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CH-47A ASSESSMENT AND COMPARATIVE FLEET EVALUATION: EXECUTIVE SUMMARY REPORT

Army Aviation Systems Command
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13. ABSTRACT

The purpose of the Executive Summary is to provide an overview and summarization of the CH-47A Assessment. The parameters presented provide management perspective of the CH-47A fleet, in addition to comparative fleet evaluations. Various presentations of RAM related parameters give the present system posture of the CH-47A fleet.

MDS Assessment and Comparative Fleet Evaluations are covered in this report. Quality and Command Program Assessments and the Command Statistics and Problem Summary are the other reports which make up the total Executive Summary for the CH-47A.

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Mission Reliability Data						
System Reliability Data						
Equipment Improvement Recommendations						
Field Service Reports						
Major Item Comparisons						

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DISPOSITION INSTRUCTIONS

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ABSTRACT

The purpose of the Executive Summary is to provide an overview and summarization of the available data on specific operational aircraft. Various presentations of RAM related parameters give the present system posture of the CH-47A fleet. The parameters presented provide management perspective of the CH-47A fleet, in addition to comparative fleet evaluations.

A Model Designation Series (MDS) Assessment and Comparative Fleet Evaluations are covered in this report. Quality and Command Program Assessments and the Command Statistics and Problem Summary are the other reports which make up the total Executive Summary for the CH-47A.

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INTRODUCTION

This Executive Summary provides the pertinent RAM and QA statistics and descriptive narrative relative to RAM and QA problems, and is primarily intended for top-level management and as such is not obscured with excessive detail. The Executive Summary for a given Model Designation Series (MDS) fleet consists of four distinct reports, each providing significant observations for a functionally oriented grouping of management information. The reports are as follows:

a. MDS Assessment and Comparative Fleet Evaluations.

b. Quality and Command Program Assessments.

c. Command Statistics and Problem Summary. (From MDS Assessment and Comparative Fleet Evaluation).

d. Command Statistics and Problem Summary. (From Quality and Command Program Assessments).

This summary covers the MDS Assessment and Comparative Fleet Evaluations.

Since field experiences can be viewed from many different perspectives, this report is limited to concentration on those subjects which indicate influences on aircraft mission accomplishments and supporting resource requirements. Although focus of the report is primarily aimed at present day aircraft configuration, it also encompasses considerations which should be anticipated in the development of future generation equipment. To more clearly relate the total objectives of this report, a graphic display of the "Life Cycle R&M Experience Plan" is provided on the succeeding page. A synopsis of this display is as follows:

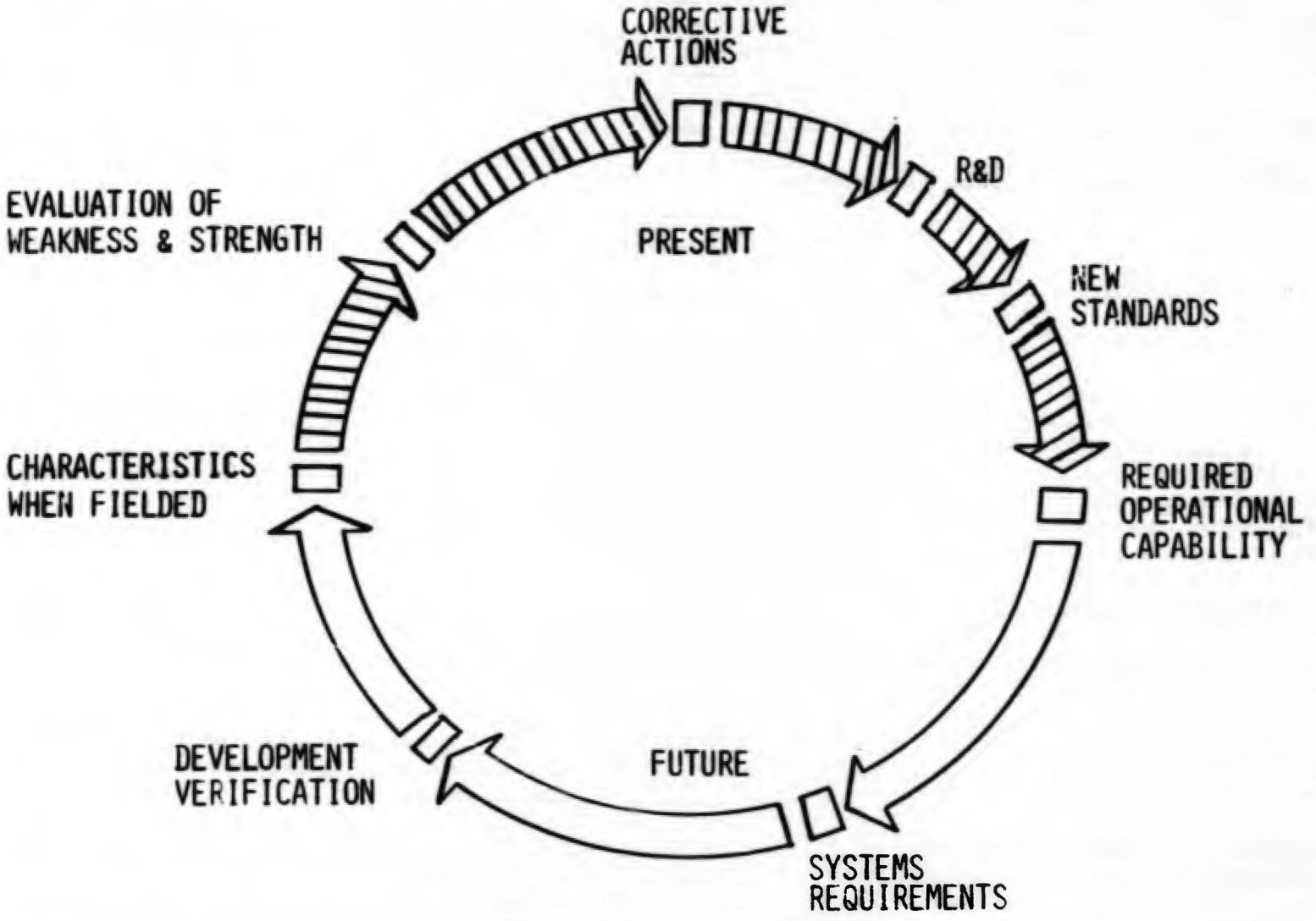
PRESENT EQUIPMENT (in the inventory)

Efforts are directed toward measuring the characteristics which identify the maintainability and reliability obtained in the actual field environment.

As Required Operational Capabilities (ROCs) are made known, the information on past and present equipment is utilized to formulate an R&M model (quantitative expressions of what equipment should demonstrate when placed in the field environment for which it was intended).

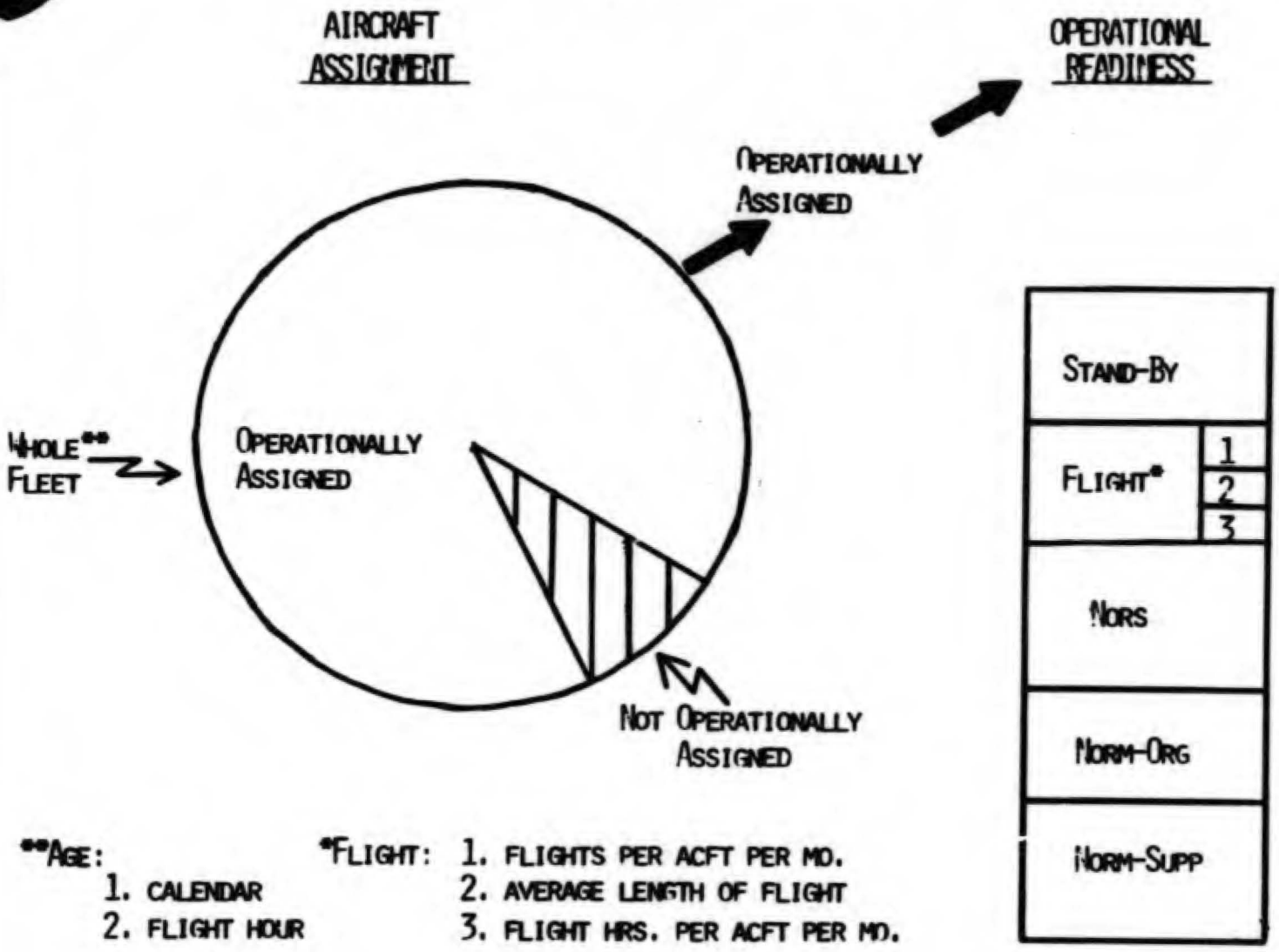
In essence, this report synthesizes all factors which directly or indirectly influence the ultimate purpose of a fully operational fleet of aircraft: mission accomplishment. It is not feasible nor desirable to present all possible parameters in a summary type report. Therefore, this report is limited to presenting what is considered significant. Appendix A provides descriptions of RAMMIT reports which are currently available.

LIFE CYCLE R&M EXPERIENCE PLAN



CH-47A
ASSESSMENT

CH-47A FLEET UTILIZATION



**AGE:
1. CALENDAR
2. FLIGHT HOUR

*FLIGHT:
1. FLIGHTS PER ACFT PER MO.
2. AVERAGE LENGTH OF FLIGHT
3. FLIGHT HRS. PER ACFT PER MO.

UTILIZATION

A fleet of aircraft is procured to be utilized in performing a particular mission. At any point in time, the major portion of the fleet will be utilized in performing this mission. This portion of the fleet is referred to as being Operationally Assigned. The remaining portion, which consists of aircraft in transit, at depot, awaiting disposition, etc., is called Not Operationally Assigned. These portions and their breakdowns are shown in Illustration 1.

An operational readiness (availability) rate is determined for that portion of the fleet operationally assigned. An aircraft is considered operationally ready when it is flying or is capable of safe flight and essential equipment necessary for performance of its primary mission is performing or ready to perform. An aircraft is Not Operationally Ready (NOR) whenever the current status symbol is a red "X" as recorded on DA Form 2408-3. If parts are not available to repair the aircraft, it is carried as Not Operationally Ready Supply (NORS) until the parts become available. While the aircraft is being repaired, it is carried as Not Operationally Ready Maintenance (NORM). If personnel, are not available to work on the aircraft, but parts are available, it remains in the NORM category. That portion of the total NORM time consumed by organization and by direct and general support maintenance is separately reported. Illustration 2 shows the trend of the percentage of time that this fleet was Operationally Ready (OR), including a breakdown into the portions flown and ready to fly. Also shown are the trends of NORM and NORS. The world wide standard for OR, NORM, and NORS is shown on the illustration.

Illustration 3 shows the age distribution of the fleet in both flight hours and calendar months as of the last day of the observation period.

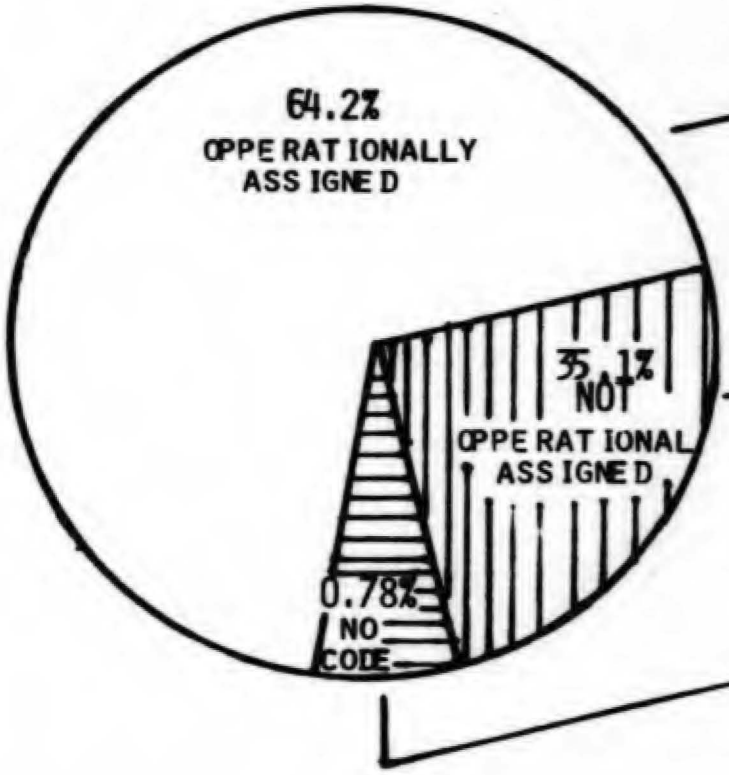
The fleet's flight time for the twelve-month observation period is shown in Illustration 4. This graph shows the number of flights per aircraft per month; the average length of flight; and flight hours per aircraft per month.

