.	2.3
571076	DUCT EXH TURBINE		

Mean Time Between Removals (MTBR)

(Data Item 08-010-2)

The component control table, Table A-3 in Section D, provides MTBR's for all on-condition and TBO components listed in TB 55-1500-307-25, October 1968.

For each component, the analysis combines the reported number of unscheduled removals beyond local repair, the accumulated component flight time, and the TBO or retirement interval currently in effect to project long term estimates of mean time between removals.

Table A-3 continues to show the effect of secondary failures and damage on the MTBR of relatively few components.

<u>Component</u>	<u>Effect of Secondary Failures and Damage on MTBR</u>
	<u>Secondary Failure and Damage Rate</u> Primary Failure Rate
Main Rotor Blade	1.89
Cargo Hoist Cable Assembly	1.19
Main Rotor Head	1.08
Engine Assembly, Turbo	.72
Cargo Hook	.26
Main Gear Box	.24

Eleven other component MTBR's are slightly affected by secondary failure and damage. The effect on these components is less than 10% of the primary failure rate.

Relative to the last quarterly report Table A-3 shows 18 components with lower MTBR's and 2 with higher MTBR's. As outlined above, except for relatively few components the effect of adding secondary failure and damage removals is slight. In general, lower MTBR's are attributable to higher rates of primary failure requiring overhaul or scrappage.

Best Available Copy

Table A-3 identifies the following as the lowest projected MTBR items:

<u>Component</u>	<u>MTBR Based on 30 Month Cumulative Data</u>	<u>MTBR Based on 33 Month Cumulative Data</u>
Main Rotor Head Assembly	322 hr.	291 hr.
APP Clutch Assembly	309 hr.	311 hr.
Tail Rotor Blade	374 hr.	345 hr.
Main Rotor Damper Assembly	391 hr.	395 hr.

MAINTAINABILITY
ANALYSIS

MAINTAINABILITYSUMMARY

This section provides detail reporting of the following program requirements:

- Average Active Maintenance Downtime/Flight Hour
- On-Aircraft MTTR (Mean Time to Repair) for Components, Subsystems, and System
- Average Manhours/Active Maintenance Downhour
- Active Maintenance Manhours/Flight Hour

The data inputs are compiled and tabulated using electronic data processing with programming techniques to provide detailed runs for the above items. The computer programs for maintenance, utilization and availability data are equipped to process data on ten million total cumulative elapsed hours and manhours and 100,000 corrective or preventive maintenance actions. These programs provide averages and rates directly applicable to the contract data items.

Based on analysis of the 33 months accumulated data from all locations, the resultant values of the above characteristics are summarized as follows along with the net change from that of the previous quarterly report:

	<u>CHARACTERISTICS</u>	<u>Value</u>	<u>Trend</u>
1.	Average Active Maintenance Downtime/Flight Hour	2.3	+0.1
2.	Elapsed Mean Time to Repair (Corrective, elapsed)	1.9	+0.0
3.	Average Manhours/Downhour	2.8	+0.0
4.	Active Maintenance Manhours/Flight Hour	6.4	+0.0

Organization codes cited on the Tables in Section D are identified in Amendment 1 of the ORE Handbook.

Average Active Maintenance Downtime per Flight Hour
(Data Item 08-010-4)

The presentation of this data item has been expanded to display (1) the current calendar quarter and (2) the total cumulative data. The analysis is further subdivided to permit comparison of maintenance activity characteristics between USAREUR, RVN and CONUS operations for the above calendar periods.

Based on all contract data inputs for 33 calendar months, the cumulative average active maintenance downtime per flight hour (for corrective and preventive maintenance actions) is as follows:

	<u>CONUS</u>	<u>RVN</u>	<u>USAREUR</u>	<u>ALL LOCATIONS</u>
Corrective Maintenance DH/FH	0.7	0.5	0.5	0.5
Preventive Maintenance DH/FH	<u>1.6</u>	<u>1.8</u>	<u>2.0</u>	<u>1.8</u>
Total Maintenance DH/FH	2.3	2.3	2.5	2.3

The complete analysis is presented in Table B-1 of Section D.

On-Aircraft Component and System Mean Time to Repair (MTTR)
(Data Item 08-010-5)

The MTTR for corrective maintenance actions, as defined in the ORE Handbook, is presented in Tables B-1 and B-2 of Section D. The analysis is presented by total aircraft and major subsystem for (1) the current calendar quarter and (2) the total cumulative data. The analysis is further subdivided to permit repair time comparisons between USAREUR, RVN and CONUS operations for the above calendar periods. The analysis for component MTTR is an extensive data run and therefore is presented only for the cumulative 33 month period at all operating locations combined.

Based on corrective action data inputs from all locations for the 33 months of the program, the cumulative average active elapsed repair time for the total CH-54A system is as follows:

<u>CONUS</u>	<u>RVN</u>	<u>USAREUR</u>	<u>ALL LOCATIONS</u>
1.7 hrs	2.0 hrs	2.0 hrs	1.9 hrs

Refer to Tables B-2 and B-3 of Section D for major subsystem breakout and component analysis data run. Also, the $MTTR_c$ and $MTTR_m$ for the major subsystems is graphically displayed in Figure B-1, page B-5.

Best Available Copy

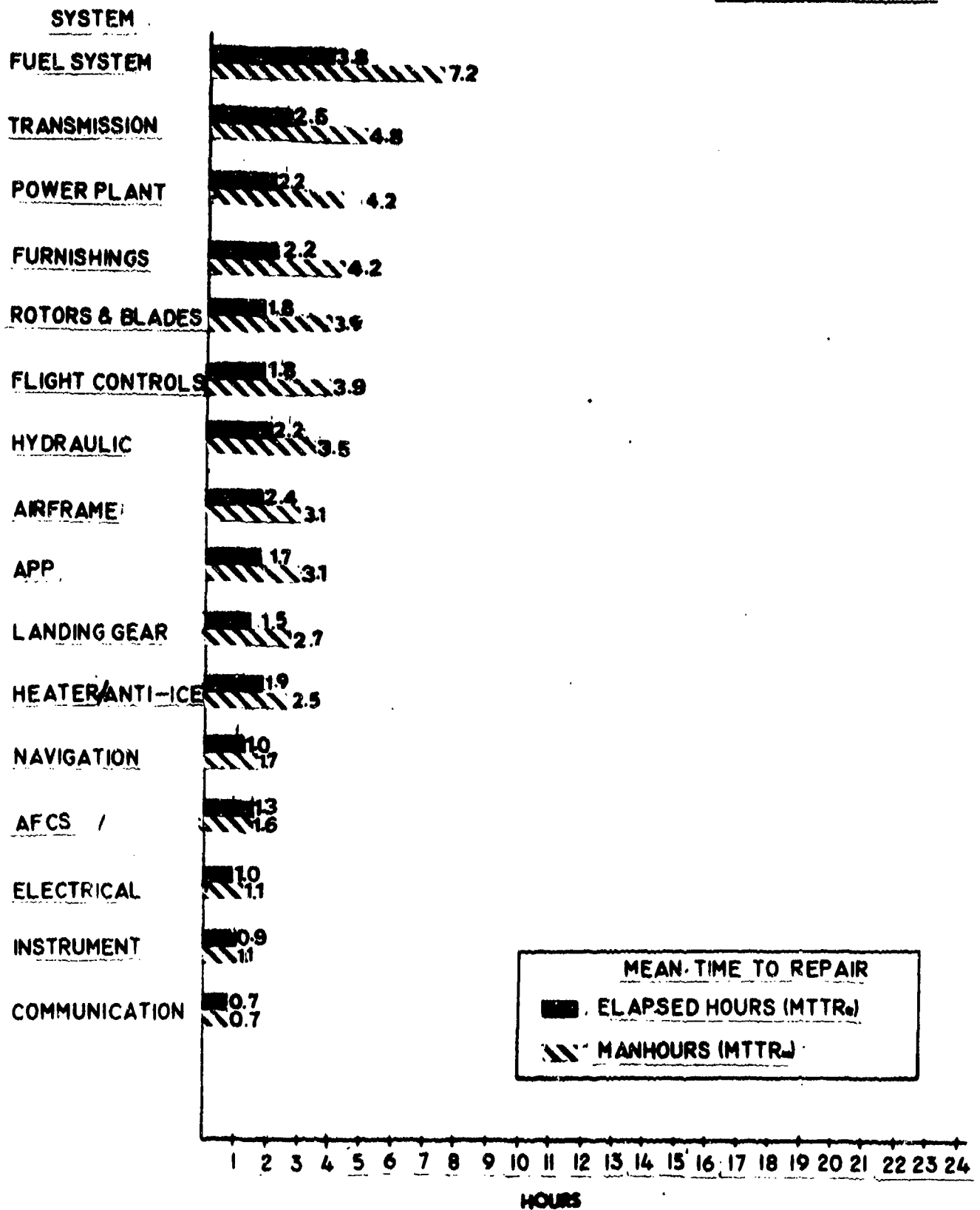


FIGURE B-1: MEAN CORRECTIVE MAINTENANCE TIME - ALL LOCATIONS - 33 MONTH AVERAGE

S-48

Average Manhours per Active Maintenance Downhour
 (Data Item 08-010-6)

The average active manhours per active maintenance downhour is presented for the total CH-54A system in Tables B-1 and B-2, and for subsystems and components in Table B-3, Section D of this report.

The analysis is presented for (1) the current calendar quarter and (2) the total cumulative data. The analysis is further subdivided to permit comparison between USAREUR, RVN and CONUS operations for the above calendar periods.

Active maintenance manhours per flight hour are also of prime interest in evaluating the weapon system characteristics. This value is cited along with active manhours per downhour in the following summation of the 33 months accumulated data.

	<u>CONUS</u>		<u>RVN</u>		<u>USAREUR</u>		<u>All Locations</u>	
	<u>MH/DH</u>	<u>MH/FH</u>	<u>MH/DH</u>	<u>MH/FH</u>	<u>MH/DH</u>	<u>MH/FH</u>	<u>MH/DH</u>	<u>MH/FH</u>
Corrective Maintenance	1.2	1.15	1.9	0.91	1.4	0.72	1.8	0.95
Preventive Maintenance	<u>3.4</u>	<u>5.36</u>	<u>3.0</u>	<u>5.46</u>	<u>2.4</u>	<u>4.80</u>	<u>3.0</u>	<u>5.41</u>
Combined	2.9	6.51	2.8	6.37	2.2	5.52	2.8	6.36
Spare Cannibalization		<u>0.13</u>		<u>0.07</u>		<u>0.20</u>		<u>0.09</u>
Total		6.64		6.44		5.72		6.45

Data input totals for the above calculated values are shown in Tables B-1 and B-2 of Section D.

A further analysis by maintenance levels of the above active MH/FH for the 33 months accumulated data, excluding cannibalizations, is as follows:

	<u>CONUS</u>		<u>RVN</u>		<u>USAREUR</u>		<u>All Locations</u>	
	<u>MH/DH</u>	<u>MH/FH</u>	<u>MH/DH</u>	<u>MH/FH</u>	<u>MH/DH</u>	<u>MH/FH</u>	<u>MH/DH</u>	<u>MH/FH</u>
Org. Level - Corrective MH/FH	0.78		0.68		0.25		0.68	
Org. Level - Preventive MH/FH	<u>5.32</u>		<u>5.28</u>		<u>4.76</u>		<u>5.27</u>	
Sub-total		6.10		5.96		5.01		5.95
Direct Support - Corrective MH/FH	0.37		0.23		0.47		0.27	
Direct Support - Preventive MH/FH	<u>0.04</u>		<u>0.18</u>		<u>0.04</u>		<u>0.14</u>	
Sub-total		0.41		0.41		0.51		0.41
Total		6.51		6.37		5.52		6.36

AVAILABILITY AND UTILIZATION
ANALYSIS

Availability and Utilization

SUMMARY

The data submitted within this section includes the following categories:

- . Inherent Availability
- . Achieved Availability
- . Operational Availability
- . Mean Configuration Change Time
- . Average Flight Hours
- . Average Flight Duration
- . Average Turnaround Time

Each additional recurring quarterly report will be provided with an increasingly larger sample of accumulated data on which to base these tabulations and averages.

Included in this report are tables showing the types of missions flown as coded in the field and identified in the ORME Handbook, Appendix 1-5. These tables identified as Aircraft Utilization - Flight Time and Mission Type (Tables C-18 thru C-34) are located in the Appendix Section for reference.

Flight data as shown in D-B and D-C Tables reflects only that flying time on the aircraft under cognizance of the Operations Reliability Engineer in the field and not the total flying hours of all CH-54A aircraft for the program period.

Based on analysis of 33 months accumulated data, resultant values of the above characteristics are summarized as follows along with the net change from that of the previous quarterly report.

<u>CHARACTERISTICS</u>	<u>Value</u>	<u>Trend</u>
Inherent Availability	57.2	-10.7%
Achieved Availability	89.2%	+0.3%
Operational Availability	54.3%	+0.2%
Mean Configuration Change Time (Elapsed Hours)	0.4	±0.0
Average Flight Hours/Quarter/Aircraft	69.3	-1.0
Average Flight Duration-Hours	2.6	+0.1
Average Turnaround Time (Elapsed Hours)	0.2	+0.0

The operational and inherent availability is graphically displayed in Figures C-1 and C-2, pages C-9 and C-10, respectively.

Inherent Availability
(Data Item 08-010-7)

The inherent availability, as defined in the ORE Handbook, is a measurement of availability in terms of inherent reliability (MTBF) and average repair times for those malfunctions used to calculate that reliability. It is expressed by:

$$A_i = \frac{MTBF}{MTBF + MTTR_e}$$

The inherent availability is shown below for the total 33 month cumulative data:

	Cumulative Data	
	33 Months	3rd Qtr 1970
	<u>All Locations</u>	
Flight Time, Hours*	47,994	3,001
Quantity of Primary Failures**	11,640	667
MTBF, hours	4.12	4.49
Downtime for Failures**, Hours	37,662	2,247
MTTR _e , Hours +	3.23	3.36
Inherent Availability	56.1%	57.2%

The cumulative (33 months) inherent availability has dropped 11.7% owing to a significant increase in MTTR. The 3rd quarter inherent availability has also dropped (12.2%) ending an upward trend which was apparent since the 4th quarter '69. The 3rd quarter 70 MTTR has also increased significantly as has the failure rate and downtime relative to quantity of primary failures. The inherent availability trend by calendar quarters is shown in Figure C-2, page C-10.

* From Table B-1

** From Table A-1, excludes corrective actions not classed as primary failures. Total corrective actions cited in Tables B-1 and B-2.

+ Total primary failure active elapsed maintenance time/total primary failures.

Achieved Availability

Achieved Availability (Aa) as defined in MIL-STD-778 differs from Inherent Availability (Ai) in that Ai deals only with equipment operating time, primary failures and the associated failure repair time, whereas, Aa includes operating time, ready time, failure repair and preventive inspection time. Therefore, one explanation of Aa is to define it as a more inclusive version of Ai, with no new factors introduced which are not directly a function of the designed reliability and/or the pre-planned maintenance cycles. Achieved Availability is expressed as:

$$Aa = \frac{MTBM}{MTBM + \bar{M}}$$

where:

MTBM = Mean-Time-Between-Maintenance consisting of (for a given calendar interval) the sum of the operating time and operationally ready time divided by the sum of the corrective and preventive maintenance actions performed.

$\bar{M}$ = Mean Active Maintenance Downtime consisting of (for a given calendar interval) the sum of the active corrective and preventive maintenance downtime divided by the sum of the corrective and preventive maintenance actions performed (excluding cannibalization actions and associated downtime) and where all supply, support equipment and administrative downtime is considered to be operationally ready time.

thus:

$$\begin{aligned} Aa &= \frac{\text{Operating Time} + \text{Ready Time}}{\text{Corrective Actions} + \text{Preventive Actions}} \\ &= \frac{\text{Operating Time} + \text{Corrective Downtime} + \text{Preventive Downtime}}{\text{Corrective Actions} + \text{Preventive Actions}} \\ &= \frac{\text{Operating Time} + \text{Ready Time}}{\text{Operating Time} + \text{Ready Time} + \text{All Maintenance Downtime}} \\ &= \frac{\text{Operating Time} + \text{Ready Time}}{\text{Total Elapsed Time}} \end{aligned}$$

Using the above definition for MTBM and $\bar{M}$ and the further derivation for Aa, it is seen that Aa can also be defined as Operational Availability (as defined by the ORE Handbook and MIL-STD-778) with the supply, support equipment and administrative downtime treated as operationally ready time.

The Achieved Availability shown below for the current quarter and for the total 33 month cumulative data is based on the above definition and data from Tables C-2 through C-17 of Section D.

	<u>3rd Quarter 1970</u>	<u>Cumulative Data 33 Months</u>
Operating Time + Ready Time (hrs)	38,747	514,531
Corrective Actions Downtime (hrs)	3,144	69,881
Preventive Actions Downtime (hrs)	2,381	32,789
*Administrative Downtime (hrs)	10,718	169,349
*Supply Downtime (hrs)	13,554	159,461
*Support Equipment Downtime (hrs)	240	812
Total Operationally Ready Time	63,259	844,153
Total Elapsed Time	68,784	946,823
Achieved Availability	91.90%	89.2%

*Treated as Operationally Ready Time

Operational Availability
(Data Item 08-010-8)

The Operational Availability, as defined in the ORE Handbook, considers flight and ready time and all downtime for maintenance, supply, and administrative reasons. The detailed summations are presented in Tables C-1 through C-17, Section D. The trend by calendar quarter is shown in Table C-1 and graphically in Figures C-1 and C-2, pages C-9 and C-10, respectively.

The tables of Section D present the data for (1) the current calendar quarter and (2) the total cumulative data. The analysis is further subdivided to show comparisons between RVN, CONUS, and USAREUR operations for the above calendar periods.

The data inputs show the following operational availability, along with the change from the previous quarter:

<u>3rd Quarter - 1970</u>								
	CONUS	Δ	RVN	Δ	USAREUR	Δ	All Locations	Δ
1. Operational Availability:	53.5%	-13.7%	62.2%	+4.7%	48.7%	-25.3%	56.3%	-6.6%
2. Not Ready Due to:								
a. Prev. Maint.	4.2%	+0.9%	4.0%	+0.5%	1.2%	-.05%	3.5%	+0.4%
b. Corr. Maint.	3.5%	+1.0%	6.7%	-6.6%	1.8%	+0.2%	4.6%	-3.7%
c. Supply	29.4%	+11.4%	7.3%	-6.8%	32.0%	+21.4%	20.0%	+5.5%
d. Admin.	9.4%	+0.4%	19.8%	+8.0%	16.3%	+4.2%	15.6%	+4.4%
Total Not Ready:	46.5%		37.8%		51.3%		43.7%	
<u>33 Month Cumulative</u>								
1. Operational Availability:	54.6%	+0.2%	52.1%	+0.6%	66.9%	-2.9%	54.3%	+0.2%
2. Not Ready Due to:								
a. Prev. Maint.	3.5%	+0.1%	3.8%	±0.0%	1.4%	±0.0%	3.5%	±0.0%
b. Corr. Maint.	4.1%	-0.1%	9.8%	-0.2%	1.8%	-0.1%	7.4%	-0.2%
c. Supply	22.0%	+0.6%	14.9%	-0.3%	15.3%	+2.9%	16.9%	+0.3%
d. Admin.	15.8%	-0.8%	19.4%	-0.1%	14.6%	+0.1%	17.9%	-0.3%
Total Not Ready:	45.4%		47.9%		33.1%		45.7%	

The operational availability presentation readily shows excursions from previous quarterly report averages. Examination of the Tables of Section D permits further isolation of gross changes by operating theater to specific activities.

3rd Quarter 1970

CONUS - The decrease (-13.7%) in operational availability is due to increases in maintenance, supply, and administrative downtime.

RVN - Operational availability has increased (+4.7%) as a result of decreases in maintenance and supply downtime.

USAREUR - The operational availability has decreased significantly (-25.3%) primarily due to increases in supply downtime (+21.4%) and less significant increases in administrative downtime.

ALL LOCATIONS - The overall operational availability showed a slight decrease (-6.6%) as a result of an increase in supply, preventive maintenance, and administrative downtime.

Cumulative - 33 Months

CONUS - The cumulative operational availability increased (0.2%) as a result of a general decrease in administrative and corrective maintenance downtime.

RVN - An increase (+0.6%) in the cumulative operational availability is the result of a reduction in corrective maintenance, supply, and administrative downtime.

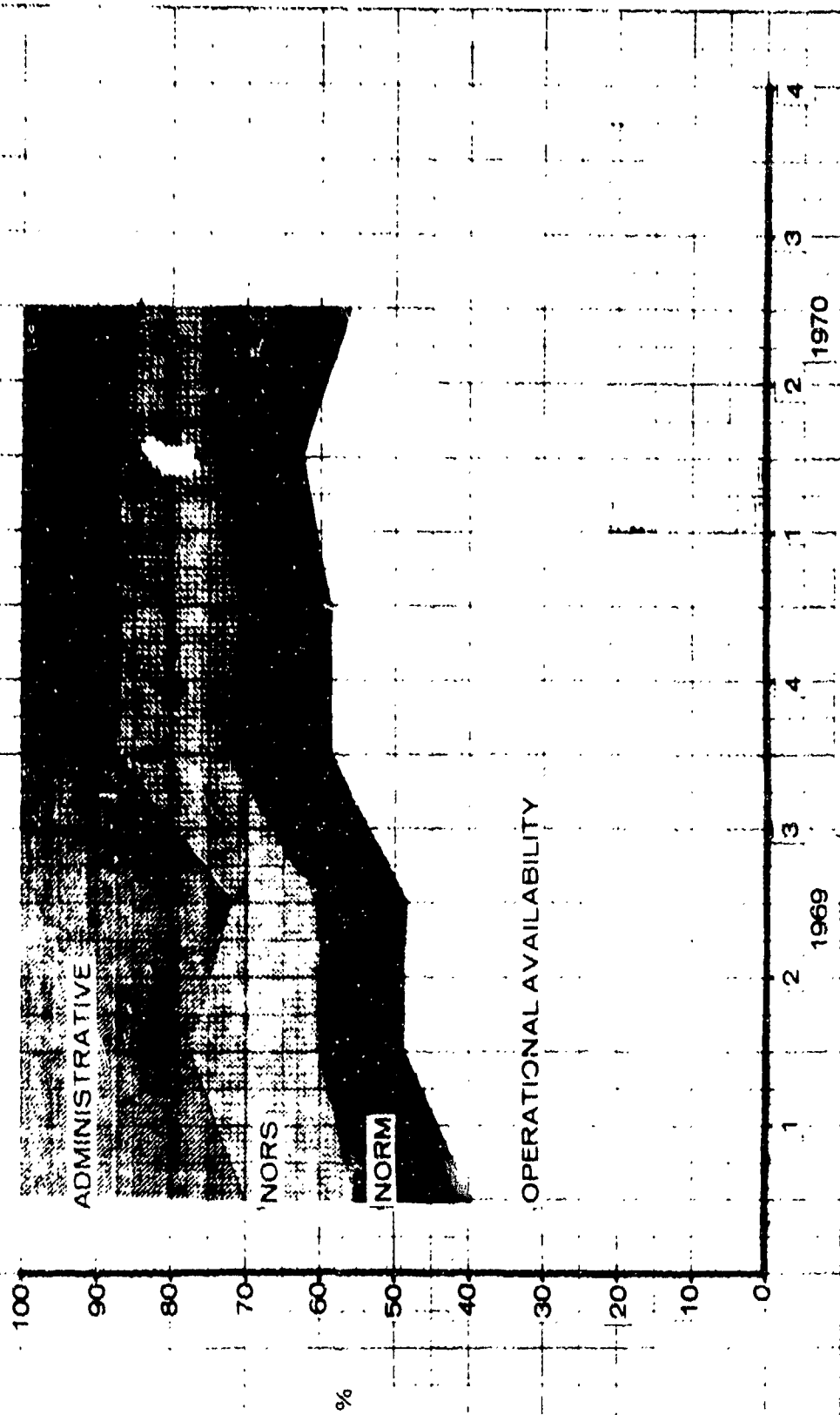
USAREUR - Overall operational availability decreased lightly due to a small increase in supply downtime.

ALL LOCATIONS - The cumulative operational availability increased (+0.2%) as a result of a decrease in administrative, and corrective maintenance downtime.

Analysis of aircraft downtime reported for supply shortages of components was performed and the following list cites the top ten contributors to operational unavailability for supply reasons over the 33 month period of this report. Items are ranked in descending order for the combined operational theaters, and show the reduction of overall availability in the specified theater due to shortages of the listed component.

<u>Rank</u>	<u>Component</u>	<u>CONUS</u>	<u>RVN</u>	<u>USAREUR</u>	<u>ALL LOCATIONS</u>
1	Engine Fuel Control P/N 571078 FSN 2915-928-3906	0.7%	0.9%	4.3%	1.2%
2	Tail Rotor Head Assy. P/N 65111-07000-047, -045 65110-07000-047 FSN 1615-975-0475	2.6%	0.1%	0.4%	0.9%
3	Clutch Assy. APP P/N S6137-91000-015, -016, -013 FSN 1615-915-7142	2.3%	0.3%	0.0%	0.8%
4	Tail Rotor Blade Assy. P/N 65160-00001-045, -042, -041 FSN 1615-966-6051	0.3%	1.1%	1.3%	0.8%
5	Engine Model T73-P-1 P/N 572200 & 6430-81100-043 FSN 2840-904-2461	0.7%	0.7%	0.0%	0.7%
6	Main Rotor Head Assy. P/N 6410-20004-014, -015, -016 -017, -023, -027 FSN 1615-915-7142	0.1%	1.0%	0.0%	0.5%
7	Speed Actuator P/N 6430-80326-101 FSN 2995-891-2461	1.0%	0.0%	0.4%	0.5%
8	Support Assy., Bearing P/N 6435-60008-010 SS9003-001 FSN 1615-915-7013	1.5%	0.0%	0.1%	0.4%
9	Main Rotor Blade Assy. P/N 6415-20201-041 FSN 1615-842-6277	0.5%	0.5%	0.0%	0.4%
10	Core, Flex Shaft P/N 572781 FSN 2995-914-5940	0.2%	0.5%	0.0%	0.4%

OPERATIONAL AVAILABILITY (DOWN-TIME TRENDS)