Data for these illustrations were taken from the Army Aircraft Inventory Status and Flying Time Reporting System (AR 710-12). This reporting system requires that a DA Form 1352 be submitted to AVSCOM each month by all Army units owning Army aircraft.

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ILLUSTRATION 1
CH-47A ASSIGNMENT OF AIRCRAFT
21 MAR 73 - 20 MAR 74

(AVERAGE FOR PERIOD)



BREAKDOWN

(AS OF 20 MAR 74)

ASSIGNMENT	% OF FLEET	NO. OF ACFT
OPERATIONAL:		
COMBAT MISSION - RESERVES	16.28	28
DIRECT COMBAT SUPPORT		
- ARMY	29.65	51
- RESERVES	25.00	43
TOTAL	70.93	122
NOT OPERATIONAL:		
MAINTENANCE TRAINERS		
- CATAGORY "A"	1.16	2
- CATAGORY "B"	0.58	1
- CATAGORY "C"	2.33	4
MAINT. FLOAT ACFT	1.74	3
IN-DEPOT MAINT. ACFT	11.63	20
IN-SERVICEABLE STORAGE	0.58	1
AWAITING DISPOSITION	6.40	11
INTRANSIT	4.07	7
TOTAL	28.49	49
NO CODE (TOTAL)	0.58	1
FLEET ACCOUNTABILITY TOTAL	100.00	172

ILLUSTRATION 2

CH-47 FLEET OPERATIONAL AVAILABILITY TRENDS
APR 1973 THROUGH MAR 1974

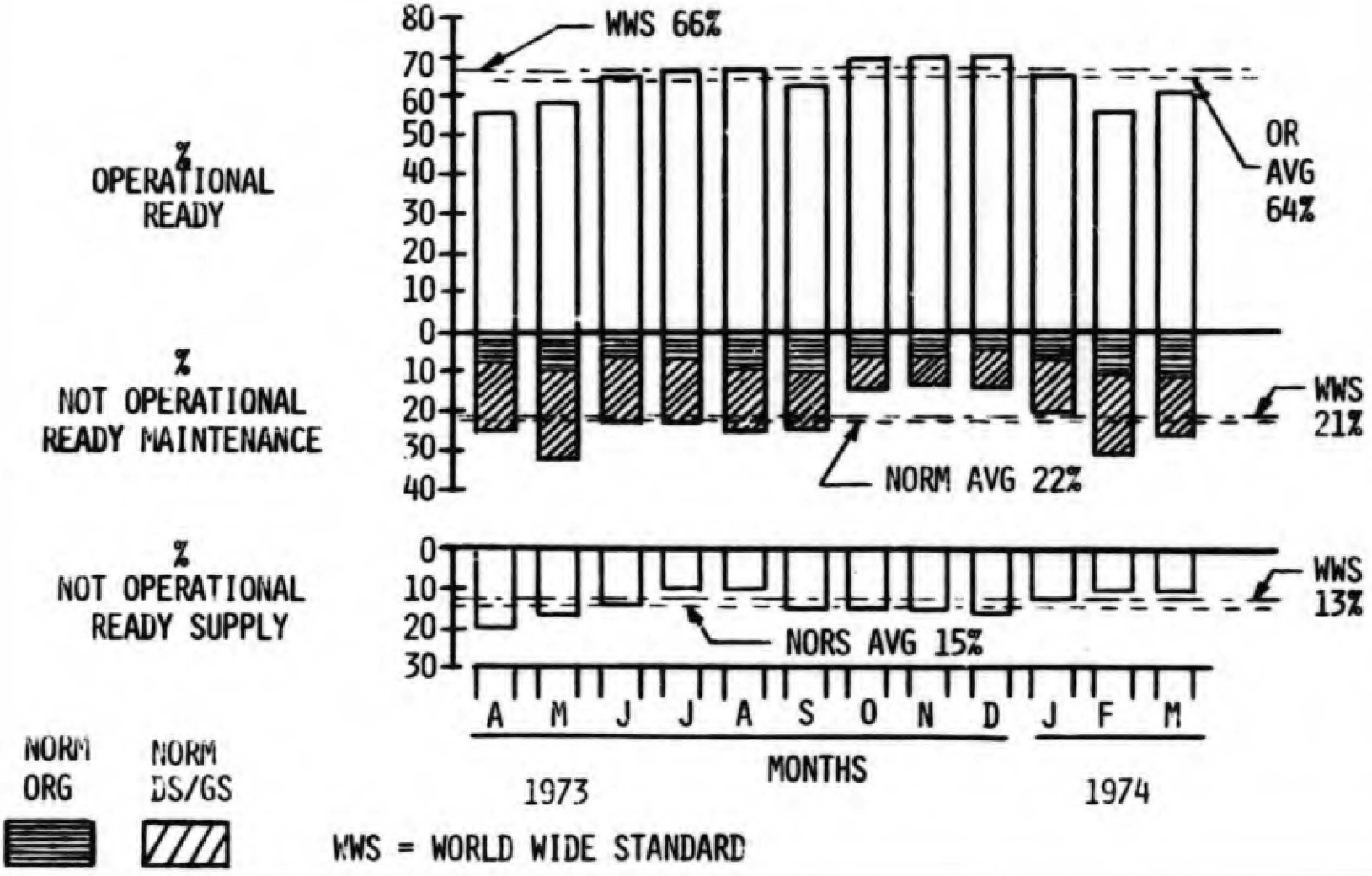
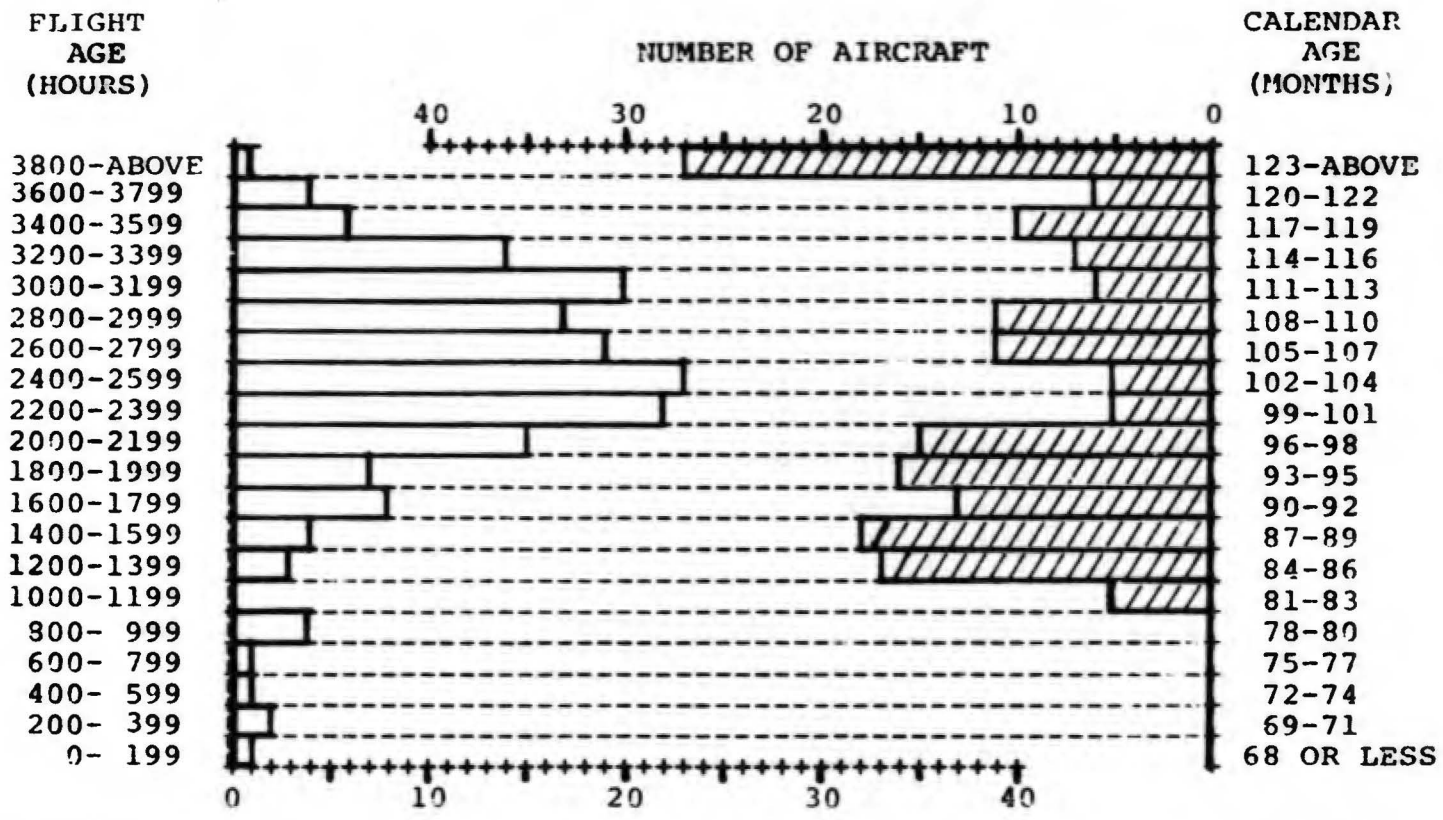


ILLUSTRATION 3
CH-47A FLEET AGE DISTRIBUTION

AS OF 20 MAR 74



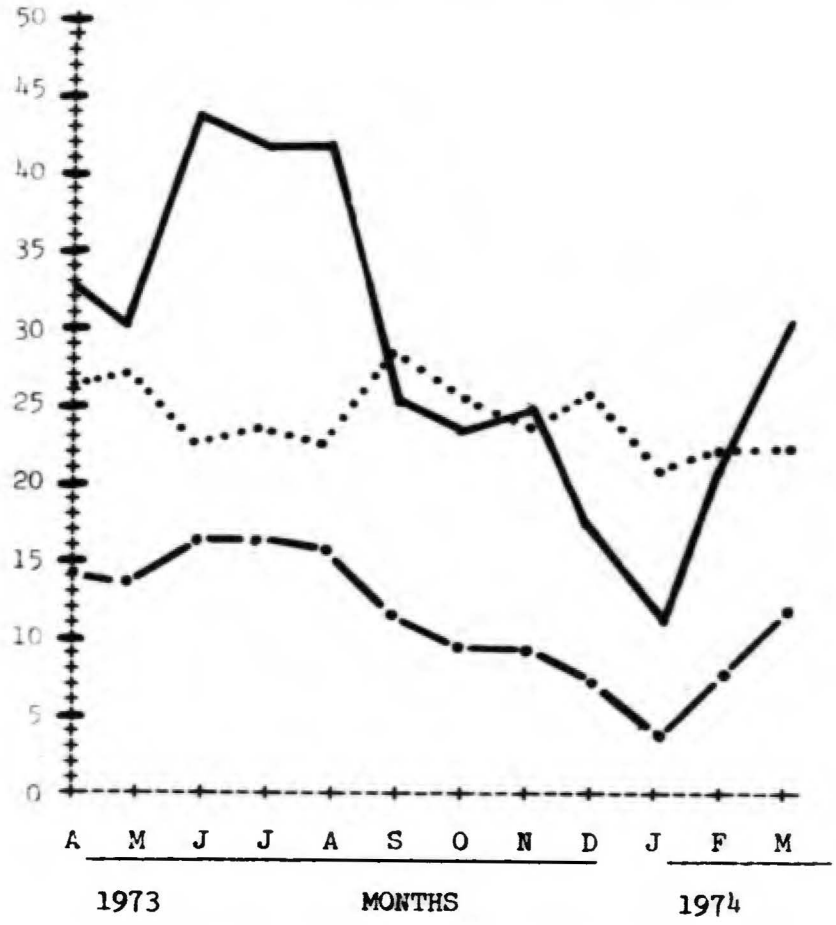
(172 AIRCRAFT IN FLEET)

ILLUSTRATION 4

CH-47A FLIGHT TIME

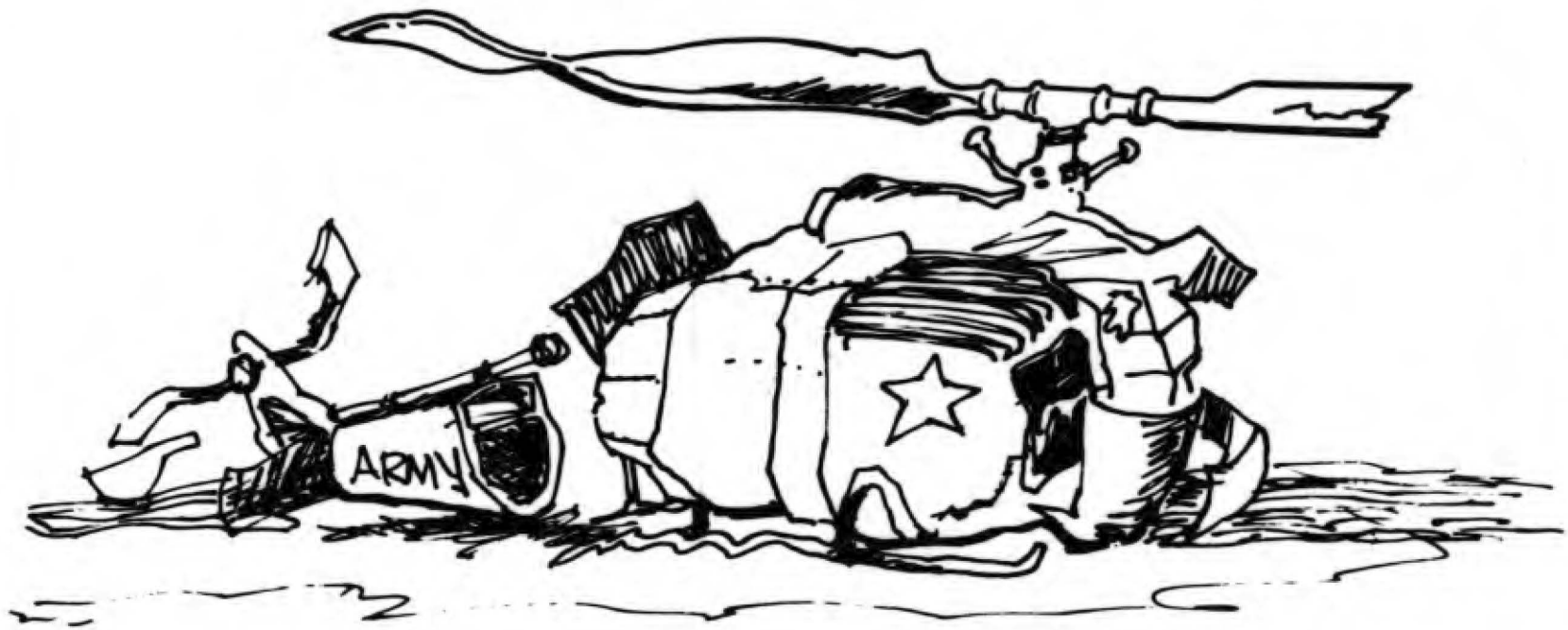
21 MAR 73 - 20 MAR 74

NO. FLIGHTS PER ACFT: FLIGHT HOURS PER ACFT; LENGTH OF FLIGHTS (MINUTES)



	12 MONTH AVERAGE
NO. FLIGHTS PER AIRCRAFT PER MONTH	28.51
LENGTH OF FLIGHT	24.16 MIN.
FLIGHT HOURS PER AIRCRAFT PER MONTH	11.48 HRS.