CALENDAR QUARTER
FIGURE C-1

OPERATIONAL & INHERENT AVAILABILITY-ALL LOCATIONS

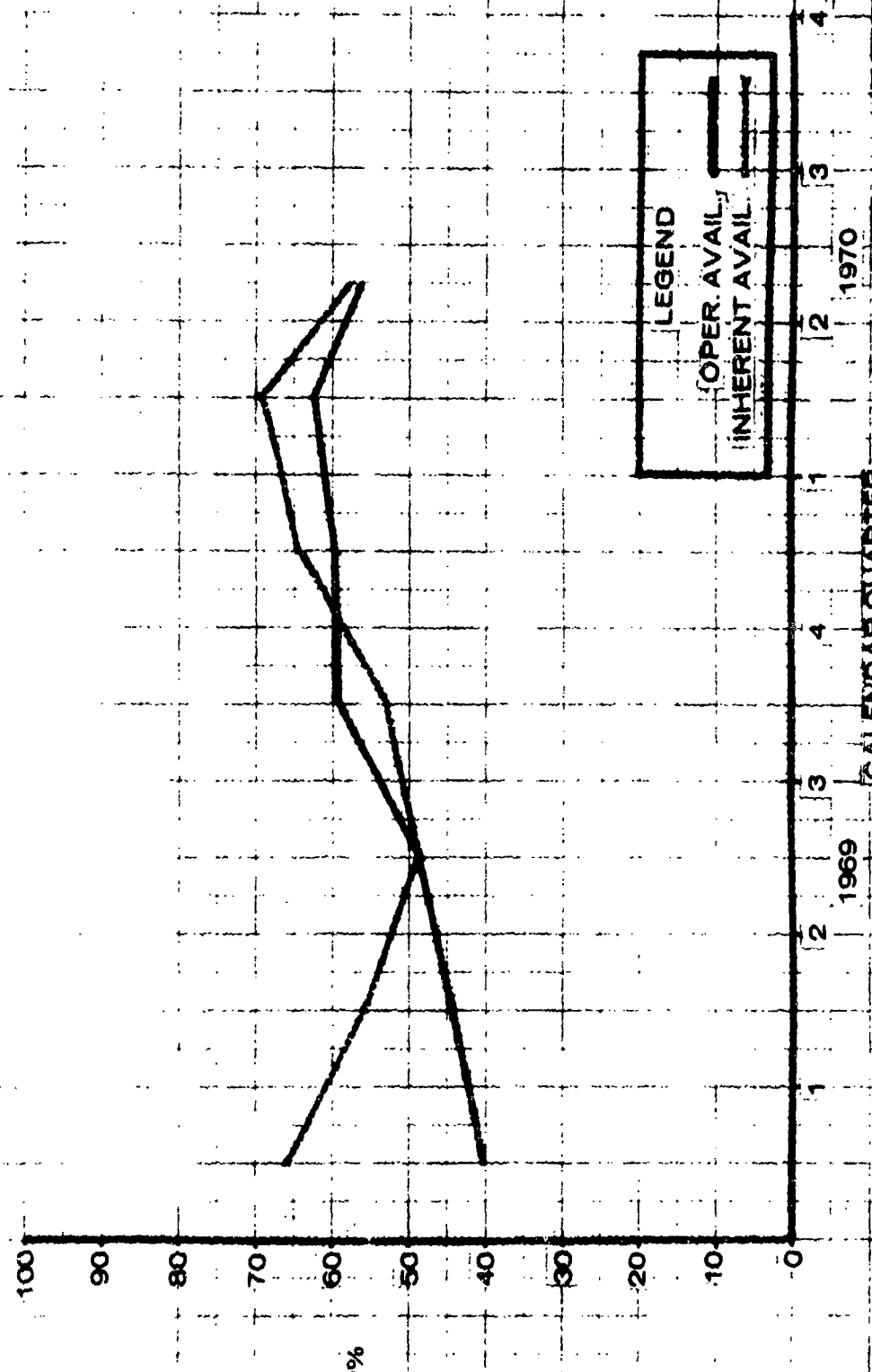


FIGURE C-2

Average Flight Hours per Aircraft
(Data Item 08-010-10)

Analysis of data processed from the Daily Flight Records, SA 978-3, is shown in Tables C-18 through C-26 of Section D. The data is presented for (1) the current calendar quarter, and (2) the total cumulative data.

The analysis is further subdivided in these tables to show each characteristic by USAREUR, RVN and CONUS to compare operational theaters.

The average flight hours accumulated on each aircraft by serial number and location is shown in Table C-18. For all reported aircraft combined, the information is as follows:

	<u>3rd Quarter</u> <u>1970</u>	<u>33 Months</u>
Average Flight Hours Accrued Per Aircraft	68.2	761.8
Average Flight Hours Accrued - (Standard Deviation)	46.5	469.6

This shows a monthly average flight hour per aircraft of 23.1 hours based on the 33 month average.

Average Flight Duration
(Data Item 08-010-11)

The average flight duration, with standard deviation, is displayed in Table C-18 of Section D for each aircraft and all aircraft combined. The data is presented by (1) the current calendar quarter and (2) the total cumulative data.

Further subdivisions are displayed in Table C-18 to show average flight duration in USAREUR, RVN and CONUS for comparing operational theaters.

For all reported aircraft combined, the information is as follows:

	<u>3rd Quarter</u> <u>1970</u>	<u>33 Months</u>
Average Flight Duration	1.81	2.56
Average Flight Duration - Standard Deviation	1.17	1.07

Best Available Copy

REV

FLIGHT TIME - 47992.6

AIRCRAFT SERIAL NO. RANGE - ALL

SYSTEM SUMMARY

SYSTEM CODE	NONFUNCTIONURE	NO. OF FAILURES	SYSTEM FAILURE RATE	SYSTEM MTBF	SYSTEM RELIABILITY (HRS)	NO. OF ABORTS	ABORTS RATE	MAN-HOURS ACT. EMT
455012A-4A	TURBO-SHAFT ENG	1032	.021503	47.	.978726	109	.002271	6359.2
455012A-4A	APP	344	.087168	140.	.997258	75	.001563	1097.3
112010	COCKPIT CANOPY	146	.003042	329.	.996962	0	.000000	197.2
112020	FORWARD FUSELAGE	130	.002709	369.	.997295	0	.000000	370.8
112030	TAIL ROTOR BOOM	49	.001021	979.	.998980	0	.000000	161.6
112040	TAIL ROTOR PYLON	72	.001500	667.	.998501	0	.000000	654.8
112050	STABILIZER	107	.002230	449.	.997773	0	.000000	342.7
117500	ARMOR PLATE	10	.000208	4799.	.999792	0	.000000	10.9
118000	MLG SUPPORT INST	79	.001646	608.	.998355	1	.000021	202.0
125010	COCKPIT FURNISH	81	.001608	593.	.998314	0	.000000	61.3
132510	NOSE LANDING GEAR	97	.002021	495.	.997981	0	.000000	370.7
132520	MLG WHEEL TIRE	17	.000354	2823.	.999646	1	.000021	58.1
132530	MAIN LANDING GEAR	123	.002563	390.	.997440	1	.000021	605.1
132540	MLG WHEEL TIRE	158	.003292	304.	.996713	1	.000021	338.0
132550	TAIL SKID	196	.004084	245.	.995924	0	.000000	282.5
132560	POD LANDING GEAR	2	.000042	23996.	.999958	0	.000000	10.3
144010	COLLECTIVE CONTR	52	.001083	923.	.998917	2	.000042	83.7
144020	CYCLIC CONTROLS	85	.001771	565.	.998230	2	.000042	68.0
144030	DIRECTIONAL CONT	222	.004626	216.	.995385	2	.000042	179.1
151000	MAIN ROTOR HEAD	409	.008522	117.	.991514	12	.000250	683.7
151100	TAIL ROTOR HEAD	199	.004146	241.	.995862	2	.000042	324.7
151500	MAIN ROTOR BLADE	483	.010064	99.	.989884	12	.000250	879.7
151600	TAIL ROTOR BLADE	519	.010814	92.	.989244	12	.000250	1172.4
231000	APP HYD START	194	.004042	247.	.995966	23	.000279	1079.1
263510	MAIN TRANSMISSION	386	.008013	124.	.991989	21	.000042	390.3
263520	INTERMED XMSN	49	.001021	979.	.998980	2	.000042	319.3
263530	TAIL TRANSMISSION	28	.000583	1714.	.999417	1	.000021	330.7
263540	TAIL DRIVE SHAFT	200	.004167	240.	.995841	4	.000083	305.2
263550	APP CLUTCH	162	.003376	296.	.996630	13	.000271	863.7
263560	ROTOR BRAKE	104	.008418	119.	.991817	10	.000208	573.7
263570	MGR OIL COOLER	326	.006793	147.	.993230	15	.000313	821.5
293000	POWER PLANT	28	.000583	1714.	.999417	1	.000021	764.5
293010	ENGINE EXHAUST	525	.010939	91.	.999417	1	.000021	75.5
293020	ENGINE CONTROLS	274	.005709	175.	.989120	20	.000206	56.6
293030	ENGINE HYD START	98	.002042	490.	.994307	29	.000504	1043.6
293040	ENGINE HOISTS	89	.002042	490.	.997960	29	.000604	854.4
293050	EAPS	161	.001856	539.	.999147	0	.000000	201.4
413000	ENG ANTIFICE DUCT	1	.003355	298.	.996451	3	.000000	170.8
415000	CABIN HEATER	24	.000021	47993.	.999979	0	.000000	302.1
415000	ENG ANTIFICE CONT	1	.000500	2000.	.999500	0	.000000	235.3
425310	AC ELECTRICAL	33	.000021	47993.	.999979	0	.000000	.3
425320	GENERATOR	38	.000688	1454.	.999313	6	.000125	47.4
425330	DC ELECTRICAL	17	.000792	1263.	.999209	17	.000354	.5
425340	BATTERY	11	.000354	2823.	.999646	0	.000000	94.6
445510	EXTERIOR LIGHTS	313	.002229	4365.	.999771	8	.000000	75.0
445520	INTERIOR LIGHTS	33	.006522	153.	.993499	1	.000021	33.8
456510	PRIMARY SERVO	104	.000688	1454.	.999313	2	.000042	6.8
456520	AFTS SERVOS	44	.002167	461.	.997835	0	.000000	332.4
456530	TAIL ROTOR SERVO	12	.000917	1091.	.999094	3	.000184	15.2
456540	UTILITY HYDRAULIC	111	.000917	3999.	.999750	1	.000021	255.6
456550	FLT CONT HYDRAULIC	197	.000250	3999.	.999750	23	.000042	471.1
456560	CARGO HOIST HYD.	368	.005313	432.	.997690	13	.000271	36.2
			.004165	244.	.995964	53	.004271	256.8
			.007668	130.	.993361		.001104	304.5
								1896.4
								949.9

SYSTEM ANALYSIS

FROM: 060101 TO: 700930

LOCATION - ALL

TABLE A-1 (cont)

FLIGHT TIME - 47992.6

AIRCRAFT SERIAL NO. RANGE -

ALL

TABLE A-1

SYSTEM CODE	NOMENCLATURE	NO. OF FAILURES	SYSTEM FAILURE RATE	SYSTEM MTBF	SYSTEM RELIABILITY (11HR)	NO. OF ABORTS	ABORT RATE	MAN-HOURS ACT. EMT
463000	FUEL	243	.005063	198.	.994950	7	.000146	1160.8
492030	CARGO SUSPENSION	60	.001250	800.	.998751	1	.000021	139.8
495010	WINDSHIELD WIPER	61	.001271	787.	.998730	0	.000000	58.8
495020	CARGO WINCH	290	.006043	165.	.993976	32	.000667	1382.6
495030	FIRE DETECTION	79	.001646	608.	.998355	2	.000042	114.6
495510	VOICE WARN ASH19	3	.000063	1598.	.999937	0	.000000	3.1
495520	LOAD LEVELER	21	.000438	2285.	.999563	0	.000000	41.3
495530	INSTRUMENTS	467	.009731	103.	.990317	19	.000396	612.4
514500	ASN-43 COMPASS	62	.001292	774.	.998709	0	.000000	104.9
514510	FLT INSTRUMENTS	165	.003438	291.	.996568	0	.000000	123.9
514520	NAV INSTRUMENTS	4	.000083	1199.	.999917	0	.000000	2.1
514530	ENG INSTRUMENTS	140	.002917	343.	.997087	2	.000042	124.2
514540	XMSN INSTRUMENTS	1	.000021	4793.	.999979	0	.000000	1.2
514550	WARNING INSTR	64	.001334	750.	.998667	1	.000021	101.6
579000	AFC5 AIV/ASN-29	53	.001104	906.	.998896	7	.000146	80.8
579010	AFC5 AMPLIFIER	78	.001625	615.	.998376	4	.000083	106.0
579020	VERTICAL GYRO	29	.000604	1655.	.999396	7	.000146	38.1
579030	REMOTE STICK	72	.001500	667.	.998501	2	.000042	105.3
626010	ARC-54 VHF	365	.007605	131.	.992424	7	.000146	502.9
626020	ARC-134 VHF	22	.000458	2181.	.999542	0	.000000	16.2
626030	T-366A VHF	3	.000063	1599.	.999937	0	.000000	2.7
626040	ARC-73 VHF	2	.000042	2396.	.999958	0	.000000	5.0
626050	ARC-131	19	.000396	2526.	.999604	0	.000000	11.4
636010	ARC-51 UHF	104	.002167	461.	.997835	3	.000063	120.7
646010	AIC-22 ICS	148	.003084	324.	.996921	1	.000021	105.4
656010	APX-84 IFF	55	.001146	873.	.998853	0	.000000	71.8
656020	APX-72 IFF	15	.000313	3200.	.999687	0	.000000	21.0
716010	ARN-82 VOR	35	.000729	1371.	.999271	0	.000000	55.9
716020	ARN-59 ADF	2	.000042	2396.	.999958	0	.000000	2.5
716030	ARN-83 ADF	133	.002771	361.	.997233	0	.000000	221.3
915000	EMERGENCY EQUIP	2	.000042	2396.	.999958	0	.000000	.8

TOTAL AIRCRAFT

11640

.242537

4.

.784634

599 .012481

37662.2

22530.9

TABLE A-2

Table A-3
COMPONENT CONTROL

Nomenclature	Part Number	FSN	Quantity of		TBO or Retirement	MTBR
			Unscheduled Removals	MTBUR		
APU Gas Turbine	37747-100	2835-931-4775	58	828	828	828
	37747-0	FSN Pending				
	T62-T16A	FSN Pending				
	T62-T16A1	2835-931-4775	0			
Blade, Main Rotor	6415-20201-041	1615-842-6277	233	1215	5000	1017
	6415-20101-041	1615-052-0408	4			
Blade, Tail Rotor	65160-00001-045	1615-986-6051	549	345		345
	65160-00001-042	1615-915-7003	5			
	65160-00001-041		2			
Cable Assy, Cargo Hoist	S6050-62356	FSN Pending	55	511		511
	S6050-62356-2	1680-019-5277	39			
	BWR-4013	1680-019-5277	0			
	BWR4005-1	FSN Pending	0			
Cargo Hook	SP7070	1560-052-0475	0	706		706
	SP7070-1	1680-994-1134	0			
	6450-62100-102	1680-994-1134	65			
	6450-62100-101	1680-994-1134	3			



Table A-3 (Cont)
COMPONENT CONTROL

omenclature	Part Number	F.N.	Quantity of Unscheduled Removals	MTBUR 19,1970	TBO or Retirement 19,1970	MTBR
Cargo Lashing Reels, Load Leveler	SP7063-3	1560-052-0467	0			191970
	SP7063-5	1560-932-3655	0			
	6420-60017-105	1560-932-3655	1			
Clutch Assy, APP	S6137-91000-013	1615-960-1543	6	480	500	311
	S6137-91000-015	1615-915-7142	94			
	S6137-91000-016	FSN Pending	0			
				1655		1655
Decoupler Device Cargo Hoist	6450-62352-104	1680-878-5215	14			
	4SS-3089-0013	1680-938-3100	0			
	6450-62352-103	1680-936-2408	2			
	4SS-3501-001	1680-936-2408	2			
	6450-62352-102		6			
	1640-62326-041		5			
*Gear Box and Servo Assembly	6435-66001-042	1615-902-4801	16	3000	1200	989
	6435-66001-041	1615-018-6426	0			

*S/N of gear box is to be used as assembly S/N.

Table A-3 (Cont.)

COMPONENT CONTROL

<u>Nomenclature</u>	<u>Part Number</u>	<u>FSN</u>	Quantity of Unscheduled Removals	<u>MTBUR</u>	TBO or Retirement	<u>MTBR</u>
Engine Assembly, Turbo	JFTD12A1	2840-919-7975	0	667	800	466
	410400	2840-919-7975	0			
	572200	2840-904-2461	143			
	T73-P-1	2840-904-2461	1			
	JFTD12A4A	2840-904-2461	0			
Gear Box, Cargo Hoist	6435-63001-013	1680-831-0480	0	23996		23996
	6435-63001-016	1680-936-2391	0			
	6435-63001-017	1680-781-6655	2			
Gear Box, Intermediate	6435-66400-041	1615-901-1914	0	1778	1200	873
	6435-66400-042	1615-902-5092	0			
	6435-66400-043	1615-986-6169	27			
Gear Box, Main	6435-20400-041	1615-984-5589	0	615	800	448
	6435-20400-046	1615-984-5605	0			
	6435-20400-047	1615-983-0065	78			

Table A-3 (Cont)
COMPONENT CONTROL

<u>Nomenclature</u>	<u>Part Number</u>	<u>FSN</u>	Quantity of Unscheduled Removals	<u>MTBUR</u>	TBO or Retirement	<u>MTBR</u>
Lug Assy. Eng.	6430-80007-07	2840-988-0181	0			
Main Rotor Head Assy						
	6410-20004-011	1615-895-4309	0	593	400	291
	6410-20004-013	1615-895-5373	1			
	6410-20004-015	1615-938-1711	37			
	6410-20004-017	1615-717-7667	2			
	6410-20004-023	1615-809-2380	34			
	6410-20004-025	FSN Pending	2			
	6410-20004-014	FSN Pending	1			
	6410-20004-016	FSN Pending	4			

Table A-3 (Cont)

COMPONENT CONTROL

Nomenclature	Part Number	FSN	Quantity of Unscheduled Removals	MTBUR	TBO or Retirement	MTBR
Damper Assy, Main Rotor	6410-26200-041	1615-983-7321	15	15156	400	395
	6410-26200-043	1615-803-2371	3			
Cylinder, Damper	6410-26001-102	FSN Pending	0			
	6410-26001-103	FSN Pending	0			
	6410-26000-012	1615-982-0554	1			
Motor, Hyd., Cargo Hoist	PMF-117B006A	1650-993-5462	1	47993		47993
Particle Separator Eng Air Inlet	6430-91000-011	FSN Pending	12	1959		1959
	6430-91000-012	FSN Pending	29			
	6430-91000-041	FSN Pending	0			
	6430-91000-047	FSN Pending	4			
	6430-91000-042	FSN Pending	0			
	6430-91000-048	FSN Pending	4			
Pump and Actuator, Cargo Hoist	IPV-093L001-S	1650-831-0273	0	923		923
	6465-20021-101	1650-831-0273	52			
Servo, AFCS	S6265-62551-10	6615-829-8443	41	1171	1000	672

Table A-3 (Cont.)
COMPONENT CONTROL

Nomenclature	Part Number	FSN	Quantity of		TBO or Retirement	MTBR
			Unscheduled Removals	MTBUR		
Servo Cylinder Assy, Load Leveler, Short	6465-62100-015	1650-934-8448	0	23996		23996
	6465-62100-017	1680-934-8434	0			
	6465-62100-019	1650-069-3344	2			
	6465-62100-021	1680-857-3285	0			
Servo Cylinder Assy, Load Leveler, Long	6465-62100-018	1650-938-8380	1	11998		11998
	6465-62100-022	1650-857-3286	0			
	6465-62100-016	1650-934-8447	0			
	6465-62100-020	1650-069-3355	2			
	6465-62100-019	1650-069-3344	1			
Servo, Main Rotor Primary	SI565-20421-10	1615-975-0355	87	1655	1000	751
Strut and Fork Assy, Main Ldg Gear	6425-50102-011	1560-854-0505	2	2182		2182
	6425-50102-014	1620-823-1122	17			
	6425-50102-013	1620-898-9587	7			
	6425-50102-012	1620-934-8424	3			
	6425-50102-015	1620-852-6688	15			

Table A-3 (Cont.)
COMPONENT CONTROL

Nomenclature	Part Number	F.N.	Quantity of		TED or Retirement	MTBR
			Unscheduled Removals	MTBUR		
Strut Assy, Nose Landing Gear	6425-5000-011	1615-988-0085	11	2823		2823
	6425-5000-011		6			
Tail Rotor Head Assembly	65110-07000-047	FSN Pending	5		800	559
	65110-07000-013	1615-992-4364	24	1043		
	65111-07000-045	1615-932-9816	0			
	65111-07000-047	1615-975-0475	17			
	65112-07000-044	1615-979-8575	0		2600	
	65112-07000-046	1615-054-3535	0			
Valve Anti-Icing	67-113-001	1995-992-9408	0	2341		2341
	6430-60131-101	1995-992-9408	41			
	32-0031-7	1995-992-9408	0			
Valve, Fuel Shutoff	6430-62045-101	1915-897-4078	1	47993		47993
	A61245	1915-897-4078	0			

Table b-1 Rev. J.
CH-54A Total System On-Aircraft Maintenance Downtime per Flight Hour
Third Quarter 1970

	CONUS	RVN	All Locations		CONUS	RVN	33 Month Cumulative Total	
			USAREUR	LOCATIONS			USAREUR	All Locations
I. Total Flight Hours	938.4	1,693.5	369.3	3,001.2	10,799.8	34,966.2	2226.6	47,993.5
II. Corrective Maintenance								
a) Active Elapsed Hours	619.9	860.8	198.0	1,678.7	7,349.1	17,136.3	1,114.6	25,600.0
b) Corrective Actions	359	381	109	849	4,241	8,731	564	13,536
c) MTTR (1)	1.7	2.2	1.8	2.0	1.7	2.0	2.0	1.9
d) Active Manhours	1040.5	1721.2	273.0	3034.7	12,411.8	31,725.4	1587.1	45,724.3
e) MTTR _m (1)	2.9	4.5	2.5	3.6	2.9	3.6	2.8	3.4
f) Avg. Manhours/Down Hours	1.7	2.0	1.4	1.8	1.7	1.9	1.4	1.8
g) Active MMH/FH	1.11	1.02	0.74	1.01	1.15	0.91	0.72	0.95
III. Preventive Maintenance (3)								
a) Active Elapsed Hours	1294.8	2,703.2	616.0	4,614.0	17,199.8	63,674.1	4,536.5	85,410.2
b) Preventive Actions	674	644	272	1,590	6,678	17,823	1,944	26,445
c) MPMT (2)	1.9	4.2	2.3	2.9	2.6	3.6	2.3	3.2
d) Active Manhours	4,124.7	4,999.4	1,986.0	11,210.1	57,843.2	191,070.2	10,685.5	259,598.5
e) MPMT (2)	3.3	1.8	3.2	2.4	3.4	3.0	2.4	3.0
f) Avg. Manhours/Down Hour	4.50	2.95	5.38	3.73	5.36	5.46	4.80	5.41
g) Active Manhours/Flt. Hour								
IV. Combined Corrective/Preventive Maintenance								
a) Active Elapsed Hours	1914.7	3,564.0	814.0	6,292.7	24,548.9	80,810.4	5651.1	111,010.2
b) Total Maintenance Actions	1033	1025	381	2,439	10,919	26,554	2508	39,981
c) Avg. Active Elapsed Hours/ Maintenance Action	1.9	3.5	2.1	2.6	1.7	2.0	2.0	1.9
d) Avg. Active Down Hour/Flight Hour	2.0	2.1	2.2	2.1	2.3	2.3	2.5	2.3
e) Active Manhours	5,265.2	6,720.6	2,259.0	14,244.8	70,254.9	222,795.6	12,272.6	305,322.8
f) Avg. Manhours/Maintenance Action (3)	5.1	6.6	5.9	5.8	6.4	8.4	4.9	7.6
g) Avg. Manhour/Down Hour	2.7	1.9	2.8	2.3	2.9	2.8	2.2	2.8
h) Active Manhours/Flight Hours	5.6	3.9	6.1	4.7	6.51	6.37	5.52	6.36

Notes: (1) Mean Time to Repair, Elapsed or Manhours, for corrective maintenance actions (Refer to ORE Handbook).
(2) Mean Preventive Maintenance Time, Elapsed or Manhours, for preventive maintenance actions.
(Refer to ORE handbook for definition.)
(3) Includes on-aircraft scheduled (TBO) removal actions at both Org. and Direct Support Activities.

WORKING TIME - 10 MINUTES

3rd Quarter 1970[illegible]

presented for the 36-month cumulative data from all locations combined in the Component Corrective Maintenance Summary, Table R-3, Pages D-24 through D-263.

Table C-1 Rev J

Operational Availability and Downtime Trends

	NORS				RVS				USAMRMC				ALL LOCATIONS			
	1970		1970		1969		1970		1969		1970		1969		1970	
	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd
Operational Availability - by Quarter	Qtr	Qtr	Qtr	Qtr	Qtr	Qtr	Qtr	Qtr	Qtr	Qtr	Qtr	Qtr	Qtr	Qtr	Qtr	Qtr
Operational Availability	55.9%	56.6%	57.1%	53.5%	58.1%	62.6%	57.5%	62.2%	64.6%	54.0%	74.0%	48.7%	59.0%	59.3%	62.9%	56.3%
Downtime due to:																
A. Preventive Maintenance	2.3%	3.0%	3.3%	4.2%	2.3%	2.2%	3.5%	4.0%	1.3%	2.9%	1.7%	1.2%	2.0%	2.6%	3.1%	3.9%
B. Corrective Maintenance	6.6%	6.1%	2.5%	3.5%	16.6%	12.4%	13.1%	6.7%	1.6%	2.0%	1.6%	1.0%	10.6%	8.8%	8.3%	4.0%
C. Supply - NORS	24.4%	22.5%	18.0%	19.4%	12.9%	14.4%	14.1%	7.3%	16.2%	10.8%	10.6%	32.0%	16.7%	16.2%	14.9%	20.0%
D. Support Equipment - NORS	0.0%	0.1%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
E. Administrative	10.8%	11.7%	9.0%	9.4%	10.0%	8.2%	11.8%	19.8%	16.5%	30.3%	12.1%	16.3%	11.7%	13.0%	11.2%	15.0%
F. Total Not Ready	44.1%	43.4%	32.8%	46.5%	26.8%	37.4%	42.5%	37.8%	35.6%	46.0%	26.0%	51.3%	41.0%	40.7%	37.1%	43.7%
Operation Availability Cumulative Seasonation by Quarters																
Operational Availability	51.1%	52.4%	54.4%	54.6%	48.0%	49.7%	51.5%	52.1%	73.4%	69.2%	69.8%	66.9%	50.5%	52.9%	54.1%	54.3%
Downtime due to:																
A. Preventive Maintenance	3.8%	3.6%	3.4%	3.5%	4.0%	3.9%	3.8%	3.8%	1.2%	1.3%	1.4%	1.4%	3.0%	3.6%	3.5%	3.5%
B. Corrective Maintenance	4.2%	4.4%	4.2%	4.1%	9.6%	9.5%	10.0%	9.8%	1.5%	1.8%	1.9%	1.0%	7.5%	7.5%	7.6%	7.4%
C. Supply - NORS	19.6%	21.8%	21.4%	22.0%	15.1%	15.4%	15.1%	14.9%	17.6%	12.7%	12.4%	15.3%	16.8%	17.0%	16.0%	16.9%
D. Support Equipment - NORS	2.1%	0.1%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%
E. Administrative	19.2%	17.7%	16.6%	15.8%	23.1%	21.4%	19.5%	19.4%	11.3%	15.0%	14.5%	14.6%	21.3%	19.8%	18.2%	17.9%
F. Total Not Ready	48.9%	47.6%	45.6%	45.4%	52.0%	50.3%	48.5%	47.9%	26.6%	30.8%	30.2%	33.1%	49.5%	48.0%	45.9%	45.7%