SAFETY RELIABILITY



SAFETY RELIABILITY

Safety reliability is the porbability that no accident caused by the systems or components failing or malfunctioning will occur. The parameter will be designated as Rs (material).

Other factors than material failures causing accidents are personnel, environment, weather, etc. When all factors causing accidents are included, safety reliability will be designated as Rs (all).

The source of data for this compilation was the US Army Agency for Avaition Safety (USAAAVS) Aircraft Accident Experience Report. An evaluation of the total losses, major and minor accidents, incidents, and forced landings reported was constructed. Precautionary Landings were not considered in this evaluation.

The top section of Illustration 1 shows trends by year for the three year period ending in May 1974, Rs (all) and related safety reliability parameters. Column 6 reveals the mean time between safety related aborts for all causes. Column 8 reveals Rs (all) for the length of an average flight.

The bottom section of Illustration 1 shows trends in Column 2 of the mean time between safety related aborts due to material causes. Rs (all) and Rs (material) are calculated for a one and two hour mission.

Illustrations 2, 3, and 4 respectively provide for the CH-47A, B, and C aircraft the definite material causes of accidents or potential accidents for the period fiscal year 1972, 1973, and 1974.

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ILLUSTRATION 1

CH-47A SAFETY RELIABILITY: FIELD EXPERIENCE

JUNE 71 THRU MAY 74

YEAR ENDING	AVERAGE INVENTORY	NO OF FLIGHTS	NO OF SAFETY* RELATED ABORTS	TOTAL FLIGHT HOURS	MTB ABORT ALL CAUSES (HOURS)*	AVERAGE FLIGHT DURATION (MINUTES)	FLIGHT SUCCESS FOR AVERAGE FLIGHT DURATION Rs (ALL)
MAY 72	243	163727	16	48032	3002.0	17.60	99.99
MAY 73	194	23507	2	10096	5048.0	25.77	99.99
MAY 74	187	38956	2	15448	7724.0	23.79	99.99

YEAR ENDING	MTB** MATERIAL FAILURES	% 1 HOUR MISSION		% 2 HOUR MISSION	
		NO ABORTS Rs (ALL)	NO MATERIAL FAILURES Rs (MATERIAL)	NO ABORTS Rs (ALL)	NO MATERIAL FAILURES Rs (MATERIAL)
MAY 72	4002.7	99.97	99.98	99.93	99.95
MAY 73	5048.0	99.98	99.98	99.96	99.96
MAY 74	15448.0	99.99	99.99	99.97	99.99

*INCLUDES ALL TOTAL LOSSES, MAJOR AND MINOR ACCIDENTS, INCIDENTS AND FORCED LANDINGS.

**INCLUDES TOTAL LOSSES, MAJOR AND MINOR ACCIDENTS, INCIDENTS AND FORCED LANDINGS FROM MATERIAL CAUSES.

ILLUSTRATION 2

CH-47A DEFINITE MATERIAL CAUSES OF ACCIDENTS OR POTENTIAL ACCIDENTS
FY 72, 73 & 74 PERIOD

FUNCTIONAL GROUP	COMPONENT	FY 72 QTY & TYPE	FY 73 QTY & TYPE	FY 74 QTY & TYPE
LANDING GEAR	LNDG GEAR LINKAGE	----	----	(1) INCIDENT
ROTORS & XMSNS	M/R BLADES	(2) TOTAL LOSS	----	----
HYDRAULIC SYS	NOT SPECIFIED	(1) INCIDENT	----	----
INSTRUMENTS	INSTRUMENT PLUMBING	----	----	(1) INCIDENT

ILLUSTRATION 3

CH-47B DEFINITE MATERIAL CAUSES OF ACCIDENTS OR POTENTIAL ACCIDENTS
FY 72, 73 & 74 PERIOD

FUNCTIONAL GROUP	COMPONENT	FY 72 QTY & TYPE	FY 73 QTY & TYPE	FY 74 QTY & TYPE
AIRFRAME	DOORS, HATCHES & WINDOWS HINGE	----	----	(1) INCIDENT
POWER PLANT	ENGINE (COMPONENT NOT SPECIFIED)	(1) FORCED LANDING	----	----

ILLUSTRATION 4

CH-47C DEFINITE MATERIAL CAUSES OF ACCIDENTS OR POTENTIAL ACCIDENTS FY 72, 73, & 74 PERIOD

FUNCTIONAL GROUP	COMPONENT	FY 72 QTY & TYPE	FY 73 QTY & TYPE	FY 74 QTY & TYPE
AIRFRAME	DOORS, HATCHES & WINDOWS	(1) INCIDENT	----	----
	ACCESS PANEL FAIRING	(1) INCIDENT	----	----
LNDG GEAR	MAIN LNDG GEAR	----	----	(1) INCIDENT
POWER PLANT	ENGINE(COMPONENT NOT SPECIFIED)	(1) FORCED LANDING	----	(1) INCIDENT (1) MINOR ACCIDENT
	ENGINE TURBINE WHEEL DISK	----	----	(1) INCIDENT
ROTORS & XMSNS	MAIN XMSN LUBRICATION	(1) FORCED LANDING	----	----
	COMBINING XMSN GEAR	(1) FORCED LANDING	----	----
	M/R FASTENERS	(1) MAJOR ACCIDENT	----	----
	ENGINE(?) XMSN	(1) FORCED LANDING	----	----
ELECTRICAL SYS	DC GENERATOR	(1) FORCED LANDING	----	----
FUEL SYSTEM	VENT OVERFLOW	----	----	(1) INCIDENT

MISSION RELIABILITY

H-47A



CHINOOK

ANALYZED BY

PROBABILITY OF FLIGHT SUCCESS
AVERAGE, 1 HR & 2 HR MISSION LENGTH

FLIGHT ABORT SUMMARY
MISHAP CATEGORY
CONTRIBUTING CAUSES

MATERIAL CAUSES OF FLIGHT ABORTS
FUNCTIONAL GROUP SUMMARY

MISSION RELIABILITY

Mission reliability is the probability of non-failures of the system during the duration of a mission, given that the system was operating at the beginning of the mission. This parameter will be designated as Rm (material).

Other factors than material failures causing mission aborts are personnel, environment, weather, etc. When all factors causing mission aborts are included, mission reliability will be designated as Rm (all).

The source of data for this compilation was the US Army Agency for Aviation Safety (USAAAVS) Aircraft Accident Experience Report. An evaluation of the total losses, major and minor accidents, incidents, forced landings and precautionary landings reported was constructed.

The top section of Illustration 1 shows trends, by year for the three year period ending in May 1974 of Rm (all) and related mission reliability parameters. Column 6 reveals the mean time between mission aborts for all causes. Column 8 reveals Rm (all) for the length of an average flight. The bottom section shows trends in column 2 of the mean time between mission aborts due to material causes. Rm (all) and Rm (material) are calculated for a one and two hour mission.

Illustration 2 shows material causes of aborts by functional group level.

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ILLUSTRATION 1
CH-47A MISSION RELIABILITY: FIELD EXPERIENCE
JUNE 71 THRU MAY 74

YEAR ENDING	AVERAGE INVENTORY	NO OF FLIGHTS	NO OF ABORTS	TOTAL FLIGHT HOURS	MTB ABORT ALL CAUSES (HOURS)	AVERAGE FLIGHT DURATION (MINUTES)	FLIGHT SUCCESS FOR AVERAGE FLIGHT DURATION R_M (ALL)
MAY 72	243	163727	113	48032	425.1	17.60	99.93
MAY 73	194	23507	28	10096	360.6	25.77	99.88
MAY 74	187	38956	40	15448	386.2	23.79	99.90

YEAR ENDING	MTB MATERIAL FAILURE	% 1 HOUR MISSION*		% 2 HOUR MISSION*	
		NO ABORT R_M (ALL)	NO MATERIAL FAILURE R_M (MATERIAL)	NO ABORT R_M (ALL)	NO MATERIAL FAILURE R_M (MATERIAL)
MAY 72	658.0	99.77	99.85	99.53	99.70
MAY 73	673.1	99.72	99.85	99.45	99.70
MAY 74	702.2	99.74	99.86	99.45	99.72

*BASED ON TAKEOFF AND LANDING AT AVERAGE FLIGHT DURATION FREQUENCY.

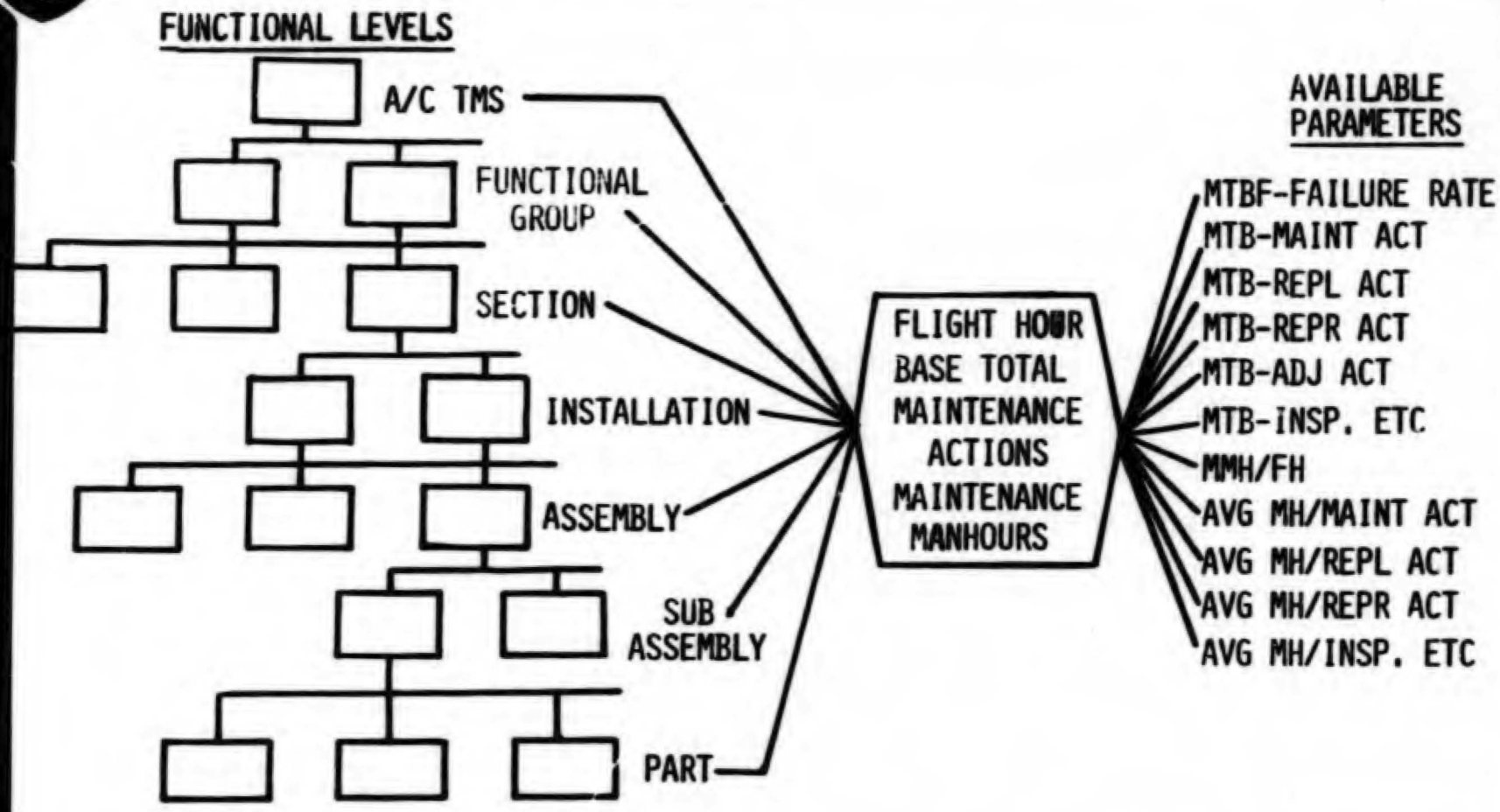
ILLUSTRATION 2

CH-47A
MAJOR MATERIAL FAILURES CAUSING FLIGHT ABORTS
JUNE 71 THRU MAY 74

FUNCTIONAL GROUP		NUMBER OF FAILURES
03	ENGINE	33
06	HYDRAULIC	32
04	ROTOR AND TRANSMISSION SYSTEMS	17
09	ELECTRICAL SYSTEM	9
01	AIRFRAME	5
11	FLIGHT CONTROL SYSTEM	5
08	INSTRUMENTS	3
02	ALIGHT GEAR	2
17	CARGO AND PERSONNEL HANDLING EQUIPMENT	2
10	FUEL SYSTEM	1
19	AVIONICS	1

BASED ON INITIAL CRASH FACTS INFORMATION

OPERATIONAL R&M CHARACTERISTICS



INFORMATION TO BE AVAILABLE FOR A PARTICULAR FLEET, ARMY AREA, COMMAND, ORGANIZATION, INDIVIDUAL AIRCRAFT, AND/OR BY MAINTENANCE ECHELONS (D, GS, DS, ORG)

OPERATIONAL RELIABILITY & MAINTAINABILITY CHARACTERISTICS

A function of the Systems Performance Assessment Division is to determine and analyze the parameters that are indicative of the operational reliability and maintainability of first line fleets of Army aircraft. The terms "reliability" and "maintainability" are defined in Appendix A, AR 702-3, and entail a determination of parameters such as mean time between failure (MTBF) and mean time to repair (MTTR). This analysis as such does not in a strict sense determine MTBF. A strict determination of MTBF would involve a detail analysis of each corrective action performed on each part and then make a determination of whether it was an inadequacy of the part that caused the corrective action or whether some external influence caused the part to be inadequate and therefore the corrective action to be performed. Only those corrective actions resulting from an inadequacy of the part when it was being used as intended would be counted as failures of the part. Since this analysis indicates that there were more than 53,000 corrective actions performed, judicious selection of those that are by definition, actions because of failure of the part, would be an exhausting task. Also, the purpose of this analysis is not to verify or disclaim the vendors claimed MTBF for his equipment, but to display the problems with this equipment when it is used in the military environment. Therefore, the following parameters are defined and presented on following pages for the whole aircraft, its functional groups and selected components.

OPERATIONAL RELIABILITY CHARACTERISTICS

Mean Time Between Corrective Maintenance Actions - the average flight hours between replacement, adjustment, repair, removed and reinstalled actions when the reason for the action (failure code) was other than No Defect (ND), ND - removed to facilitate other maintenance, ND - removed for scheduled maintenance, ND - removed for time change, ND - removed in trouble shooting and ND - MWO partial or complete compliance.

Mean Time Between Any Maintenance Action - the average flight hours between any type of action except Modification Work Orders, Command Maintenance Management Inspection and Technical Bulletin Compliance.

Mean Time Between Replacement - the average flight hours between replacement actions.

Mean Time Between Repair - the average flight hours between repair action.

Mean Time Between Preventive Maintenance Actions - the average flight hours between daily, intermediate, and periodic inspections, scheduled replacement of major and minor items, service actions, initial and final inspections, calibration and tested actions.

Dominant Reason for Corrective Actions and Percent of Total Corrective Actions - select the largest reason for corrective action and its quantity and divide it bv the sum of all reasons for corrective actions.

OPERATIONAL MAINTAINABILITY CHARACTERISTICS

Maintenance Man Hours (MMH) per Flight Hour - the total MMH divided bv the total acceptable flight hours.

MMH per Corrective Maintenance Action - the corrective MMH divided by the corrective maintenance actions.

MMH per any maintenance action - total MMH divided by the total maintenance actions.

MMH per replace maintenance action - the replace MMH divided by the replace maintenance actions.

MMH per repair maintenance action - the repair MMH divided by the repair maintenance actions.

MMH per preventive maintenance action - the preventive MMH divided bv the preventive maintenance actions.

The data base from which the above parameters were generated is known as the Maintenance Action File and originates from DA Forms 2407, 2408-3, and 2410, submitted in accordance with TM 38-750. These forms are completed by maintenance personnel at organization, direct, and general support echelons.

This fleet accumulated 68,778 flight hours during the period (April 1971-March 1973) that this data was taken. However, as a result of various editing techniques used on the data an acceptable base of 51,259 flight hours was determined. The size of the fleet at the beginning of the data period was 250 aircraft and at the end of the data period it was 173 aircraft.

Illustration 1 summarizes the maintenance action and man hour data determined for the total aircraft system.

Illustration 2 summarizes the scheduled inspections data.

Illustration 3 presents the operational reliability characteristics determined for the total system and each of its functional groups.

Illustration 4 presents the operational maintainability characteristics determined for the total system and each of its functional groups.

Illustrations 5 Thru 8 present a selection from all functional groups of the thirtv components with the worst operational reliabiltiy (first two illustrations) and worst operational maintainabilitv (next two illustrations) characteristics.

Illustrations 9 thru 36 present some of the components from each functional group with the worst operational reliability and maintainability characteristics.

Functional groups 00 - Miscellaneous, and 30 - Armament, were purposelv excluded.

ILLUSTRATION 1

CH-47A MAINTENANCE ACTION AND MANHOUR SUMMARY
ORGANIZATION, DIRECT, AND GENERAL SUPPORT MAINTENANCE LEVELS
1 APRIL 1971 THRU 30 MARCH 1973

TYPE MAINTENANCE ACTIONS	% OF TOTAL MAINTENANCE ACTIONS	MEAN TIME BETWEEN (TYPE) ACTION	% OF TOTAL MAINTENANCE MANHOURS	MMH/ (TYPE) ACTION
ANY	100.0	0.45	100.0	6.79
SCHEDULED	22.3	2.04	45.8	13.93
UNSCHEDULED	77.7	0.59	54.2	4.74
CORRECTIVE	47.8	0.95	26.7	3.80
PREVENTIVE	43.7	1.04	67.0	10.39
NEITHER	8.5	5.36	6.3	5.05
REPLACE	43.9	1.03	22.6	3.49
REPAIR	10.4	4.38	11.0	7.21
OTHER	45.7	1.00	66.4	9.87

MAINTENANCE MAN HOURS/FLIGHT HOURS = 14.94

UNSCHEDULED MMH/FLIGHT HOUR = 8.10

NEITHER = ACTIONS TO FACILITATE OTHER MAINTENANCE

ILLUSTRATION 3

CH-47A SYSTEMS OPERATIONAL RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 1971 THRU MARCH 1973

FUNCTIONAL GROUPS (FG) END ITEM & TOTAL SYSTEMS	MEAN TIME BETWEEN					
	CORRECTIVE MA	ANY MA	REPLACE MA	REPAIR MA	PREVENTIVE MA	TOTAL NO. OF MA
FG 00 MISC	4.36	3.26	4.20	22.28	18.47	15,724
FG 01 AIRFRAME	3.45	2.39	6.45	8.45	9.32	21,449
FG 02 LNDG GEAR	23.49	18.00	25.43	301.52	152.10	2,847
FG 03 POWER PLANT	21.85	9.81	19.81	123.81	31.94	5,226
FG 04 ROTORS & XMSNS	5.74	3.51	4.31	163.77	17.65	14,615
FG 06 HYDRAULIC SYS	12.94	9.60	12.86	151.65	84.73	5,337
FG 08 INSTRUMENTS	76.17	48.63	69.36	732.27	303.31	1.054
FG 09 ELECTRICAL SYS	20.30	13.47	24.28	92.03	51.73	3,805
FG 10 FUEL SYSTEM	70.51	48.40	90.40	272.65	332.85	1.059
FG 11 FLIGHT CONTROL	18.72	13.26	19.51	120.33	61.24	3,866
FG 12 UTILITY SYS	77.67	58.18	82.54	457.67	296.29	881
FG 17 CARGO & HANDLING	211.81	149.01	240.65	1025.18	610.23	344
FG 18 AUX POWER UNIT	112.16	69.93	104.82	1067.89	207.53	733
FG 19 AVIONICS	30.28	10.79	34.80	88.38	23.81	4,752
FG 30 ARMAMENT	985.75	406.82	2050.36	4271.58	702.18	126
END ITEM	575.94	1.65	575.94	1164.98	1.66	31,004
TOTAL SYSTEM	0.95	0.45	1.03	4.38	1.04	112,822

ILLUSTRATION 4

CH-47A SYSTEM OPERATIONAL MAINTAINABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 1971 THRU MARCH 1973

FUNCTIONAL GROUP (FG) END ITEM & TOTAL SYSTEM	MMH PER FLIGHT HOUR	CORRECTIVE MA	ANY MA	REPLACE MA	REPAIR MA	PREVENTIVE MA	TOTAL NO. OF MMH
FG 00 MISC	1.12	2.34	3.64	1.22	4.76	11.11	57,179.3
FG 01 AIRFRAME	1.71	4.98	4.08	3.12	8.51	2.18	87,508.6
FG 02 ALIGN GEAR	.19	2.84	3.34	3.10	9.17	2.07	9,520.3
FG 03 POWER PLANT	.69	7.30	6.73	7.53	9.89	7.59	35,152.3
FG 04 ROTORS & XMSNS	1.94	3.31	6.80	5.59	4.88	13.87	99,340.7
FG 06 HYDRAULIC SYS	0.32	3.41	3.09	3.23	4.75	3.18	16,493.2
FG 08 INSTRUMENTS	.06	1.95	2.70	1.89	1.93	6.10	2,840.0
FG 09 ELECTRICAL SYS	.15	1.87	2.02	1.65	2.88	2.14	7,667.2
FG 10 FUEL SYS	.07	3.64	3.59	1.92	8.09	2.03	3,799.0
FG 11 FLIGHT CONTROLS	.35	4.62	4.57	4.65	2.28	3.16	17.665.4
FG 12 UTILITY SYS	.03	1.92	1.92	1.63	2.68	1.58	1,693.9
FG 17 CARGO & HANDLING	.03	3.91	3.98	2.91	6.10	3.86	1,368.5
FG 18 AUX POWER UNIT	.07	6.01	5.19	6.51	5.49	3.33	3,803.1
FG 19 AVIONICS	.16	2.25	1.73	1.40	3.39	1.37	8.234.1
FG 30 ARMAMENT	.01	5.36	4.54	10.98	1.86	3.94	571.5
END ITEM	8.06	74.88	13.33	31.6	133.1	13.10	413,161.9
TOTAL SYSTEM	14.94	3.80	6.79	3.49	7.21	10.39	765,999.2

ILLUSTRATION 5
CH-47A WORST COMPONENT RELIABILITY CHARACTERISTIC FROM ALL FUNCTIONAL GROUPS
PERIOD OF DATA APRIL 1971 THRU MARCH 1973

FG	COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
				CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
01	AFT STRUCTURE ASSY	1	BROKEN - 52.2%	1059	1650	191	912	577	48	31	268	56	88
04	HOSE ASSY, XMSN LUB SYS	4	LEAKING - 41%	866	870	846	20	4	237	236	242	10252	51259
01	PANEL	1	BROKEN - 48.1%	770	1426	111	660	745	67	36	462	78	69
02	FRICTION LINING	6	WORN EXCESS - 89%	535	550	535	---	13	575	559	575	---	23658
01	FAIRING ASSY	1	BROKEN - 71.6%	530	938	96	435	388	97	55	534	118	132
04	SIGHT CUP OIL	6	BROKEN - 83%	529	529	522	2	---	581	581	585	153777	---
01	POD ASSY	1	BROKEN - 52.7%	483	918	21	461	415	106	56	2441	111	124
01	MOUNT	6	BROKEN - 52.5%	446	465	436	9	49	690	661	705	3417	6277
01	COWLING	1	BROKEN - 81.6%	421	494	156	267	44	122	104	329	192	1165
04	MOUNT, RESILIENT	4	BROKEN - 69%	419	419	415	---	---	489	489	494	---	---
04	PLAIN SEAL-HEAD ASSY FWD AFT	36	LEAKING - 86%	409	452	449	1	---	4512	4083	4110	1845324	---
01	COVER	1	BROKEN - 64.8%	407	650	103	306	208	126	79	498	168	247
06	SERVOCYLINDER	21	LEAKING - 84%	398	503	496	1	---	2705	2141	2170	512590	---
01	DOOR	1	BROKEN - 55.6%	334	631	53	277	144	153	81	967	185	356
03	FUEL CONTROL VALVE	2	LEAKING - 37%	333	430	421	---	94	308	238	244	---	1091
09	ELECTRICAL HARNESS	2	NO DATA	322	343	110	205	92	318	299	932	500	1114
03	POWER PLANT	2	BROKEN - 20%	321	995	443	62	306	319	103	231	1654	335
04	BEARING SELF ALIGN	4	WORN EXCESS - 93%	290	305	305	---	---	707	672	672	---	---
04	XMSN ENGINE	2	WORN EXCESS - 14%	263	456	420	2	201	390	225	244	51259	510

ILLUSTRATION 6

CH-47A WORST COMPONENT RELIABILITY CHARACTERISTIC FROM ALL FUNCTIONAL GROUPS (CONT'D)
PERIOD OF DATA APRIL 1971 THRU MARCH 1973

FG	COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
				CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
01	FORMER ASSY	1	BROKEN - 91.1%	235	334	39	197	98	218	154	1314	260	523
04	SLEEVE BUSHING	4	WORN EXCESS - 90%	222	222	222	---	---	924	924	924	----	----
09	LAMP	2	BURNED - 67.7%	222	222	221	1	---	462	462	464	102518	----
02	PACKING	3	WORN EXCESS - 79%	219	219	219	---	---	702	702	702	----	----
18	APU GAS TURB ENG	1	NOT DETERMINED - 46% LEAKING - 19% BROKEN - 14%	214	307	290	---	89	240	167	177	----	576
04	FWD BLADE ASSY	3	BROKEN - 23%	213	749	596	7	285	722	205	258	21968	540
04	XMSN SHAFT	2	EXCESS VIB - 10%	209	265	249	---	65	491	387	412	----	1577
04	SHAFT ASSY, SYNC. RTR. DR.	7	COLLAPSED - 51%	190	482	442	---	1	1889	744	812	----	358813
04	FLUTTER DAMPNER	6	LEAKING - 49%	187	207	183	---	1	1645	1486	1681	----	307554
11	ELEC-MECH ACTUATOR	1	WORN EXCESS - 50% BURNED - 50%	186	256	256	---	---	276	200	200	----	----
04	LINK ASSY OR BEARING FWD & AFT ROTOR	6	WORN EXCESS - 92%	180	187	187	---	---	1709	1645	1645	----	----

ILLUSTRATION 7

CH-47A WORST COMPONENT MAINTAINABILITY CHARACTERISTICS FROM ALL FUNCTIONAL GROUPS
PERIOD OF DATA APRIL 1971 THRU MARCH 1973