Table C-18 Rev. I
CH-54A Utilization Characteristics

Aircraft Serial No.	Flight Hrs. for 3rd Qtr. 70	Landings/Period 3rd Qtr. 70	Avg. Hrs./Flight 3rd Qtr. 70	Total Accumulated Flight Hrs. (At End of 3rd Qtr. 70)	Latest Location
66-18405	70.0	30	*	1233.9	RVN (Strike)
66-18408	69.0	307	4.71	1850.3	RVN
66-18409	69.0	307	4.96	1556.7	RVN
66-18410	121.5	2587	1.96	1606.4	USAREUR
66-18411	*	2476	4.95	1548.3	RVN
66-18412	143.4	827	1.86	1776.9	RVN
66-18413	112.8	7572	1.82	1572.1	RVN
67-18414	*	712	2.69	628.8	RVN
67-18415	170.8	10803	1.84	1962.9	COMUS
67-18416	*	1674	1.78	1157.7	RVN
67-18418	109.0	2643	1.88	1506.2	RVN
67-18419	64.9	3471	4.33	1750.1	COMUS
67-18420	66.1	3007	4.54	1455.0	RVN
67-18421	*	945	3.50	657.3	RVN
67-18422	*	2464	2.43	1236.6	RVN
67-18423	53.4	483	1.61	346.7	COMUS
67-18424	*	2855	2.81	1294.1	RVN
67-18425	*	1911	2.47	771.8	RVN
67-18426	126.3	2525	1.83	1397.1	RVN
67-18427	64.7	2770	4.04	1308.4	RVN
67-18428	121.8	2785	1.62	1317.4	RVN
67-18429	90.8	2854	3.95	1394.1	RVN
67-18430	128.6	2964	2.22	1246.2	RVN
67-18431	*	3035	2.56	1208.4	RVN
68-18432	*	2819	2.26	959.3	RVN
68-18433	139.9	1676	1.75	865.9	RVN

Sikorsky Aircraft DIVISION OF UNITED STATES HELICOPTER CORPORATION

TITLE EIGHTH (8th) QUARTERLY CH-53 READINESS REPORT

REPORT NUMBER PS 65-K-8

PREPARED UNDER N000 19-68-C-0471 MOD P00102

REPORT DATE 31 DECEMBER 1971

REPORT PERIOD APRIL 1971 - JUNE 1971

This report is applicable to the following aircraft model(s) and contract(s):
MODEL **CONTRACT**

Prepared by C. A. Canner/B. Bickering Checked by J. S. White
 C. A. Canner/B. Bickering J. S. White
 Approved by P. Shurko

REV	CHANGED BY	REVISED PAGE(S)	ADDED PAGE(S)	DELETED PAGE(S)	DESCRIPTION	DATE	APPROVAL

REVISIONS CONTINUED ON NEXT PAGE

ABSTRACT

A total of thirty (38) assemblies have been presented and discussed in the CH-53 Readiness Program over the preceeding 2 year period. In this the eighth (8th) and last report under the terms of the current contract, we will summarize some of the major items which include:

1. Continue mini-course and audi-scan training programs to help insure that maintenance personnel can attain a high degree of proficiency in the support of the various systems encompassed in the CH-53 helicopter.
2. Review possibility of improving structural integrity of lower personnel door.
3. Approve VIECP 7383 to expedite availability of long spline drive shaft for the utility system hydraulic pump.
4. Approve Sikorsky Letter SE 5064 requesting ECP coverage to authorize carburizing internal areas of nose gear box gears.
5. Continue evaluation of PPG all glass and Goodyear composite windshield panels.
6. Expedite concurrence with ECP IHS-T62-029 to introduce improved APU pressure switches into the supply system.
7. Modify in service clutch assemblies per ECP 7418.

TABLE OF CONTENTS

	Page Number
ABSTRACT	ii
INTRODUCTION	1
DEFINITIONS	9
SECTION I: ABORTS, NOR AND MANHOUR DATA	
1. ABORT-NOR-MANHOUR BAR GRAPH . .	16
2. ABORT RATE CHARTS	19
SECTION II: IMPACT ANALYSIS/INVESTIGATION SUMMARY	21
SECTION III: ACTION SHEET FOLLOW-UP	
READINESS REPORT PS 65-K-2	
A. GLASS INSTALLATION	25
B. ACTION CONSIDERED CLOSED	
C. ACTION CONSIDERED CLOSED	
D. ACTION CONSIDERED CLOSED	
E. ACTION CONSIDERED CLOSED	
F. ACTION CONSIDERED CLOSED	
G. APP CLUTCH ASSEMBLY	31
H. ACTION CONSIDERED CLOSED	

	Page Number
I. NOSE GEAR BOX	43
J. BLADE FOLD HARNESS	47
K. ACTION CONSIDERED CLOSED	
L. AFCS CONTROL PANEL	51

READINESS REPORT PS 65-K-4

A. APP FUEL CONTROL	56
B. ACTION CONSIDERED CLOSED	
C. APP PRESSURE SWITCH	60
D. ACTION CONSIDERED CLOSED	
E. ALTIMETER	62
F. ACTION CONSIDERED CLOSED	
G. ACTION CONSIDERED CLOSED	
H. HYDRAULIC TANK ASSEMBLY	65
I. UTILITY HYDRAULIC PUMP	68

READINESS REPORT PS 65-K-6

A. LOWER PERSONNEL DOOR ASSEMBLY. .	73

Page Number

APPENDIXES:

A.	MANHOUR AND ABORT RANKING BY WUC	78
B.	IMPACT ANALYSIS DERIVATIONS	83
C.	NORS, NORM, FAILURE ANALYSIS	86

Introduction

This report represents the eighth and last submittal under Sikorsky Aircraft's CH-53 Readiness Program. These quarterly reports, authorized by MOD P00102 to Contract N00019-68-C-0471, have been prepared and distributed by the Readiness Group within the Product Support Department under direction of the CH-53 Model Manager.

The major statistical input of this group was 3M data supplied by the Maintenance Support Office (MSO) through NATSF. Both manual and machine processing was used in reducing the data for analysis. 3M data was used to determine high cost items on the CH-53 in terms of manhour expenditures and component repairs/replacements. NORS and NORM data was analyzed and top problem items in NORS, NORM and 3M reported component failure areas identified. Once these top problem areas were identified, further analysis was conducted to determine the exact nature of the problem. Data inputs from a Sikorsky Readiness Representative, stationed at NARF, North Island, supplemented 3M data with information concerning depot level maintenance. This supplemental data was sifted and analyzed in order to pinpoint possible problem areas. Once identified, these problems were attacked from a number of directions. Areas were investigated with a view toward possible recommendations for:

(a) changes or revisions to MIMS and other handbooks, (b) development of Audi-Scan programs to assist in improving field maintenance techniques, (c) initiation of SICR action to change procurement levels for parts/components showing usage differing from programmed levels, (d) changes to priority listings for kit deliveries, (e) ECP action to improve current designs in order to increase readiness rates. Both short and long term solutions were investigated with the intent of providing the most effective and expedient solution possible.

Close coordination was maintained between the Readiness Group and other areas of Sikorsky Aircraft. Programs, Engineering, O&R, and areas of Product Support including Supply Support, Field Support and Technical Publications were kept abreast of the group's efforts to insure coordinated and meaningful action on the part of Sikorsky Aircraft to improve operational readiness of the CH-53 helicopter.

Report Format:

There are three basic sections within this report: short rate data, maintenance manhour data, and NOR hour data are included in the first section. This information, gathered from the 3M system, is presented in a graphic format.

The second section contains: (a) impact analysis information on selected components. Impact Analysis being a study of the logistics connected with certain time control components. Adequacy of spare parts provisioning is studied taking into account various parameters such as Time Between Overhaul (TBO), Aircraft Utilization Rates, Actual Mean Time Between Removals for Overhaul (MTBR for Overhaul), Depot Turn Around Time (TAT), aircraft and parts deliveries, etc. The output of the study is a comparison of projected parts/component requirements versus projected parts availability. Obviously, any major difference between the two outcomes would be cause for remedial action. (b) is devoted to problems analysis of areas affecting the Operational Ready Rates for the CH-53A/D aircraft. The format consists of an investigation summary and a number of action sheets stating particular problems, their effect on readiness, maintenance manhours, etc. and recommended action to alleviate these problems. Where an ECP is referenced, a flow chart is

included to reflect its status. 3M data is used as an information source and an analytical study of this data indicates those areas where further research is required. The data is ranked by systems as contributors to NORS, NORM and component failure burdens for the aircraft. The major problems are further studied in order to determine what actions can be taken to improve the system or component. This analysis forms the basis of the action sheets presented.

The third section reflects the status of suggested actions to improve readiness of areas discussed in earlier reports. These are presented in narrative form and include charts or graphs where their use adds clarity to the presentation.

Details and background information, including the ranking determined from 3M data, are presented in the appendices. In this way the cursory reader is spared the maze of numbers and charts while the information is made available for those who want, or have, to be aware of these details.

Current Report

NOR and failure data for this report have an identical time frame: January 1971 through June 1971. The Abort Summary covers April 1971 through June 1971.

The Airframe, Rotor System, Landing Gear System, Transmission System, Flight Control System and Power Plant Support System occupy the first (6) positions in the system performance chart, and are responsible for 58.12% of all aircraft failures, based on MSO 4790, A2142-01 of 20 August 1971. All have been discussed in earlier reports.

Thirty-eight (38) assemblies responsible for significant contributions to CH-53 failure and NOR statistics have been discussed during the past two years in the readiness reports. In this the eighth (8th) and last report under the terms of the current contract, we will summarize some of the major points presented in lieu of introducing additional problem items.

1. Perhaps the greatest single item affecting aircraft readiness is the quality of maintenance available at the field level. This of course relates directly to the need for dynamic training programs. The personnel attrition rate imposes considerable strain on any squadron's qualified roster but sophisticated systems such as those encompassed in the CH-53 cannot be maintained in the same manner as those aircraft designed and fabricated a decade or two ago. This was evidenced when 3M data was analyzed for the many assemblies we have discussed, such as:

- a. The high cannibalization rate of AFCS components.

- b. The frequent entry in the action taken block "No Defect - Checked OK. "
- c. Mission aborts due to tires with "Bad or Worn Tread", "Skin Cracks" in the ramp. These should be detected and corrected during scheduled aircraft maintenance periods and not left for the flight crew to locate.

The training recommended by the contractor includes Audi-Scan and Mini-Courses on selected trouble spots and OJT on all phases of maintenance tailored to the CH-53 helicopters.

2. The process from "Need for an Improvement to Incorporation of that Improvement" is too costly timewise. Analysis conducted during preparation of these reports emphasized the need for more expedient methods for completing ECP actions. (i. e.)

- a. Sikorsky Letter of Intent SEL 5154 was forwarded to NASC in October 1970. The contractor is not in receipt of either confirmation or rejection correspondence. Letter SEL 7733 is similarly in process having been forwarded to NASC in January 1971.
- b. Sikorsky Letter SE 593 dated 12 February 1968 started the ball rolling to modify engine nacelle aft panels which were becoming charred due to exhaust impingement

encountered under certain operational conditions. It was not until November 1970 that improved panels were installed on production aircraft. Kits for retrofit of in-service aircraft are scheduled for availability in February 1972.

- c. It became apparent, shortly after deployment of the CH-53, in 1967, that the matrix-switches in the AFCS control panel would not function in the sandy environment of SEA. An ECP was submitted to NASC in June 1971 which recommended installing protective boots to preclude dust contamination of these assemblies.

These few incidents have been mentioned only to point out the length of time required to complete ECP projects and amplify the need for an accelerated procedure to implement beneficial modifications to an aircraft system.

3. The abort rate for the CH-53 has displayed gradual improvement over the 3 years (84,317 flight hours) reviewed under this contract as noted in the abort graph in section one (1) of this report. The new or short plot of lines shows that aborts, when analyzed and adjusted to exclude erroneous entries from the 3M base data, have reached the Sikorsky predicted MTBA of 50 flight hours, (.020 Aborts/Hr)

The balance of the report is devoted to problems reviewed previously to highlight areas where additional effort might further improve aircraft readiness.

Fleet wide operationally/ready rate statistics have been omitted from this report in order to maintain its unclassified status. Readiness information is available from other sources and unless a strong need for this type of information becomes evident, it will not be included in this or future reports.

DEFINITIONS

Mean Time Between Removal for Depot Overhaul/Repair (MTBR)

The Mean Time Since New or Overhaul of components being returned to a depot level facility for any reason. Components returned without TSO information are disregarded. NOTE: The number so generated cannot be used as a true reliability figure for the component because it will include returns for such items as maintenance or handling damage, etc.

3M Reported Failure

Maintenance Actions reported in 3M card codes 11, 21, and 31 having Action Taken Codes 1 through 9, B, C, or Z.

Depot Turn Around Time (TAT)

Time elapsed from receipt of component at depot facility until component returned to RFI status.

"Timely Tips"

A Sikorsky developed and prepared directive designed to keep our Field Support Representatives abreast of new maintenance techniques, etc.

"Sound Off"

An internal document used to provide comments from our representatives in the field to up date and improve Sikorsky publications.