			QUANTITY OF TYPE MMH					MMH PER					
FG	COMPONENT	QTY/ ACFT	TOTAL	CORRECT	REPLACE	REPAIR	PREVENT	FLT HOUR	ANY MA	CORRECT MA	REPLACE MA	REPAIR MA	PREVENT MA
03	POWER PLANT	2	17059.7	7499.0	10366.2	1438.4	4969.2	1664.2	17.2	23.4	23.4	23.2	16.2
01	AFT STRUCTURAL ASSY	1	8842.2	7833.3	771.8	7023.1	976.9	1725.0	5.4	7.4	4.0	7.7	1.7
03	EXHAUST CONE	2	6767.0	1671.5	215.2	1437.8	4866.7	660.1	5.4	10.5	3.2	18.2	7.2
04	XMSN ASSY, FWD ROTOR	1	5961.5	1469.2	5583.6	123.5	2245.0	1163.0	43.5	35.8	51.7	9.5	40.8
04	BLADE ASSY - AFT	3	5772.3	762.0	3864.0	18.0	3394.7	375.4	7.9	7.3	7.0	9.0	7.0
04	BLADE ASSY - FWD	3	5669.6	1407.2	3635.6	126.0	1913.3	368.7	7.6	6.6	6.1	18.0	6.7
04	XMSN ASSY, AFT ROTOR	1	5444.3	1079.8	5080.8	223.2	3286.3	1062.1	42.5	31.8	58.5	24.8	44.4
06	HYD SERVOCYLINDER	21	4654.0	3709.5	4588.0	6.0	---	43.2	9.3	9.3	9.3	6.0	---
01	PYLON	1	3793.0	3467.8	2.0	3466.8	261.0	738.0	12.8	16.1	1.0	16.2	4.7
04	HEAD ASSY - FWD	1	3671.5	832.3	3444.0	---	2034.0	716.3	25.0	28.7	28.7	---	24.8
04	SHAFT ASSY, SYNC. RTR. DR.	7	3544.6	10.0	3241.2	---	20.0	98.8	7.4	.1	7.3	---	20.0
01	COCKPIT FLOOR	1	3134.5	613.5	320.0	605.9	1609.2	611.5	13.5	8.5	7.8	7.9	17.3
01	COWLING	1	3115.1	2754.8	87.4	2637.8	97.0	607.7	6.3	6.5	0.6	9.9	2.2
04	LINK ASSY, ROTARY	6	3010.8	---	2550.2	---	18.0	97.9	8.6	---	8.3	---	3.0
01	FAIRING ASSY	1	2753.5	2257.5	1006.5	1286.5	411.6	537.2	3.0	4.3	10.5	3.0	1.1
02	FRICTION LINING	6	2744.8	2690.7	2664.7	---	4.1	89.2	5.8	5.0	5.1	---	0.4

ILLUSTRATION 10

CH-47A, FG 01, AIRFRAME
WORST COMPONENT MAINTAINABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

		QUANTITY OF TYPE MMH					MMH PER					
COMPONENT	QTY/ ACFT	TOTAL	CORRECT	REPLACE	REPAIR	PREVENT	10,000 FLIGHT HOURS	ANY MA	CORRECT MA	REPLACE MA	REPAIR MA	PREVENT MA
AFT STRUCTURAL ASSY.	1	8842.2	7833.3	771.8	7023.1	976.9	1725.0	5.4	7.4	4.0	7.7	1.7
PYLON	1	3783.0	3467.8	2.0	3466.8	261.0	738.0	12.8	16.1	1.0	16.2	4.7
COCKPIT FLOOR	1	3134.5	613.5	320.0	605.9	1609.2	611.5	13.5	8.5	7.8	7.9	17.3
COWLING	1	3115.1	2754.8	87.4	2637.8	97.0	607.7	6.3	6.5	0.6	9.9	2.2
FAIRING ASSY.	1	2753.5	2257.5	1006.5	1286.5	411.6	537.2	3.0	4.3	10.5	3.0	1.1
CARGO LOADING	1	2545.3	2459.2	1047.2	1392.5	54.0	479.8	23.6	23.9	104.7	15.3	13.5
FUSELAGE	1	2308.3	36.0	18.0	1533.3	749.0	450.3	30.8	0.6	18.0	26.9	46.8
POD ASSY	1	1734.3	1597.4	452.9	1153.6	108.9	338.3	1.9	3.3	21.6	2.5	0.3
BOOM ASSY	1	1522.5	1380.5	1078.4	302.1	142.0	297.0	11.5	17.7	32.7	67.1	2.6

ILLUSTRATION 11

CH-47A, FG 02, ALIGHTING GEAR
WORST COMPONENT RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

			QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
FRICTION LINING	6	WORN EXCESS. - 89%	535	550	535	--	13	575	559	575	--	2 58
PACKING	3	WORN EXCESS. - 79%	219	219	219	--	--	702	702	702	--	--
PNEUMATIC TIRE	2	BROKEN - 72%	111	116	110	1	5	924	884	932	102518	20504
PNEUMATIC TIRE	2	BROKEN - 80%	106	110	105	1	4	967	932	976	102518	25630
DISC BRAKE	2	LEAKING - 61%	91	101	79	7	7	1127	1015	1298	14645	14645
ELECTROSTATIC DISCHARGER	1	MISSING - 76%	74	78	74	--	3	693	657	693	--	17086
SEAL	2	BROKEN - 45%	65	83	49	16	18	1577	1235	2092	6407	569
SEAL, PLAIN	2	WORN EXCESS. - 57%	54	54	54	--	--	1899	1899	1899	--	--
DISC BRAKE ASSY.	1	WORN EXCESS. - 51%	51	51	50	--	--	1005	1005	1025	--	--
PACKING, PREFORMED	1	LEAKING - 100%	43	43	43	--	--	1192	1192	1192	--	--
BEARING SEAL	2	WORN EXCESS. - 100%	33	33	33	--	--	3102	3102	3102	--	--
BEARING	2	WORN EXCESS. - 70%	32	48	32	--	12	3204	2136	3204	--	8543
INNER TUBE	2	WORN EXCESS. - 64%	30	30	30	--	--	3417	3417	3417	--	--
AFT SWIVEL LOCK PISTON	1	BROKEN - 83%	30	30	30	--	--	1709	1709	1709	--	--
BRAKE PLUNGER & LINING	1	WORN EXCESS. - 55%	27	27	27	--	--	1899	1899	1899	--	--

ILLUSTRATION 13

CH-47A, FC 03, POWER PLANT
WORST COMPONENT RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
			CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
FUEL CONTROL VALVE	2	LEAKING - 37%	333	430	421	--	94	308	238	244	--	1091
POWER PLANT	2	BROKEN - 20%	321	995	443	62	306	319	103	231	1654	335
EXHAUST CONE	2	LOOSE OR MISSING PARTS - 26%	160	1249	68	79	673	641	82	1508	1298	152
ENGINE LINK ASSY.	2	WORN EXCESS. - 85%	119	119	117	--	--	862	862	876	--	--
GENERATOR	2	WORN EXCESS. - 31%	113	123	111	1	8	907	834	924	102518	12815
ELECTRO-MECH. ACTUATOR	4	WORN EXCESS. - 33%	83	171	149	3	5	2470	1199	1376	68345	41007
OIL PUMP	2	LEAKING - 48%	71	197	191	2	124	1444	520	537	51259	827
HYD. ENG. STARTER	2	LEAKING - 75%	70	79	67	4	5	1465	1298	1530	25630	20504
BLEEDER VALVE	2	MISSING - 70%	44	51	44	--	7	2330	2010	2330	--	14645
CABLE ASSY.	2	WORN EXCESS. - 43%	34	35	34	--	--	3015	2929	3015	--	--

ILLUSTRATION 14

CH-47A, FG 03, POWER PLANT
WORST COMPONENT MAINTAINABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

		QUANTITY OF TYPE MMH					MMH PER					
COMPONENT	QTY/ ACFT	TOTAL	CORRECT	REPLACE	REPAIR	PREVENT	10,000 FLIGHT HOURS	ANY MA	CORRECT MA	REPLACE MA	REPAIR MA	PREVENT MA
POWER PLANT	2	17059.7	7499.0	10366.2	1438.4	4969.2	1664.1	17.2	23.4	23.4	23.2	16.2
EXHAUST CONE	2	6767.0	1671.5	215.2	1437.8	4866.7	660.1	5.4	10.5	3.2	18.2	7.2
FUEL CONTROL VALVE	2	2671.5	2029.4	2623.0	--	573.2	260.6	6.2	6.1	6.2	--	6.1
OIL PUMP	2	1863.6	656.4	1795.4	0.6	1165.6	181.8	9.5	9.3	9.4	0.3	9.4
ELECTRO-MECH ACTUATOR	4	753.1	374.0	536.4	20.0	4.7	36.7	4.4	4.5	3.6	6.7	0.9
HYD. ENG. STARTER	2	448.6	405.9	345.1	43.5	20.0	43.8	5.7	5.8	5.2	10.9	4.0
GENERATOR	2	405.9	346.9	329.9	9.0	47.0	39.6	3.3	3.1	3.0	9.0	5.9
ENG. LINK ASSY.	2	375.9	373.9	373.9	--	--	36.6	3.2	3.1	3.2	--	--
BLEEDER VALVE	2	168.2	167.2	167.2	--	1.0	16.4	3.3	3.8	3.8	--	0.1
WIRING HARNESS	6	152.2	134.4	134.4	--	17.8	5.0	8.0	11.2	11.2	--	2.5

ILLUSTRATION 15

CH-47A, FG 04, ROTORS & XMSNS
WORST COMPONENT RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

			QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
HOSE ASSY, XMSN LUB SYS	4	LEAKING - 41%	866	870	846	20	4	237	236	242	10252	51259
SIGHT CUP, OIL	6	BROKEN - 83%	529	529	522	2	--	581	581	589	153777	--
MOUNT, RESILIENT	4	BROKEN - 69%	419	419	415	--	--	489	489	494	--	--
HEAD ASSY PLAIN SEAL - FWD, AFT	36	LEAKING - 86%	409	452	449	1	--	4512	4083	4110	1845324	--
HEAD CONTROLS BEARING SELF-ALIN.	4	WORN EXCESS. - 93%	290	305	305	--	--	707	672	672	--	--
XMSN ENGINE	2	WORN EXCESS. - 14%	263	456	420	2	201	390	225	244	51259	510
SLEEVE BUSHING	4	WORN EXCESS. - 90%	222	222	222	--	--	924	924	924	--	--
BLADE ASSY, FWD	3	BROKEN - 23%	213	749	596	7	285	722	205	258	21968	540
XMSN SHAFT	2	EXC. VIBRATION - 10%	209	265	249	--	65	491	387	412	--	1577
SHAFT ASSY	7	COLLAPSED - 51%	190	482	442	--	1	1888	744	812	--	358813
FLUTTER DAMPNER	6	LEAKING - 49%	187	207	183	--	1	1645	1486	1681	--	307554
BEARING	6	WORN EXCESS. - 92%	180	187	187	--	--	1709	1645	1645	--	--
BLADE ASSY, AFT	3	BROKEN - 26%	166	852	672	2	482	926	181	229	76889	380
BOOT ASSY, WEATHER	6	BROKEN - 51%	145	146	145	--	--	2121	2107	2121	--	--
ROD END BEARING	6	WORN EXCESS. - 95%	137	142	142	--	--	2245	2166	2166	--	--

ILLUSTRATION 16

CH-47A, FG 04, ROTORS & XMSNS (CONT'D)
WORST COMPONENT RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
			CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
PLASTIC TUBING	6	BROKEN - 54%	116	116	115	--	--	2651	2651	2674	--	--
SELF ALIN BEARING, DMPNR	6	WORN EXCESS. - 94%	104	104	104	--	--	2957	2957	2957	--	--
NUT SELF-LOCK	8	WORN EXCESS. - 87%	61	113	89	--	24	6722	3629	4608	--	17086
TRANSDUCER, XMSN LUB SYS	5	NOT DETERMINED - 43%	60	106	106	--	--	4272	2418	2418	--	--
FLAT WASHER	18	WORN EXCESS. - 67%	56	56	56	--	--	16476	16476	16476	--	--
SEAL, XMSN AFT ROTOR	3	LEAKING - 71%	56	56	56	--	--	2746	2746	2746	--	--
BUSHING, SWASHPLATE	8	NO DATA	53	54	42	9	1	7737	7594	9764	45564	410072
ADAPTER ASSY, FWD DRIVE	1	COLLAPSED - 33%	52	82	78	--	44	986	625	657	--	1165
GENERATOR	2	NOT DETERMINED - 55%	51	149	140	1	1	2010	688	732	102518	102518
ARM ASSY, HEAD CONTROL	2	WORN EXCESS. - 52%	48	157	154	--	103	2136	653	665	--	995

ILLUSTRATION 17

CH-47A, FC 04, ROTORS & XMSNS
WORST COMPONENT MAINTAINABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

COMPONENT	QTY/ ACFT	QUANTITY OF TYPE MMH					MMH PER					
		TOTAL	CORRECT	REPLACE	REPAIR	PREVENT	10,000 FLIGHT HOURS	ANY MA	CORRECT MA	REPLACE MA	REPAIR MA	PREVENT MA
XMSN ASSY, FWD ROTOR	1	5961.5	1469.2	5583.6	123.5	2245.0	1163.0	43.5	35.8	51.7	9.5	40.8
BLADE ASSY, AFT	3	5772.3	762.0	3864.0	18.0	3394.7	375.4	7.9	7.3	7.0	9.0	7.0
BLADE ASSY, FWD	3	5669.6	1407.3	3635.6	126.0	1913.3	368.7	7.6	6.6	6.1	18.0	6.7
XMSN ASSY, AFT ROTOR	1	5444.3	1079.8	5080.8	223.2	3286.3	1062.1	42.5	31.8	58.4	24.8	44.4
HEAD ASSY, FWD	1	3671.5	832.3	3444.0	--	2034.0	716.3	25.0	28.7	28.7	--	24.8
SHAFT ASSY	7	3544.6	10.0	3241.2	--	20.0	98.8	7.4	0.1	7.3	--	20.0
LINK ASSY	6	3010.8	--	2550.2	--	18.0	97.9	8.6	--	8.3	--	3.0
XMSN ASSY, ENGINE	2	2709.1	640.1	2352.0	1.7	1105.8	264.3	5.9	5.5	5.6	0.9	5.5
XMSN ASSY, COMBINING	1	2301.0	434.9	1990.0	3.0	963.3	448.9	19.2	15.5	19.9	1.0	19.3
SWASHPLATE, AFT	1	2162.5	653.4	2138.4	--	1128.7	421.9	19.3	19.8	19.8	--	19.5
SWASHPLATE, FWD	1	2080.6	345.1	2070.6	--	1258.6	405.9	20.0	20.3	20.3	--	20.3
HOSE ASSY, XMSN LUB. SYS.	4	2044.4	2040.4	2030.4	10.0	4.0	99.7	2.4	2.4	2.4	0.5	1.0
SHAFT ASSY, AFT XMSN TO RTR	1	1931.2	525.6	1927.2	--	1109.6	376.8	28.8	29.2	29.2	--	29.2
PLAIN SEAL - FWD & AFT	36	1758.8	1591.2	1751.5	1.8	--	9.5	3.9	3.9	3.9	1.8	--
HEAD ASSY, AFT	1	1715.5	364.5	1606.5	--	1053.0	334.7	14.0	13.5	13.5	--	13.5

ILLUSTRATION 18

CH-47A, FG 04, ROTORS & XMSNS (CONT'D)
WORST COMPONENT MAINTAINABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

		QUANTITY OF TYPE MMH					MMH PER					
COMPONENT	QTY/ ACFT	TOTAL	CORRECT	REPLACE	REPAIR	PREVENT	10,000 FLIGHT HOURS	ANY MA	CORRECT MA	REPLACE MA	REPAIR MA	PREVENT MA
MOUNT RESILENT. SYNC. DR.	4	1459.3	1459.3	1452.5	--	--	71.2	3.5	3.5	3.5	--	--
COLLAR ASSY, HEAD CONTROLS	2	1339.0	154.5	1339.0	--	1122.7	130.6	10.3	10.3	10.3	--	10.3
GENERATOR	2	1283.6	453.3	1238.6	1.0	4.0	125.2	8.6	8.9	8.6	1.0	4.0
XMSN SHAFT	2	1179.1	624.8	1095.6	--	282.6	115.0	4.5	4.4	4.4	--	4.4
SPRING PACK	6	1154.6	528.5	1051.3	16.8	37.5	37.5	48.1	88.1	105.1	2.8	6.3

ILLUSTRATION 20

CH-47A, FG 06, HYDRAULIC SYSTEM
WORST COMPONENT MAINTAINABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

		QUANTITY OF TYPE MMH					MMH PER					
COMPONENT	QTY/ ACFT	TOTAL	CORRECT	REPLACE	REPAIR	PREVENT	10,000 FLIGHT HOURS	ANY MA	CORRECT MA	REPLACE MA	REPAIR MA	PREVENT MA
HYDRAULIC SERVOCYLINDER	21	4654.0	3709.5	4588.0	6	--	43.2	9.3	9.3	9.3	6.0	--
SAFETY RELIEF VALVE	17	701.6	528.0	693.6	--	8.0	8.1	6.7	6.8	6.7	--	8.0
HYDRAULIC ACCUMULATOR	1	559.5	485.7	491.4	20.6	32.5	109.2	3.8	3.8	3.7	10.3	5.4
HYDRAULIC MOTOR	1	347.8	315.5	347.8	--	--	67.9	7.1	7.2	7.1	--	--
FILTER, FLUID PRESSURE	2	325.0	322.0	322.0	--	1.0	31.7	2.5	2.6	2.6	--	1.0
HYDRAULIC GEAR BOX MOTOR	1	295.6	232.9	265.0	3.6	2.0	97.7	5.0	5.2	5.3	1.8	.7
PUMP	1	269.4	269.4	262.4	3.0	--	52.6	3.3	1.1	3.2	1.5	--
ANGLE VALVE	17	257.6	148.8	128.5	20.8	13.3	3.0	3.0	2.2	2.4	3.0	1.0
ACTUATOR	1	255.8	167.3	129.0	35.3	4.5	50.0	9.1	9.3	10.3	8.8	.8
CHECK VALVE	20	203.2	179.8	200.2	--	3.0	2.0	2.5	2.5	2.5	--	1.0

ILLUSTRATION 21

CH-47A, FG 08, INSTRUMENTS
WORST COMPONENT RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
			CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
ATTITUDE INDICATOR	1	BURNED - 58%	50	71	65	--	3	1025	772	789	----	17086
CLOCK	1	BROKEN - 63%	47	73	58	2	11	1091	702	884	25630	4660
ROTARY OIL PRESSURE SWITCH	1	BURNED - 47%	37	53	53	--	--	1385	967	967	----	---
TORQUEMETER INDICATOR	1	INT FAILURE - 55%	30	36	26	1	5	1709	1424	1972	51259	10252
AIR SPEED INDICATOR	1	INT ADJUST - 37%	27	54	33	2	15	1899	949	1553	25630	3417
TURN & SLIP INDICATOR	1	INT FAILURE - 55%	26	87	62	1	13	1972	589	827	51259	3943
ANSW OIL PRESSURE INDICATOR	1	BURNED - 58%	25	40	37	--	2	2050	1282	1385	----	25630
PITOT TUBE	1	BROKEN - 41%	24	42	16	6	14	2136	1221	3204	8543	3661
COURSE INDICATOR	1	BROKEN - 46%	24	37	26	2	3	2136	1385	1972	25630	17086
PRESSURE ALTIMETER	1	INT ADJUST - 50%	20	21	18	--	--	2563	2441	2848	----	---

ILLUSTRATION 23

CH-47A, FG 09, ELECTRICAL SYSTEM
WORST COMPONENT RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

			QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
ELECTRICAL HARNESS	2	NO DATA	322	343	110	205	92	318	299	932	500	1114
LAMP	2	BURNED - 47.7%	222	222	221	1	--	462	462	464	102518	--
LIGHT	1	BURNED - 47.1%	85	87	84	1	--	603	589	633	51259	--
CONTROL BOX	1	MISSING - 100.0%	81	95	69	12	10	633	540	743	4272	5126
SWITCH	2	NO DATA	79	96	65	10	14	1298	1068	1578	10252	7323
RELAY	6	NO DATA	59	77	134	72	77	5213	3994	2295	4272	3994
LAMP	2	BURNED - 64.3%	56	56	51	1	56	1831	1831	2010	102518	1831
LIGHT	2	BROKEN - 37.9%	53	53	50	3	--	1934	1934	2050	34173	--
PANEL	1	BURNED - 58.5%	50	105	98	--	6	1025	488	523	--	8543
LAMP	1	BURNED - 53.8%	44	44	44	--	--	1165	1165	1165	--	--
VOLTAGE REGULATOR	4	BURNED - 100.0%	34	57	56	--	--	6030	3587	3662	--	--
LENS	3	NO DATA	34	39	21	13	5	4523	3943	7323	11829	30755
HOSE	2	BROKEN - 71.4%	33	35	33	--	2	3107	2929	3107	--	51252
LIGHT	1	BURNED - 70.0%	30	38	34	2	2	1709	1349	1508	25630	25630

ILLUSTRATION 24

CH-47A, FG 09, ELECTRICAL SYSTEM
WORST COMPONENT MAINTAINABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

		QUANTITY OF TYPE MMH					MMH PER					
COMPONENT	QTY/ ACFT	TOTAL	CORRECT	REPLACE	REPAIR	PREVENT	10,000 FLIGHT HOURS	ANY MA	CORRECT MA	REPLACE MA	REPAIR MA	PREVENT MA
HARNESS	2	870.7	801.1	154.0	623.1	67.6	84.9	2.5	2.5	1.4	3.0	0.7
BATTERY	1	788.1	33.4	20.4	13.1	737.4	153.8	3.9	1.2	0.7	2.6	4.6
LIGHT	2	498.4	200.5	134.0	214.5	99.3	48.6	1.7	1.2	1.0	3.0	1.3
LIGHT	1	254.2	249.2	252.0	1.0	--	49.6	2.9	2.9	3.0	1.0	--
RELAY	1	225.0	206.7	216.0	1.0	8.0	43.9	7.5	8.3	8.6	1.0	2.0
SWITCH	2	191.2	176.7	136.0	13.8	11.0	37.3	2.0	2.2	2.1	1.4	0.8
RELAY	6	189.4	175.9	134.2	34.7	9.5	36.9	2.5	3.0	3.0	3.5	0.6
VOLTAGE REGULATOR	4	141.9	84.3	141.4	--	--	6.9	2.5	2.5	2.5	--	--
RELAY	1	121.0	37.1	48.0	--	63.0	23.6	6.4	2.7	2.5	--	0.8

ILLUSTRATION 25

CH-47A, FC 10, FUEL SYSTEM
WORST COMPONENT RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

			QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
RUBBER HOSE ASSY	11	OUT OF ADJUSTMENT - 37%	91	134	87	4	43	6196	4208	6481	140962	13113
SEAL	22	LEAKING - 60%	77	77	77	--	--	14645	14645	14645	--	--
AIRCRAFT GATE VALVE	1	LEAKING - 42%	27	29	25	2	2	1899	1768	2050	25630	25630
FUEL VALVE	1	DIRTY - 73%	23	26	10	16	--	2229	1972	5126	3204	--
DRAIN VALVE	6	DIRTY - 82%	22	27	--	21	5	13980	11391	--	14645	61511
SUBMERGED PUMP	2	LEAKING - 57%	17	31	31	--	--	6031	3307	3307	--	--
CAP & ADAPTER ASSY	1	BROKEN - 60%	16	16	16	--	--	3204	3204	3204	--	--
FUEL CELL	1	BROKEN - 100%	12	21	--	11	3	4272	2441	--	4660	17086

ILLUSTRATION 27

CH-47A, FG 11, FLIGHT CONTROL SYSTEM
WORST COMPONENT RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
			CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
ELECTROMECHANICAL ACTUATOR	1	WORN EXCESS - 50% BURNED - 50%	186	256	256	---	---	276	200	200	---	---
BELL CRANK ASSY, FWRD	1	BURNED - 76.6%	162	311	44	115	146	316	165	1165	446	351
HYD SERVOCYLINDER	3	LEAKING - 89.0%	158	191	190	---	---	973	805	809	---	---
BEARING, PLAIN, ROD END	2	WORN EXCESS - 71.4%	135	161	128	3	26	759	637	801	3417	3943
ACTUATING CYLINDER	1	LEAKING - 70.5%	114	213	121	5	80	450	241	423	1025	641
ELECTROMECHANICAL ACTUATOR	1	BURNED - 51.7%	108	140	125	4	4	475	366	410	1281	1281
MAGNETIC BRAKE ASSY	1	WORN EXCESS - 71.4%	84	103	98	---	1	610	498	523	----	51259
LINEAR ELECTROMECHANICAL	1	WORN EXCESS - 64.7%	83	113	112	---	---	618	454	458	----	----
HYD BRAKE CYLINDER	1	LEAKING - 90.4%	80	80	79	---	---	641	641	649	----	----
BUSHING, SLEEVE	2	WORN EXCESS - 90.2%	73	81	57	16	8	1404	1266	1799	6407	12815

ILLUSTRATION 29

CH-47A, FG 12, UTILITY SYSTEMS
WORST COMPONENT RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
			CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
RUBBER BUSHING	25	WORN EXCESS. - 56%	171	175	171	--	4	7494	22426	7494	--	320369
SENSING ELEMENT FIRE DETECTION SYSTEM	3	BROKEN - 46%	121	121	121	--	--	1271	424	424	--	--
GASKET FUEL CONTROL	4	NOT DETERMINED - 43%	36	36	33	--	--	5696	14239	1553	--	--
AIRCRAFT HEATER ASSY.	1	ADJUSTMENT IMPROPER - 33%	24	54	14	13	22	2136	51313	3661	3943	2330
AIR CONDITIONING AND HEATER DUCT	9	BROKEN - 60%	22	44	4	18	22	20970	10485	3	30	70
CLAMP, FIRE DETECTION SYSTEM	25	CHAFED - 67%	18	27	27	--	--	71193	47462	47462	--	--
CLAMP, HOSE, HEATER INSTALLATION	2	BROKEN - 57%	14	18	13	1	4	7323	5695	7886	10252	25630
FAN, VANEAXIAL, HEATER INSTALLATION	1	BURNED - 50%	12	13	12	--	1	4272	3943	4272	--	51259
SHELL ASSY, FAIRING INDUCTION SYSTEM INSTALLATION	1	BROKEN - 63%	10	16	15	--	--	5126	3204	3417	--	--
LEAD ASSY, SHIELDED/ HEATER INSTALLATION	1	WORN EXCESS. - 40%	10	10	10	--	--	5126	5126	5126	--	--
SHELL AND INSERT SENSING ELEMENT	1	BURNED - 33%	10	15	15	--	--	5126	3417	3417	--	--
HOSE, AIR DUCT--INDUCTION SYSTEM INSTALLATION	1	BROKEN - 22%	9	12	5	3	2	5695	4272	10252	17086	25630
BAND, RETAINER	1	MISSING - 50%	9	9	9	--	--	5695	5695	5695	--	--

ILLUSTRATION 30

CH-47A, FG 12, UTILITY SYSTEMS
WORST COMPONENT MAINTAINABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

COMPONENT	QTY/ ACFT	QUANTITY OF TYPE MMH					MMH PER					
		TOTAL	CORRECT	REPLACE	REPAIR	PREVENT	10,000 FLIGHT HOURS	ANY MA	CORRECT MA	REPLACE MA	REPAIR MA	PREVENT MA
SENSING ELEMENT, FIRE DETECTION SYSTEM	3	326.7	326.7	326.7	---	---	21.30	2.7	2.7	2.7	---	---
AIRCRAFT HEATER ASSY	1	227.1	124.8	107.3	91.0	81.1	44.30	4.2	5.2	7.7	7.0	3.7
DIFFUSER, AIR	1	137.6	127.5	24.6	106.8	6.2	26.80	2.5	3.4	3.1	3.5	0.5
BASKET--FUEL CONTROL	4	121.8	121.8	111.8	---	---	5.94	3.4	3.4	3.4	---	---
ACFT/FIRE EXTINGUISHER	4	103.9	7.5	81.6	.6	5.9	5.07	5.6	2.5	2.0	.2	.3
BUSHING, RUBBER	25	29.8	28.8	28.8	---	1.0	0.23	0.2	0.2	0.2	---	0.2
DUCT, AIR COND, HEATER	9	18.2	14.9	3.2	11.7	3.3	.39	.4	.7	.8	.7	.2
TUBE, ASSY, METAL	5	16.5	15.7	9.6	6.1	.8	.64	0.7	.9	1.9	.5	.1
CLAMP, BASE HEATER INSTALLATION	2	14.9	14.7	7.7	7.0	.2	1.45	.8	1.1	.6	7.0	.1