Abbreviations and Definitions

AFC	Airframe Change
ASO	Aviation Supply Office
BUNO	Bureau Number
ECP	Engineering Change Proposal
IGB	Intermediate Gear Box
IMA	Intermediate Maintenance Activity
LES	Local Engineering Specification
MAG	Marine Air Group
MEA	Maintenance Engineered Analysis (MEAR)
MGB	Main Gear Box
MR	Main Rotor
MTPR	Mean Time Between Removal for Depot Overhaul/Repair
NARF	Naval Air Rework Facility
NATSF	Naval Air Technical Services Facility
NASC	Naval Air Systems Command

NOR	Not Operationally Ready
NORIS	North Island, California
NORM	Not Operationally Ready - Maintenance
NORS	Not Operationally Ready - Supply
O & R	Overhaul and Repair
OJT	On Job Training
PMRC	Periodic Maintenance Requirement Cards
RFI	Ready for Issue
SEA	South East Asia
SICR	Supply Item Change Record
SS	Sikorsky Standard
TAT	Turn Around Time
TBO	Time Between Overhauls
TGB	Tail Gear Box
TR	Tail Rotor

SECTION I

ABORTS - NOR - MAINTENANCE MANHOURS

This section of the Readiness Report presents Abort, Not Operationally Ready, (NOR) and Maintenance Manhour (MMH) data in a readily understandable graphical form. The data is grouped by two (2) digit work unit codes (WUC), i. e. : aircraft sub-system - - airframe, flight controls, drives and transmissions, etc. - - and is presented in WUC order. Aborts, NOR and MMH charged to each work unit code are shown as a percentage of total in their particular category. The abort period covered by this report is April, May, and June 1971, the information having been retrieved from 3M data tapes received by Sikorsky. The graph presented in this section reflects aborts per hour (experience versus predicted) for the CH-53A and D. The abort rate line is computed using as a starting point September 1969 and 84 837.4 total flight hours.

During the period October 1969 - December 1969 the abort rate was .03904 per 9,784.0 flight hours (total flight hours 94,621.4) or one (1) abort every 25,613 flight hours.

During the period January 1970 - March 1970 the abort rate was .03353 per 8,766.8 flight hours (total flight hours 103,388.2) or one (1) abort every 29,819 flight hours.

During the period April 1970 - June 1970 the abort rate was .03021 per 13,370.5 flight hours (total flight hours 116,758.7) or one (1) abort every 33.095 flight hours.

During the period July 1970 through September 1970 the abort rate was .04100 per 9,999.5 flight hours (total flight hours 126,758.2) or one (1) abort every 24.389 flight hours.

The abort rate during the period October 1970 through December 1970 was .03744 per 9,132.5 flight hours (total flight hours 135,891.0) or one abort every 26.704 flight hours.

The abort rate during the period January 1971 through March 1971 was .03286 per 10,133.6 flight hours. (Total flight hours 146,024.6) or one abort every 30.431 flight hours.

The abort rate during the period April 1971 through June 1971 was .04485 for 9386.7 flight hours. (Total flight hours 155,411.3) or one abort every 22.297 flight hours; which represents an increase in the abort rate for this report period.

A detailed analysis of the data base covering both flight and ground aborts revealed that 44.89% of the recorded abort actions were the direct result of poor maintenance techniques, lack of aircraft familiarization, or inequities in the 3M reporting system. The last chart in this section

of the report includes additional "Plots" which reflect the "Adjusted" abort rate.

Attention is directed to this curve, covering four (4) quarters, July 1970 through June 1971. While the "Recorded" abort actions continue in an erratic course the "Adjusted" curve reflects a steady decline. This clearly highlights the need for a continuing vigorous training program to keep all field level personnel knowledgeable and highly efficient so that the need for maintenance can be detected and accomplished during scheduled maintenance periods and not left to be identified by flight crews which invariably results in aborted missions.

NOR data was extracted from 3M tapes covering October 1970 through March 1971. The maintenance manhour data base is a 3M report generated by MSO and also covers CH-53 operations from January 1971 through June 1971. Reference MSO-4790, A2142-1 655-02 of 20 August, 1971.

In this report maintenance manhours for the CH-53A and CH-53D aircraft are grouped together since the relative rankings by WUC are nearly identical. See the Chart of Appendix C. Independent rankings will be made for each following report and if any significant differences occur they will be highlighted.

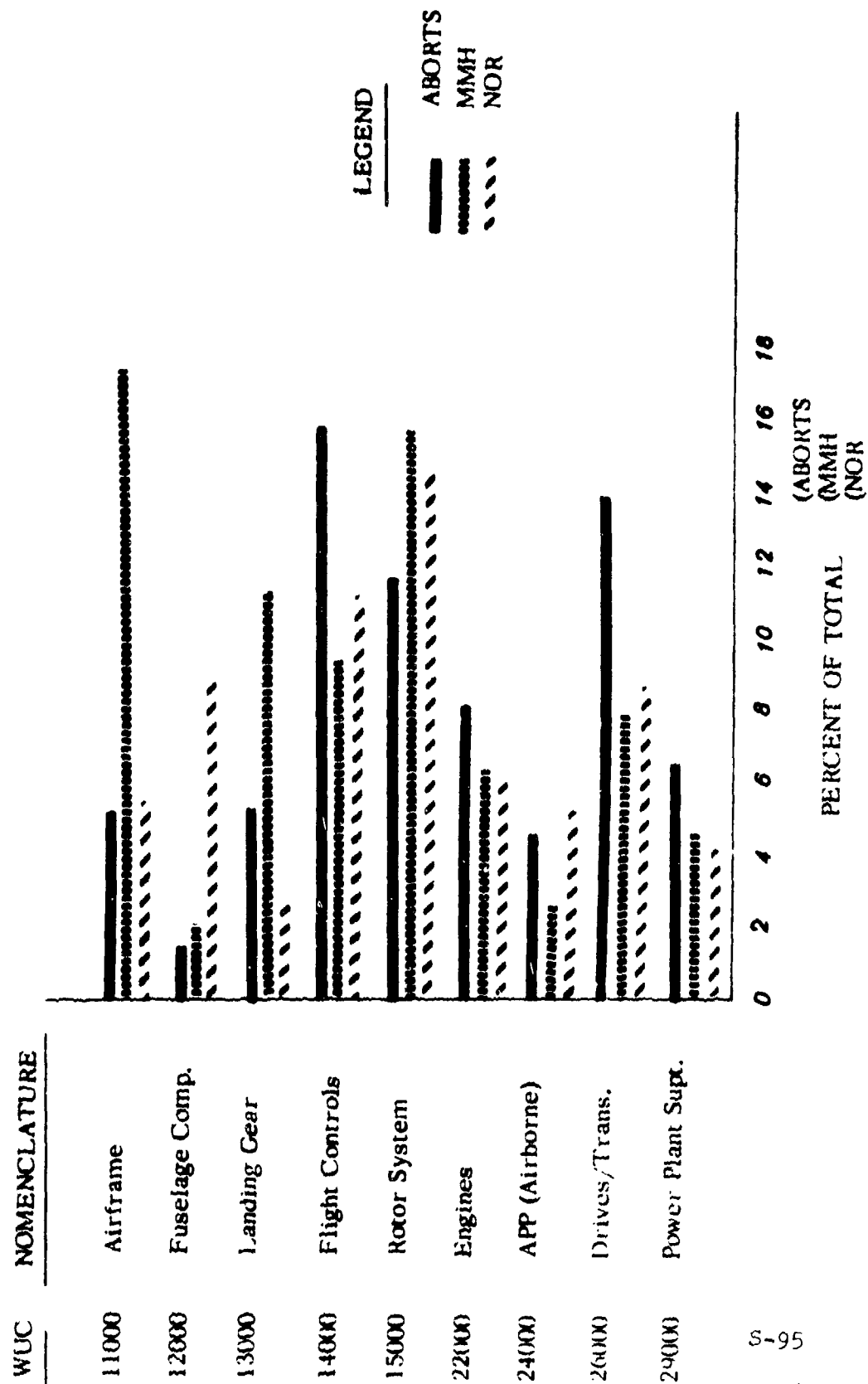
Sikorsky Aircraft

**U
A**

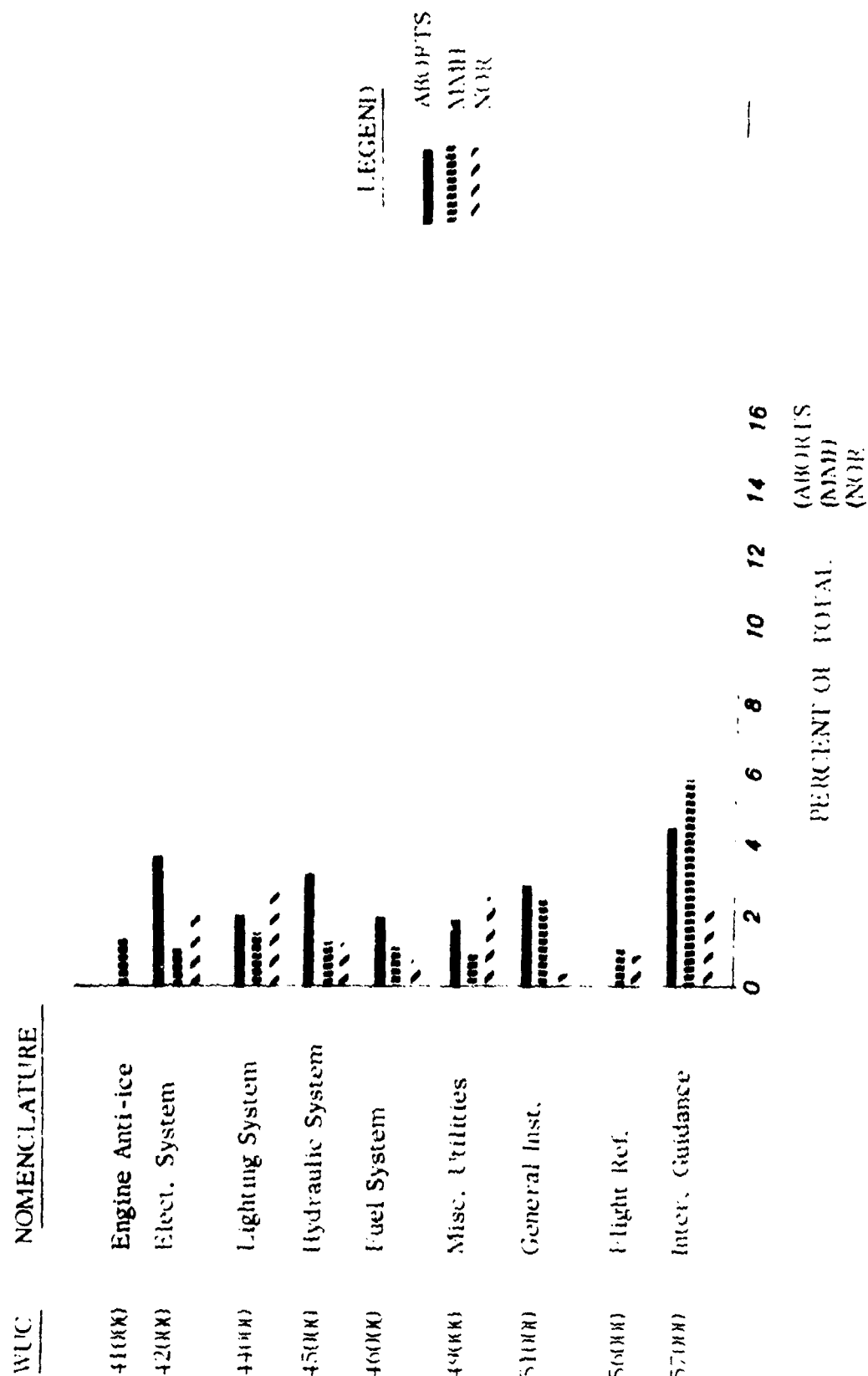
REPORT NO PS 65-K-8

This section provides an accurate indication of which areas of the CH-53 are consuming manhours and reducing availability through aborts and NOR conditions.