ILLUSTRATION 31

CH-47A, FG 17, CARGO & HANDLING
WORST COMPONENT RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
			CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
CARGO HOIST HOOK	1	BROKEN & MISSING - 45%	56	107	45	25	30	915	479	1139	2050	1709
RETAINER STRAP ASSY	1	BROKEN - 76.5%	18	18	17	---	1	2848	2848	3015	----	51259
COVER ASSY, L.H.	1	BROKEN - 90.0%	12	12	10	---	---	4272	4272	5126	----	-----
WINCH CABLE ASSY	1	BROKEN - 70.0%	10	10	10	---	---	5126	5126	5126	----	-----
RESCUE & CARGO WINCH ASSY	1	BROKEN - 28.6%	9	17	6	1	5	5695	3015	8543	51259	10252
EXTERNAL CARGO GUARD ASSY	1	BROKEN - 85.7%	7	7	7	---	---	7323	7323	7323	-----	-----
CARRIAGE ASSY SIDE PLATE	2	WORN EXCESSIVE - 50.0%	7	7	6	1	---	3661	3661	4272	25630	----
BEAM TRACK	1	WORN EXCESSIVE - 66.7%	6	6	6	---	---	8543	8543	8543		-----

ILLUSTRATION 32

CH-47A, FC 17, CARGO & HANDLING
WORST COMPONENT MAINTAINABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

		QUANTITY OF TYPE MMH					MMH PER					
COMPONENT	QTY/ ACFT	TOTAL	CORRECT	REPLACE	REPAIR	PREVENT	10,000 FLIGHT HOURS	ANY MA	CORRECT MA	REPLACE MA	REPAIR MA	PREVENT MA
CARGO HOIST HOOK	1	319.9	251.1	175.6	62.5	42.9	62.4	3.0	4.5	3.9	2.5	1.4
WINCH CABLE ASSY	1	94.0	94.0	94.0	--	--	18.3	9.4	9.4	9.4	--	--
COVER ASSY - LH	1	64.2	64.2	63.0	--	--	12.5	5.4	5.4	6.3	--	--
CARGO & RESCIE WINCH ASSY	1	61.4	32.6	18.0	5.0	2.3	12.0	3.6	3.6	3.0	5.0	0.5
HOIST BRACKET	1	49.1	49.1	0.2	48.9	--	9.6	12.3	12.3	0.2	16.3	--
SPEED CENTRAL SWITCH	1	35.0	--	--	--	35.0	6.8	35.0	--	--	--	35.0
CARRIAGE ASSY CARGO	1	30.4	30.4	30.4	--	--	5.9	7.6	7.6	7.6	--	--
BEAM TRACK	1	26.4	26.4	26.4	--	--	5.2	4.4	4.4	4.4	--	--
EXTERNAL CARGO GUARD ASSY	1	23.8	23.8	23.8	--	--	4.6	3.4	3.4	3.4	--	--

ILLUSTRATION 33

CH-47A, FG 18, AUXILIARY POWER UNIT
WORST COMPONENT RELIABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

COMPONENT	QTY/ ACFT	DOMINANT REASON FOR CORRECTIVE ACTION & % OF TOTAL	QUANTITY OF TYPE MAINT ACTION					MEAN TIME BETWEEN TYPE ACTION				
			CORRECT	ANY	REPLACE	REPAIR	PREVENT	CORRECT	ANY	REPLACE	REPAIR	PREVENT
APU GAS TURBINE ENGINE	1	NOT DETERMINED - 46% LEAKING - 19% BROKEN - 14%	214	307	290	--	89	240	167	177	--	576
HYDRAULIC MOTOR PUMP	1	LEAKING - 48%	48	52	48	--	1	1067	986	1068	--	51259
ENGINE AIR HOSE DUCT	1	COLLAPSED - 50%	10	11	10	--	--	5126	4660	5126	--	--
CONNECTING LINK ASSY.	1	WORN EXCESS. - 90%	9	10	9	--	--	5695	5126	5695	--	--
HOSE CLAMP	2	WORN EXCESS. - 60%	7	7	7	--	--	14645	14645	14645	--	--

ILLUSTRATION 34

CH-47A, FG 18, AUXILIARY POWER UNIT
WORST COMPONENT MAINTAINABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

		QUANTITY OF TYPE MMH					MMH PER					
COMPONENT	QTY/ ACFT	TOTAL	CORRECT	REPLACE	REPAIR	PREVENT	10,000 FLIGHT HOURS	ANY MA	CORRECT MA	REPLACE MA	REPAIR MA	PREVENT MA
APU GAS TURBINE ENGINE	1	2349.2	1619.2	2175.0	--	621.5	458.3	7.8	7.6	7.5	--	6.9
HYDRAULIC MOTOR PUMP	1	419.8	386.1	394.8	--	8.0	81.9	8.1	8.0	8.2	--	8.0
ENGINE AIR HOSE DUCT	1	38.5	34.6	36.5	--	--	7.5	3.5	3.5	3.7	--	--
CONNECTING LINK ASSY.	1	35.5	32.0	25.5	--	--	6.9	1.4	5.2	--	5.2	1.0
GEAR SHIFT SPOR	1	28.0	28.0	28.0	--	--	5.5	9.3	9.3	9.3	--	--

ILLUSTRATION 36

CH-47A, FG 19, AVIONICS
WORST COMPONENT MAINTAINABILITY CHARACTERISTICS
PERIOD OF DATA APRIL 71 THRU MARCH 73

		QUANTITY OF TYPE MMH					MMH PER					
COMPONENT	QTY/ ACFT	TOTAL	CORRECT	REPLACE	REPAIR	PREVENT	10,000 FLIGHT HOURS	ANY MA	CORRECT MA	REPLACE MA	REPAIR MA	PREVENT MA
SAS AMPLIFIER	2	935.2	454.4	104.2	83.7	349.2	182.5	2.0	2.6	1.7	2.8	1.5
RADIO	1	691.0	433.4	31.9	195.7	13.1	123.1	4.2	4.6	1.5	6.1	0.3
VHF-FM RADIOS	1	345.1	166.3	18.9	213.0	92.5	67.3	3.1	6.7	1.0	23.7	1.2
INTERCOM	6	296.8	120.9	11.4	88.3	121.6	9.7	17.0	19.6	5.7	23.0	13.0
RT-7-12/ARC 51BX RCVR/XMTR	1	279.2	39.7	139.1	16.0	125.5	54.5	1.2	1.4	1.3	5.3	1.0
RT-348/ARC 54 RCVR/XMTR	1	227.8	125.3	144.5	20.0	81.0	44.4	0.9	1.1	1.0	2.5	0.9
CN-811/ASN DISPLACEMENT GYRO	1	137.7	100.7	87.2	12.5	24.8	26.9	1.1	1.1	1.1	4.2	1.1
C-1611/AIC COMM C	6	128.4	61.3	55.9	51.0	18.8	4.2	10.1	14.7	11.2	23.5	3.9
UHF/AM RADIOS	1	117.1	56.7	19.6	36.0	31.1	22.9	1.7	2.6	2.0	3.3	0.9

FIELD OPERATING COST ANALYSIS (FOCA)

FOCA is a part of the Army's overall program of assessing and reducing Army aircraft life cycle costs. Specifically, the purpose of FOCA is to determine the cost per flight hour of parts consumption and maintenance manhours at organization, direct, and general support levels of maintenance for first line Army aircraft fleets.

Weapon/Support Systems Cost Categories and Elements, AR 37-18, defines "Operating Costs" as "those direct costs resulting from the operation, maintenance, and consumption of materials and supplies for a weapon/support system after acceptance into the Army inventory." It also establishes weapon/support life cycle cost structures, elements, and categories to be used by DA Cost Analysis activities.

A computer model was developed which utilizes the Army Maintenance Management System (TAMMS) data submitted per TM 38-750, on reported maintenance actions and maintenance manhours and an adjusted flight hour base determined from TAMMS data validation techniques. The outputs of the model are two elements of field operation cost, maintenance manhour cost, and parts consumption cost per flight hour. These in turn are broken down further as follows:

a. Parts consumption is displayed in terms of Procurement of Equipment and Missiles Army (PEMA) Fund vs. Stock Fund and New vs. Overhauled Parts. A consumption ratio of 10% new parts to 90% overhauled parts was used where overhaul was applicable. The component costs were taken from the master data record and were the most recent new cost or overhaul cost paid for a particular federal stock number. Only those parts consumed at organization, direct, and general support maintenance that could be charged against a specific serial number of aircraft are included, i.e., bench replacement or off the aircraft replacement are not included.

b. Maintenance manhour cost was calculated from a rate of $11.60 per manhour. All maintenance manhours reported were used. Included in the manhour count are both scheduled and unscheduled manhours. Again, bench repair or off the aircraft repair manhours are not included in the maintenance manhour totals.

The computer model utilizes the RAMMIT Work Unit Code (WUC) system to determine parts consumption and maintenance manhours down to the lowest part level, and these amounts are then accumulated successively to higher levels of indenture within the aircraft system functional breakdown.

This fleet accumulated 68,778 flight hours during the period (April 1971 - March 1973) that this data was taken. However, as a result of various editing techniques used on the data an acceptable base of

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51,259 flight hours was determined. The size of the fleet at the beginning of the data period was 250 aircraft and at the end of the data period it was 173 aircraft.

Illustration 1 presents the CH-47A two year parts consumption and maintenance manhour dollars.

Illustration 2 summarizes the parts consumption and maintenance manhour dollars determined for the total aircraft system.

Illustration 3 shows organization, direct, and general support parts replacement cost per flight hour for the total system, end item aircraft, and functional groups. A breakdown into PEMA and Stock Fund replacement cost per flight hours is provided in addition to an overhaul and new part replacement cost per flight hour. Also shown are total manhour expenditure, total number of parts replaced and total manhour cost per flight hour for the total system end item aircraft and each functional group.

Illustrations 4, 5, and 6 list the thirty most expensive items from all functional groups.

Illustrations 7 thru 20 list the most expensive components within each functional group. Functional Groups 00, Miscellaneous, and 30, Armament were purposely excluded.

The parameters utilized in the above illustrations are defined and presented as follows for the end item aircraft, its functional group, and selected components:

Stock Fund, PEMA, New Item, and Overhaul Costs are those taken directly from the computer model.

Total Cost Per Flight Hour = (Total Parts Cost + Maintenance Manhour Cost) ÷ Flight Hour Base of 51259.

Maintenance Manhour Cost = (Maintenance Manhour X 11.60 (labor rate) ÷ Flight Hour Base of 51259.

Maintenance Manhour = Maintenance time utilized to perform all reported maintenance actions on the aircraft.

The data base from which the above parameters were generated is obtained from the maintenance action file that originates from DA Forms 2407, 2408-3, and 2410, which are submitted in accordance with TM 38-750.

ILLUSTRATION 1

CH-47A PARTS CONSUMPTION & MAINTENANCE MANHOUR DOLLAR
PERIOD APRIL 1971 THRU MARCH 1973

EST 2 YR PARTS & MMH $ = 68.9 MILLION

DURING PERIOD:

PARTS & MMH $/FLIGHT HOUR = 1001.439

AVG FLEET SIZE = 211 ACFT

% OPERATIONALLY ASSIGNED = 60

NUMBER OF HOURS FLOWN = 68,778

AVG USAGE RATE/MONTH = 22.6 FLIGHT HOURS

ILLUSTRATION 2

CH-47A

FIELD OPERATING COSTS

SUMMARY OF COST COMPUTATIONS

A. PARTS CONSUMPTION:

$828.063 PER FHR

1. FUND TYPE BREAKDOWN

STOCK ----$116.536

PEMA -----$711.527

2. NEW VS. OVERHAUL BREAKDOWN

NEW ---------$393.36

OVERHAUL ----$434.704

B. MANHOUR EXPENDITURE:*

$173.347 PER FHR

TASK BREAKDOWN:

REPLACE----$39.12

REPAIR ----$19.07

OTHER----$115.16

*BASED ON $11.60/HR LABOR RATE

ILLUSTRATION 3

CH-47A FIELD OPERATING COST ORG, DS & GS UNITS
COMPONENT REPLACEMENT & MMH $/FH
PERIOD OF DATA APRIL 1971 THRU MARCH 1973

	COST PER FLIGHT HOUR								
FUNCTIONAL GROUPS (FG) END ITEM AND TOTAL SYSTEMS	TOTAL	TOTAL PARTS	STOCK FUND	PEMA	NEW ITEM	OVHL	MMH	NO. OF REPL	NO. OF MMH
FG 00 MISC	27.088	14.148	12.236	1.912	14.148	----	12.940	12,204	57,179.3
FG 01 AIRFRAME	47.111	27.309	27.309	----	27.309	----	19.803	7.947	87,508.6
FG 02 LNDG GEAR	13.259	11.104	6.873	4.231	11.049	0.055	2.155	2,016	9,520.3
FG 03 POWER PLANT	274.983	268.376	6.020	261.008	80.510	186.518	7.955	2,588	35,152.5
FG 04 ROTORS & XMSNS	403.776	381.295	18.585	362.710	155.081	226.214	22.481	11,883	99,340.7
FG 06 HYDRAULIC SYS	22.465	18.733	8.710	10.023	11.682	7.051	3.732	3,985	16,493.2
FG 08 INSTRUMENTS	5.510	4.870	3.990	0.880	4.870	----	0.640	739	2,840.0
FG 09 ELECTRICAL	10.610	7.520	8.435	0.435	8.870	----	1.740	2,111	7,667.2
FG 10 FUEL SYS	1.398	0.539	0.539	----	0.539	----	0.859	567	3,799.0
FG 11 FLIGHT CONTROL	31.101	27.103	16.776	10.327	20.725	6.379	3.998	2,628	17,665.4
FG 12 UTILITY SYS	2.219	1.836	1.836	----	1.836	----	0.383	621	1,693.9
FG 17 CARGO & HANDLING	3.505	3.195	3.195	----	3.195	----	0.310	213	1,368.5
FG 18 AUX POWER UNIT	46.642	45.782	0.010	45.772	45.782	----	0.860	733	3,803.0
FG 19 AVIONICS	17.633	15.770	1.541	14.229	7.283	8.487	1.863	1,473	8,234.1
FG 20 ARMAMENT	0.190	0.061	0.061	----	0.061	----	0.129	25	571.5
END ITEM	93.919	0.420	0.420	----	0.420	----	93.499	89	413,161.9
TOTAL SYSTEMS	1001.439	828.063	116.536	711.527	393.36	434.704	173.347	49,578	765,999.2