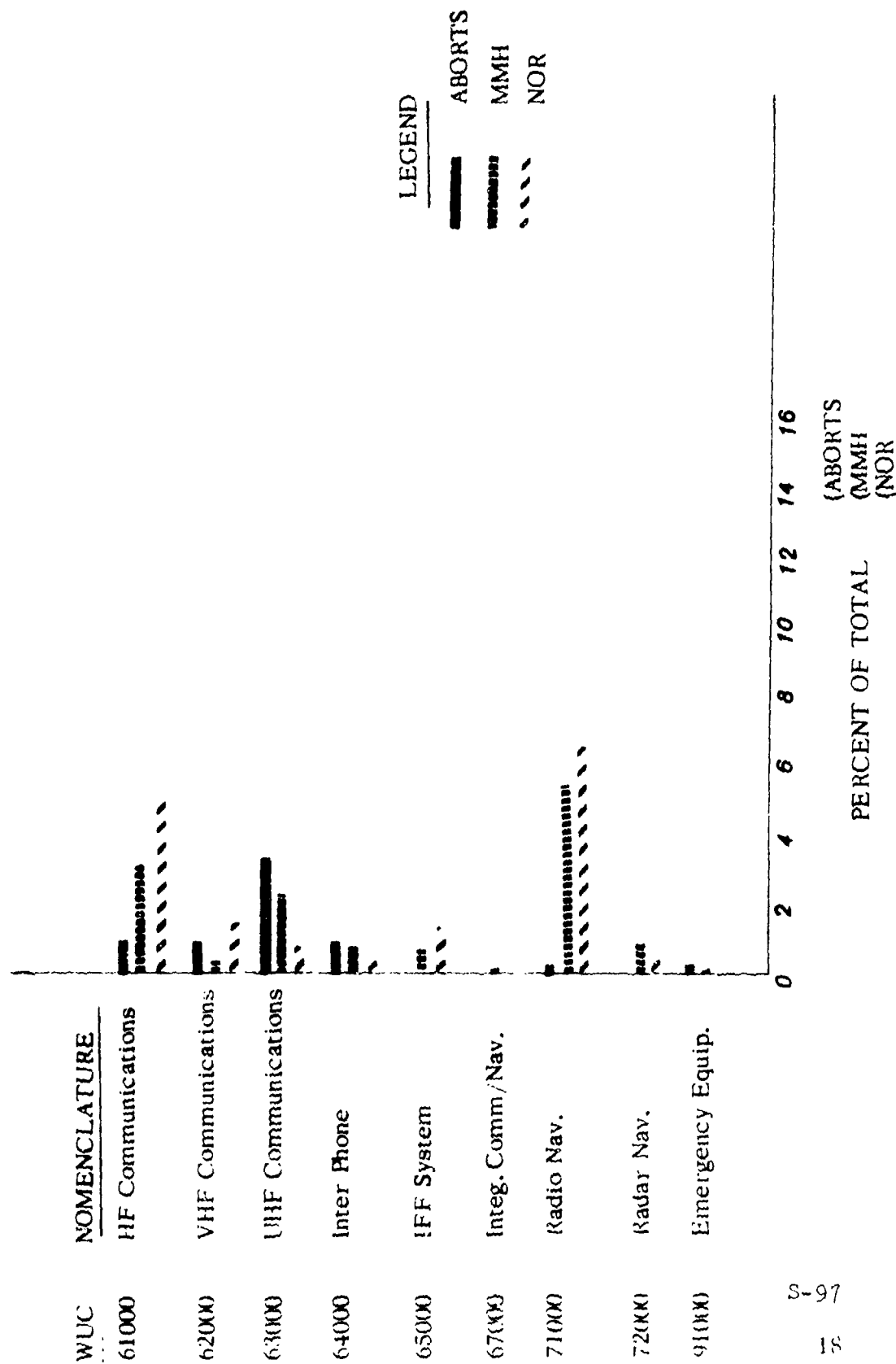
ABORTS, MAINTENANCE MANHOURS, AND NOR BY SYSTEM

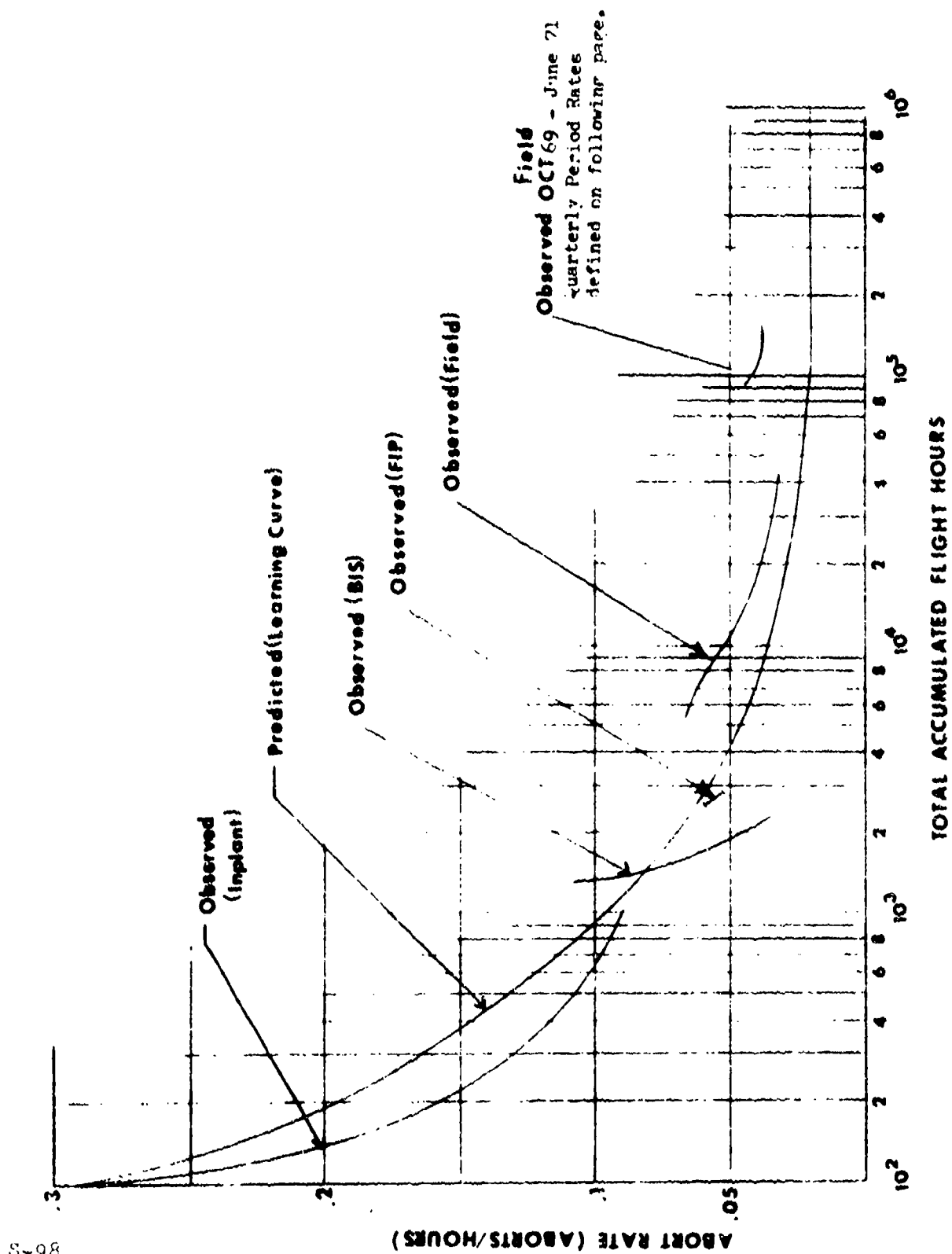


ABORTS, MAINTENANCE MANEUVERS, AND NOR BY SYSTEM

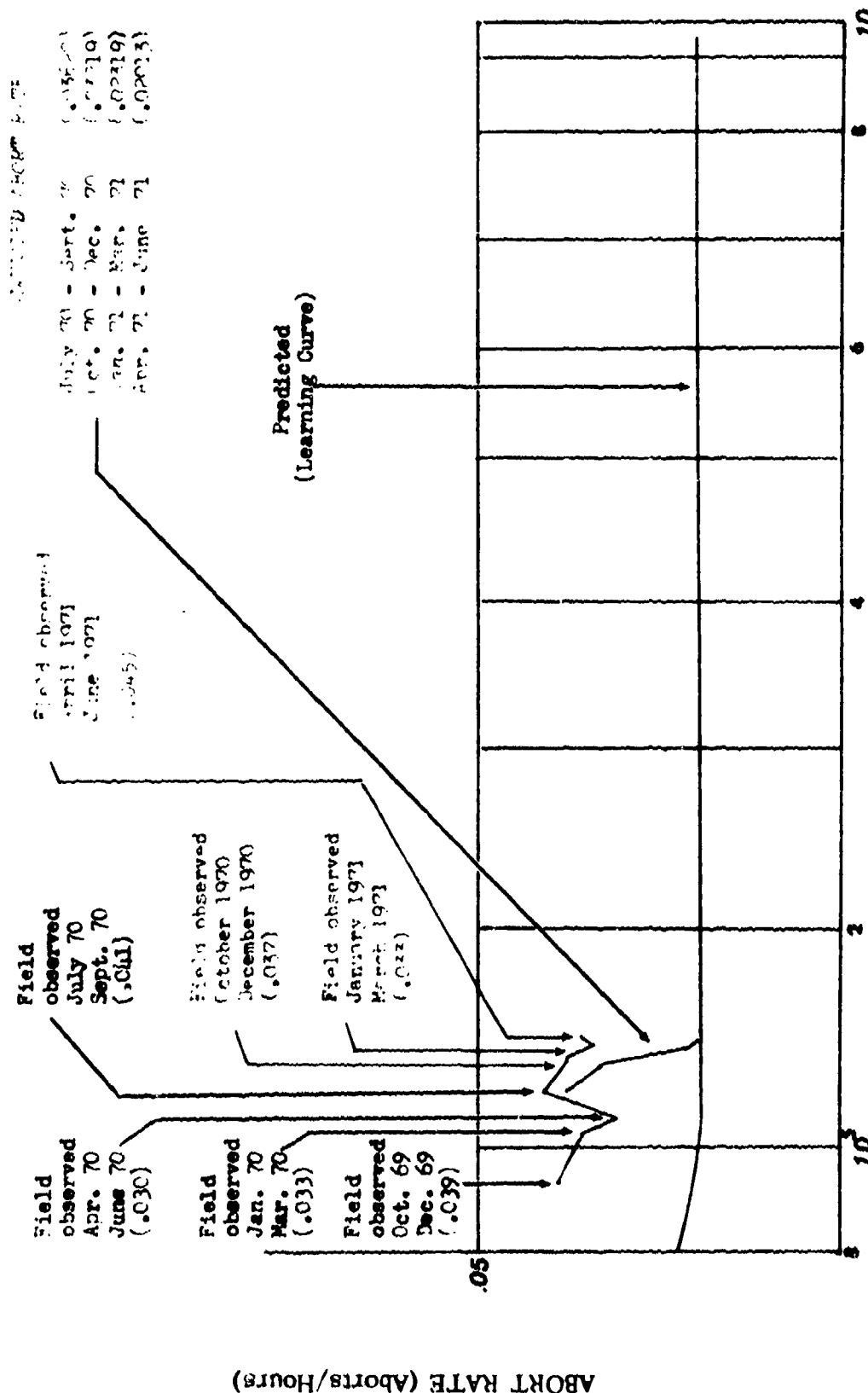


ABORTS, MAINTENANCE MANHOURS, AND NOR BY SYSTEM





CH-53A/D Abort Rate Experience versus Predicted



TOTAL ACCUMULATED FLIGHT HOURS

SECTION II

IMPACT ANALYSIS - INVESTIGATION SUMMARY

The Impact Analysis section of the report studies the logistic considerations of time control components of the CH-53. The concept is not complex but the outcome is significant.

Impact analysis starts with an estimate of fleet requirements for time control components for a specified period. The object is to determine the number of new or overhauled spare components that will be required to support 100% utilization in the fleet. There are several parameters that must be taken into consideration. These include such items as: number of aircraft, new aircraft deliveries, monthly flight hour standards, depot outputs, etc. The other major parameter is defined as Mean Time Between Removal (MTBR) for Overhaul and is the Time Since Overhaul (TSO), for components returning to a depot for any reason. This number is not a reliability figure for the component because it will include returns for such items as handling or maintenance damage, etc. What is determined is the length of time that an average component is available at the user level. Components which are removed for local repair are not considered since they remain at or near the usage site and are expected to be available on a short turn around time.

Fleet requirements can be estimated by dividing the flight hour estimate by the MTBR for Overhaul/Repair. This number of components must then be supplied from the output of Depot facilities and from new spare deliveries. Any difference between requirements and projected deliveries is cause for further analysis and remedial action.

A description of the derivation of the actual numbers, flight hours, and MTBR for overhaul, is contained in Appendix B.

The component investigation portion presents a comprehensive analysis of systems, sub-systems, or components which are adversely affecting aircraft readiness.

3M data forms the base for this section of the report. Two different 3M reports are used to generate the data. A special read-out of the 3M tape supplied to Sikorsky Aircraft provides NOR data. Report number MSO-4790, A2142-01 655-02, "Reliability and Maintainability Summary" provides failure, maintenance action, and manhour data. The data is ranked by contributions to NORS, NORM and component failures and then cross-indexed to show interrelationships between the three categories. Top problem areas are then chosen for analysis. See Appendix C.

Analysis starts with a search for specific reasons or causes which account for the high ranking of the component. Sikorsky Field Support

Representatives reports and reports from the Sikorsky Readiness Representative at NARF, North Island provide much of this information.

Once specific causes are isolated, a search begins for possible solutions. Solutions are analyzed with the assistance of Product Support and Supply Support and recommendations are formulated.

The text of this section describes the problem areas and presents the recommendations. Following the text are Action Sheets which summarize individual problems and the required action to alleviate that specific problem. Flow Charts are included to reflect the actual status of referenced ECP's highlighting required action and established responsibility. However, since no new items are being introduced in this, the eighth (8th) report, no impact analysis or investigation summary will be presented.

APPENDIX A

ABORT/MANHOURLY DATA

ABORTS	April 1971 THROUGH June 1971	MANHOURS	January 1971	THROUGH June 1971	MSO 4790-A2142-01
WUC	SYSTEM NOMENCLATURE	NO. ABORTS	% TOTAL ABORTS	53 A/D MANHOURS	RANK
11000	Airframe	23	5.46	11.840	16.66
12000	Fuselage Compartments	7	1.66	1.464	2.06
13000	Landing Gear System	23	5.46	5.379	7.57
14000	Flight Controls	68	16.15	6.533	9.19
15000	Rotor System	46	11.93	10.511	14.79
22000	Engines	35	8.31	4.526	6.37
24000	APP	20	4.75	1.661	2.34
26000	Drives/Transmission	60	14.25	5.627	7.92
29000	Power Plant Support System	28	6.65	3.063	4.31
41000	Engine Anti-Ice Comp.	0	0	430	.61
42000	Electrical System	15	3.56	810	1.14
44000	Lighting System	8	1.90	1,202	1.69
4500	Hydraulic Power Supply	13	3.09	976	1.37

WUC	SYSTEM NOMENCLATURE	NO. ABORTS	% TOTAL ABORTS	RANK	53 A/D MANHOURS	% MANHOURS	RANK
46000	Fuel System	8	1.90	15	737	1.04	19
49000	Miscellaneous Utilities	8	1.90	16	609	.86	21
51000	General Instruments	12	2.85	13	1,711	2.41	11
56000	Flight Reference	0	0	24	806	1.13	18
57000	Integrated Guidance	19	4.51	9	3,386	4.76	8
61000	IIF Communications	4	.95	18	2,258	3.18	10
62000	VHF Communications	4	.95	19	253	.36	25
63000	UHF Communications	14	3.33	11	1,614	2.27	13
64000	Inter Phone System	4	.95	20	611	.86	22
65000	IFF System	0	0	25	503	.71	23
71000	Radio Navigation	1	.24	21	3,849	5.42	7
72000	Radar Navigation	0	0	26	623	.88	20
91000	Emergency Equipment	1	.24	22	25	.04	26
TOTAL		421	100.99		71,043	99.94	

53 A/D
MANHOURS
% MANHOURS
RANK

APPENDIX B

IMPACT ANALYSIS DATA

1. Derivation of MTBR for Overhaul

A survey of all components processed through the depot facilities since the beginning of the CH-53 program is constantly being conducted. Inputs are being received from Sikorsky Readiness Representatives at NARF, North Island and from the Sikorsky O&R Production Control Department. Components received at a depot without Time Since Overhaul information are disregarded unless the time can be otherwise ascertained.

It should be noted that the numbers so generated do not reflect component reliability, since all causes for return to a depot facility are considered, including no-defect components, handling or maintenance damaged components, etc., are included in the survey. The intent here is not to define a reliability number for the component but to accurately study the loss of RFI components from the fleet supply system for any reason.

Computation is affected on the date noted on the chart. This data is used as an additional tool to assist in isolating areas for analysis and is considered when selecting assemblies to discuss in the Readiness Report.

MAJOR COMPONENT MEAN TIME BETWEEN REMOVAL HOURS (MTBR)

Statistical Data Accrued from 1967 Through the Period Noted

<u>COMPONENT</u>	<u>JULY 1970</u>	<u>MARCH 1971</u>	<u>JUNE 1971</u>	<u>SEPTEMBER 1971</u>	<u>DECEMBER 1971</u>
Main Gear Box	416.22	502.36	490.69	492.36	499.26
Intermediate Gear Box	728.43	673.88	732.98	729.98	752.98
Tail Gear Box	499.62	602.17	578.07	606.90	619.92
Accessory Gear Box	518.16	550.79	558.81	579.38	573.66
Nose Gear Box	490.00	529.11	540.40	536.26	537.37
Main Rotor Head	329.13	382.20	383.98	383.40	383.30
Swashplate	416.13	499.46	472.73	476.15	477.37
Main Rotor Damper	243.11	285.25	280.95	294.64	295.20
Sleeve and Spindle	390.75	403.43	379.87	285.92	315.63
Tail Rotor Head	465.36	509.00	484.86	483.30	464.06
Tail Rotor Servo	549.94	540.20	531.47	584.00	Not Reported
Primary Servo	325.22	377.21	399.88	417.99	Not Reported

<u>COMPONENT</u>	<u>JULY 1970</u>	<u>MARCH 1971</u>	<u>JUNE 1971</u>	<u>SEPTEMBER 1971</u>	<u>DECEMBER 1971</u>
AFCs Servo	344.52	399.96	418.18	495.84	Not Reported
Main Rotor Blades	418.40	453.33	442.96	490.85	482.52
Tail Rotor Blades	372.00	326.99	375.05	383.25	383.89

Report No.
PS 65-K-8

S-107

2. Derivation of Predicted Flight Hours

As of 30 November 1971, 232 aircraft were in inventory (strike aircraft having been eliminated). It is assumed that approximately 5 aircraft will be added to inventory during the balance of calendar year 1971. Based on past history, 2 additional strikes are assumed for 1971. A Utilization Standard of 30.00 flight hours per month per aircraft has been used.

Predicted flight hours per month are obtained by multiplying the average number of aircraft in the fleet for each month by the utilization standard. A summation of monthly totals leads to a gross estimate of 54,360 flight hours for the year with allowances for anticipated NARF PAR induction schedules and known storage periods considered. It should be noted that the flight hour estimate assumes 100% utilization.

APPENDIX C**NORM, NORS AND FAILURE ANALYSIS****Reference:**

- (a) Reliability and Maintainability Summary - - MSO-4790, A2142-01 dated 20 August 1971. The failure statistics reflected are based on maintenance and flight data for the period from January 1971 through June 1971. This summary was selected for the generation of data for the eighth CH-53 Readiness Report and provides the latest complete accumulated information available.
- (b) High NORM/NORS Data Base - - read out of 3M tape supplied to Sikorsky Aircraft reflecting data on all fifth level WUC's. This summary also covers the period from January 1971 through June 1971.

1. NORM, NORS Items Ranking

- (a) Identification and ranking of sub-system WUC's is based on the contribution of the WUC item, measured in hours, to the total reported NORM hours. The percentage of contri-

bution the item makes to the total NORM hours is also given.

- (b) WUC ranking for NORS items is developed in the same manner as for the NORM items.

UNSCHEDULED NORM ITEM RANKING

WUC	NOMENCLATURE	NORM HRS.	% OF NORM	RANK
15110	Rotary Wing Head	3, 256. 3	14. 17	1
14410	Forward Cabin Flight Control Components	1, 293. 1	5. 58	2
22600	T-64 Engine	1, 101. 5	4. 79	3
14A10	R/W Pylon Hydraulic Components	966. 7	4. 21	4
57560	Automatic Flight Control System	873. 8	3. 80	5
15310	Rotary Wing Blades	776. 1	3. 38	6
26270	Main Gear Box	606. 6	2. 64	7
22660	Main Fuel System (T64)	585. 1	2. 55	8
26B30	APP Clutch Components	478. 3	2. 08	9
71430	AN/ARN 52 Tacan Set	454. 9	1. 98	10
13110	MLG Mechanical Components	398. 0	1. 73	11
45110	Utility Hydraulic System Components	385. 9	1. 68	12
15220	Blade Positioning Components	381. 7	1. 66	13
53130	Engine/Gear Box Instruments	378. 2	1. 65	14
26720	Nose Gear box Components	341. 8	1. 40	15

Report No.
PS 65-K-8

NORS ITEM RANKING

WUC	NOMENCLATURE	NORS HRS.	% OF NORS	RANK
15110	Rotary Wing Head	9,453.4	7.31	1
71430	AN ARN52(V) Tacan Set	6,471.6	5.01	2
15220	Blade Positioning Components	5,477.8	4.24	3
12710	Cargo Hook System Components	5,306.6	4.10	4
14410	Forward Cabin Flight Control Components	5,234.4	4.05	5
12610	Cargo Winch Components	4,410.2	3.41	6
44110	Exterior Lights	4,096.9	3.17	7
612EO	AN/ARC 131 VHF / FM Radio Set	3,976.4	3.08	8
26830	APP Clutch Components	3,786.6	2.93	9
14A10	R/W Pylon Hydraulic Components	3,763.0	2.91	10
29510	Engine Ignition, Starting Components	3,517.9	2.72	11
15100	Rotary Wing Head	3,340.9	2.58	12
22660	Main Fuel System (T-64)	3,283.1	2.54	13
51130	Engine Gear Box Instruments	3,282.0	2.54	14
49510	APP Heater Fire Extinguisher Components	3,052.7	2.36	15

Report No.
PS 65-K-8

TOTAL SCHEDULED NORM HOURS	-	21,835.1
TOTAL UNSCHEDULED NORM HOURS	-	22,987.1
TOTAL NORS HOURS	-	129,302.6
TOTAL AWAITING MAINTENANCE HOURS	-	112,151.7
TOTAL NOR HOURS	-	286,268.4

Reference 3M Tabulation NOR Summary - January 1971 - June 1971

2. Failure Ranking

- (a) Twenty-seven (27) system work unit codes are ranked by the number of failures the specific WUC contributed to the overall number of failures reported. The percentage each system contributed is also shown.

SYSTEM PERFORMANCE BY WORK UNIT CODE AND RANKING

RANK	WUC	NOMENCLATURE	PREVIOUS REPORT	TOTAL FAILURES	%	TOTAL MAINT. ACT.	%	TOTAL MANHOURS	%
1	11000	Airframe	1	1,975	17.43	2,337	13.05	11,840	16.66
2	15000	Rotor System	2	1,219	10.76	1,942	10.85	10,511	14.79
3	13000	Landing Gear System	3	1,020	9.00	1,407	7.86	5,379	7.57
4	26000	Transmission	4	881	7.78	1,344	7.51	5,627	7.92
5	14000	Flight Controls	5	844	7.45	1,370	7.65	6,533	9.19
6	29000	Power Plant Support	6	646	5.70	938	5.24	3,063	4.31
SUB-TOTAL				6,585	58.12	9,338	52.16	42,953	60.44
7	71000	Radio-Navigation	10	489	4.32	954	5.33	3,849	5.42
8	51000	Instruments	7	487	4.30	832	4.65	1,711	2.41
9	22000	Turbo Shaft Engine	8	468	4.13	734	4.10	4,526	6.37
10	57000	Integrated Guidance	9	434	3.83	835	4.66	3,386	4.76
11	44000	Lighting System	11	389	3.43	560	3.13	1,202	1.69
12	12000	Fuselage Compartment	12	375	3.31	582	3.25	1,464	2.06

* Sub-Total of those work unit codes accounting for a least (5) percent of all system failures.

REPORT NO.
X-K-8

SYSTEM PERFORMANCE BY WORK UNIT CODE AND RANKING (continued)

RANK	WUC	NOMENCLATURE	PREVIOUS REPORT	TOTAL FAILURES	%	TOTAL MAINT. ACT.	%	TOTAL MANHOURS	%
13	61000	HF Communications	15	319	2.81	636	3.55	2,258	3.18
14	24000	APP (Airborne)	13	311	2.74	614	3.43	1,661	2.34
15	45000	Hydraulic Power	14	239	2.10	371	2.07	976	1.37
16	63000	UHF Communications	16	226	1.99	498	2.78	1,614	2.27
17	42000	Electrical System	17	182	1.60	315	1.76	810	1.14
18	56000	Flight Reference	20	153	1.35	307	1.71	806	1.13
19	49000	Misc. Utilities	19	140	1.24	286	1.60	609	.86
20	64000	Interphone System	18	125	1.10	279	1.56	611	.86
21	46000	Fuel System	21	115	1.01	217	1.21	737	1.04
22	65000	IFF Systems	23	83	.73	183	1.02	503	.71
23	72000	Radar Navigation	24	77	.68	127	.71	623	.88
24	62000	VHF Communications	22	51	.45	86	.48	253	.36

SYSTEM PERFORMANCE BY WORK UNIT CODE AND RANKING (continued)

RANK	WUC	NOMENCLATURE	PREVIOUS REPORT	TOTAL FAILURES	%	TOTAL MAINT. ACT.	%	TOTAL MANHOURS	%
25	41000	Surface Ice Control	25	50	.44	79	.44	430	.61
26	91000	Emergency Equipment	26	14	.12	33	.18	25	.04
				4,727	41.68	8,528	47.62	28,054	39.50
				6,585	58.12	9,338	52.16	42,953	60.44
				11,312	99.80	17,866	99.78	71,007	99.94

TOTAL FLIGHT HOURS ----- 13,621
TOTAL FAILURES ----- 11,331
TOTAL MAINTENANCE ACTIONS --- 17,905
TOTAL MANHOURS ----- 71,073



3. High NORM, NORS and Component Failure Ranking

- (a) The preceding NORM, NORS and Component Failure Charts have been combined here to facilitate comparison. The high fourteen (14) WUC's for each category were selected. (Ref. Chart One).
- (b) The second chart shows the interrelationship of the WUC's referenced on their respective NORM, NORS and Component Failure Rankings. The 42 codes were consolidated into 15 parent system WUC's for this presentation.

HIGH NORM, NORS, AND SYSTEM FAILURE RANKING

NORM		NORS		SYSTEM FAILURES	
WUC	NOMENCLATURE	WUC	NOMENCLATURE	WUC	NOMENCLATURE
15000	Rotor System	15000	Rotor System	11000	Airframe
14000	Flight Controls	14000	Flight Controls	15000	Rotor System
26000	R/W Drives/Trans.	12000	Fuselage Compartment	13000	Landing Gear System
22000	Turbo Shaft Engines	26000	R/W Drives/Trans.	26000	R/W Drives/Trans.
11000	Airframe	71000	Radio Navigation	14000	Flight Controls
24000	APP (Airborne)	61000	HF Comm. System	29000	Power Plant Inst'l.
13000	Landing Gear System	11000	Airframe	71000	Radio Navigation
57000	Integrated Guidance	22000	Turbo Shaft Engines	51000	Instruments
24000	Power Plant Inst'l.	24000	APP (Airborne)	22000	Turbo Shaft Engines
51000	Instruments	29000	Power Plant Inst'l.	57000	Integrated Guidance
71000	Radio Navigation	44000	Lighting Systems	44000	Lighting System
42000	Electrical System	49000	Misc. Utilities	12000	Fuselage Compartment
46000	Fuel System	13000	Landing Gear System	61000	HF Comm. System
45000	Hydraulic Power Supply	42000	Electrical System	24000	APP (Airborne)

Report No.
65-K-8

INTERRELATIONSHIP OF NORM, NORS, SYSTEM FAILURES

WUC	NOMENCLATURE	NORM	NORS	SYSTEM FAILURES
11000	Airframe	x	x	x
12000	Fuselage Compartments	o	x	x
13000	Landing Gear System	x	x	x
14000	Flight Controls	x	x	x
15000	Rotor System	x	x	x
22000	Turbo Shaft Engines	x	x	x
24000	APP (Airborne)	x	x	x
26000	R/W Drives	x	x	x
29000	Power Plant	x	x	x
42000	Electrical System	x	x	o
44000	Lighting Systems	o	x	x
51000	Instruments	x	o	x
57000	Integrated Guidance	x	o	x
61000	HF Communication System	o	x	x
71000	Radio Navigation	x	x	x

Report No.
65-K-2

The 15 system work unit codes described above are derived by consolidating the WUC's shown on the previous page NORM, NORS, SYSTEM FAILURE RANKING CHART to the system level. Ranking in the above chart was determined by the items appearance on two or more of the 3 reports.

x Indicates item appeared on respective NORM, NORS or FAILURE LISTING.

o Indicates item did not appear on the respective list.