ILLUSTRATION 4
CH-47A, TOTAL SYSTEMS
LARGEST COMPONENT FIELD OPERATING COST
PERIOD OF DATA APRIL 71 THRU MARCH 73

	$ COST PER FLIGHT HOUR								
COMPONENT	TOTAL	STOCK	PEMA	NEW	O/H	MMH	NO. OF REPLACE	NO. OF MMH	FROM PG
POWER PLANT	227.101	----	224.755	62.408	162.347	3.861	443	17059.7	03
BLADE ASSY, FWD	78.836	----	77.553	15.179	62.374	1.283	596	5669.6	04
BLADE ASSY, AFT	62.814	----	61.508	13.138	48.370	1.306	552	5772.3	04
XMSN ASSY, FWD	49.814	----	48.465	8.643	39.821	1.349	108	5961.5	04
GAS TURBINE POWER	44.445	----	43.914	43.914	----	.532	290	2349.2	18
XMSN ASSY, ENGINE	40.670	----	40.057	7.555	32.503	.613	420	2709.1	04
FUEL CONTROL VALVE	32.582	----	31.975	7.804	24.171	.605	421	2671.5	03
HEAD ASSY, FWD	31.684	----	30.853	6.503	24.350	.831	120	3671.5	04
XMSN ASSY, AFT	24.482	----	23.250	6.800	16.450	1.232	87	5444.3	04
HEAD ASSY, AFT	22.653	----	22.350	6.019	16.331	.388	119	1715.5	04
XMSN ASSY, COMBINE	12.219	----	11.698	3.621	8.077	.521	100	2301.0	04
HYDRAULIC SERVOCYLINDER	9.871	----	9.780	2.730	7.051	.091	504	5048.4	06
SWASHPLATE, AFT	7.879	----	7.390	.942	6.447	.489	108	2162.5	04
SHAFT ASSY, AFT ROTOR	6.328	----	.607	.553	.055	.082	442	3544.6	04
COWLING	5.810	5.105	----	5.105	----	.705	156	3115.1	01

ILLUSTRATION 6

CH-47A, TOTAL SYSTEMS
LARGEST COMPONENT FIELD OPERATING COST
PERIOD OF DATA APRIL 71 THRU MARCH 73

	$ COST PER FLIGHT HOUR								
COMPONENT	TOTAL	STOCK	PEMA	NEW	O/H	MMH	NO. OF REPLACE	NO. OF MMH	FROM FG
ELECT-MECH ACTUATOR	3.014	2.824	----	2.824	----	.189	181	825.2	11
HYD SERVOCYLINDER	2.970	----	2.764	2.764	----	.206	190	895.0	11

ILLUSTRATION 8
CH-47A, FG 02, ALIGHTING GEAR
LARGEST COMPONENT FIELD OPERATING COST
PERIOD OF DATA APRIL 71 THRU MARCH 73

	$ COST PER FLIGHT HOUR							
COMPONENT	TOTAL	STOCK	PEMA	NEW	O/H	MMH	NO. OF REPLACE	NO. OF MMH
LANDING SKID INSTL	3.972	---	3.952	3.952	---	.020	16	88.0
POWER STEERING ASSY	3.706	3.653	----	3.653	---	.053	42	229.3
SWIVEL HOUSING ASSY	.638	.601	----	.601	---	.038	7	164.1
SHOCK STRUT ASSY	.474	.452	----	.452	---	.022	5	94.5
SHOCK CYLINDER ASSY	.470	.464	----	.464	---	.006	8	28.0
DISC BRAKE	.339	.284	----	.284	---	.055	56	237.8
LANDING GEAR WHEEL	.188	.150	----	.150	---	.038	28	163.3
SWIVEL HOUSING	.181	.098	----	.098	---	.083	53	359.0
DISC BRAKE ASSY	.178	.091	----	.091	---	.088	50	381.1
BEARING	.169	.069	----	.069	---	.101	110	438.7
SHOCK STRUT ASSY	.101	.095	----	.095	---	.005	2	23.0
PNEUMATIC TIRE	.100	.032	----	.032	---	.068	105	294.3
LANDING GEAR INSTL	.097	.094	----	.094	---	.003	1	3.0
BRAKE LINING	.085	.005	----	.005	---	.080	110	347.8
POWER ACTUATOR ASSY	.063	.063	----	.063	---	.001	1	1.5

ILLUSTRATION 9

CH-47A, FG 03, POWER PLANT
LARGEST COMPONENT FIELD OPERATING COST
PERIOD OF DATA APRIL 71 THRU MARCH 73

	$ COST PER FLIGHT HOUR							
COMPONENT	TOTAL	STOCK	PEMA	NEW	O/H	MMH	NO. OF REPLACE	NO. OF MMH
POWER PLANT	227.101	---	224.755	62.408	162.347	3.861	443	17059.7
FUEL CONTROL VALVE	32.582	---	31.975	7.804	24.171	.605	421	2671.5
ELECTRO-MECH ACTUATOR	2.916	2.746	----	2.746	---	.170	149	753.1
OIL PUMP	2.181	1.759	----	1.759	---	.422	191	1863.6
HYD ENG STARTER	1.925	---	1.823	1.823	---	.102	67	448.6
EXHAUST CONE	1.906	.374	----	.374	---	1.531	68	6767.0
SERVO	.193	---	.188	.188	---	.005	6	23
ENG LINK ASSY	.165	.080	----	.080	---	.085	117	375.9
ENG SCREEN	.163	.136	----	.136	---	.030	5	131.0
GENERATOR	.156	.064	----	.064	---	.092	111	405.9

ILLUSTRATION 12

CH-47A, FG 06, HYDRAULIC SYSTEM
LARGEST COMPONENT FIELD OPERATING COST
PERIOD OF DATA APRIL 71 THRU MARCH 73

	$ COST PER FLIGHT HOUR							
COMPONENT	TOTAL	STOCK	PEMA	NEW	O/H	MMH	NO. OF REPLACE	NO. OF MMH
HYDRAULIC SERVOCYLINDER	9.871	----	9.780	2.730	7.051	.091	504	5048.4
HYDRAULIC GEAR BOX MOTOR	1.394	1.327	----	1.327	----	.068	50	295.6
HYDRAULIC MOTOR	.626	.546	----	.546	----	.080	49	347.8
SAFETY RELIEF VALVE	.445	.284	----	.284	----	.161	103	701.6
ACCUMULATOR	.353	.224	----	.224	----	.129	134	559.5
FLUID PRESSURE FILTER	.316	.242	----	.242	----	.075	126	325.0
HYDRAULIC SYSTEM MANIFOLD	.313	.281	----	.281	----	.031	36	136.5
CHECK VALVE	.290	.243	----	.243	----	.047	80	203.2
HYDRAULIC FLUID TANK	.285	.247	----	.247	----	.023	32	100.5
HOSE ASSY	.181	.074	----	.074	----	.107	298	464.4

ILLUSTRATION 13

CH-47A, FG 08, INSTRUMENTS
LARGEST COMPONENT FIELD OPERATING COST
PERIOD OF DATA APRIL 71 THRU MARCH 73

	$ COST PER FLIGHT HOUR							
COMPONENT	TOTAL	STOCK	PEMA	NEW	O/H	MMH	NO. OF REPLACE	NO. OF MMH
ATTITUDE INDICATOR	.998	.971	----	.971	---	.028	65	121.7
COURSE INDICATOR	.867	.042	.810	.851	---	.015	26	67.2
ROTARY OIL PRESSURE SWITCH	.477	.464	----	.464	---	.014	53	60.9
OIL PRESSURE INDICATOR	.303	.267	.025	.292	---	.011	37	47.7
LIQUID QUANTITY INDICATOR	.283	.272	----	.272	---	.011	20	48.1
TURN & SLIP INDICATOR	.233	.194	----	.194	---	.029	62	129.9
TORQUEMETER INDICATOR	.187	.134	----	.134	---	.053	26	233.8
TEMPERATURE INDICATOR	.177	.168	----	.168	---	.010	20	43.5
CLOCK	.175	.147	----	.147	---	.028	58	123.3

ILLUSTRATION 14
CH-47A, FG 09, ELECTRICAL SYSTEM
LARGEST COMPONENT FIELD OPERATING COST
PERIOD OF DATA APRIL 71 THRU MARCH 73

	$ COST PER FLIGHT HOUR							
COMPONENT	TOTAL	STOCK	PEMA	NEW	O/H	MMH	NO. OF REPLACE	NO. OF MMH
VOLTAGE REGULATOR PROTECTION PANEL	3.324	3.270	----	3.270	----	.054	98	239.3
VOLTAGE REGULATOR	.803	.771	----	.771	----	.032	56	141.9
RELAY ASSY	.755	.726	----	.726	----	.029	22	109.8
LIGHT	.581	.523	----	.523	----	.058	84	254.2
PACKING	.376	.345	----	.345	----	.031	113	134.2
CONTROL BOX	.329	----	.319	.319	----	.010	29	44.1
INVERTER	.318	.301	----	.301	----	.017	25	75.1
CONTROL BOX	.265	.207	.047	.254	----	.011	12	48.0
HARNESS	.240	.043	----	.043	----	.197	110	870.7
RELAY	.118	.067	----	.067	----	.051	25	225.0
LIGHT	.114	.001	----	.001	----	.113	134	498.4
RELAY	.114	.071	----	.071	----	.043	45	189.4
LIGHT	.103	.084	----	.084	----	.019	34	82.4
RELAY	.049	.022	----	.022	----	.027	15	121.0

ILLUSTRATION 16
CH-47A, FG 11, FLIGHT CONTROLS
LARGEST COMPONENT FIELD OPERATING COST
PERIOD OF DATA APRIL 71 THRU MARCH 73

	$ COST PER FLIGHT HOUR							
COMPONENT	TOTAL	STOCK	PEMA	NEW	O/H	MMH	NO. OF REPLACE	NO. OF MMH
ELCT-MECH ACTUATOR	4.656	---	4.382	.668	3.714	.274	256	1193.0
ACTUATING CYLINDER	3.029	2.745	----	2.745	---	.285	121	1238.0
ELCT-MECH ACTUATOR	3.014	2.824	----	2.824	---	.189	181	825.2
HYD SERVOCYLINDER	2.970	---	2.764	2.764	---	.206	190	895.0
LINEAR ELCT-MECH	1.428	1.279	----	1.279	---	.148	112	645.1
ELCT-MECH ACTUATOR	0.973	.956	----	.956	---	.017	125	729.1
MAGNETIC BRAKE ASSY	0.498	.411	----	.411	---	.087	98	377.2
HYD BRAKE CYL	0.470	.406	----	.406	---	.064	79	279.6
ELCT-MECH ACTUATOR	0.458	.444	----	.444	---	.014	17	60.9
CONTROL CABLE ASSY	0.212	.134	----	.134	---	.079	160	342.5
FWD BELL CRANK	0.203	.091	----	.091	---	.111	44	484.7
FUS BELL CRANK	0.169	.144	----	.144	---	.025	28	107.0
FLIGHT CONTROLS	0.145	.047	----	.047	---	.098	12	426.1
ROD END BEARINGS	0.141	.017	----	.017	---	.124	128	539.4
DAMPER VISCOUS	0.136	.062	----	.062	---	.074	28	321.0

ILLUSTRATION 17

CH-47A, FG 12, UTILITY SYSTEMS
LARGEST COMPONENT FIELD OPERATING COST
PERIOD OF DATA APRIL 71 THRU MARCH 73

	$ COST PER FLIGHT HOUR							
COMPONENT	TOTAL	STOCK	PEMA	NEW	O/H	MMH	NO. OF REPLACE	NO. OF MMH
AIRCRAFT HEATER	.366	.315	----	.315	----	.051	14	227.1
HEATER, FUEL CONTROL VALVE	.305	.277	----	.277	----	.028	33	121.8
SHELL ASSY, FAIRING	.294	.280	----	.280	----	.014	15	63.5
SENSING ELEMENT FIRE DETECTION SYSTEM	.210	.136	----	.136	----	.074	121	326.7
AIRCRAFT FIRE EXTINGUISHER	.169	.145	----	.145	----	.024	48	103.9
DIFFUSER, AIR	.079	.048	----	.048	----	.031	8	137.6
AIR CONDITIONING CARTRIDGE	.005	----	.001	.001	----	.004	8	18.8

ILLUSTRATION 18

CH-47A, FG 17, CARGO AND HANDLING
LARGEST COMPONENT FIELD OPERATING COST
PERIOD OF DATA APRIL 71 THRU MARCH 73

	$ COST PER FLIGHT HOUR							
COMPONENT	TOTAL	STOCK	PEMA	NEW	O/H	MMH	NO. OF REPLACE	NO. OF MMH
CARGO HOIST HOOK	2.834	2.761	----	2.761	----	0.073	45	319.9
WINCH CABLE ASSY.	0.035	0.014	----	0.014	----	0.021	10	94.0
CARGO CARRIAGE ASSY.	0.025	0.018	----	0.018	----	0.007	4	30.4
HOIST MOTOR	0.023	0.021	----	0.021	----	0.002	3	9.9
COVER ASSY.-LH	0.020	0.005	----	0.005	----	0.015	10	64.2

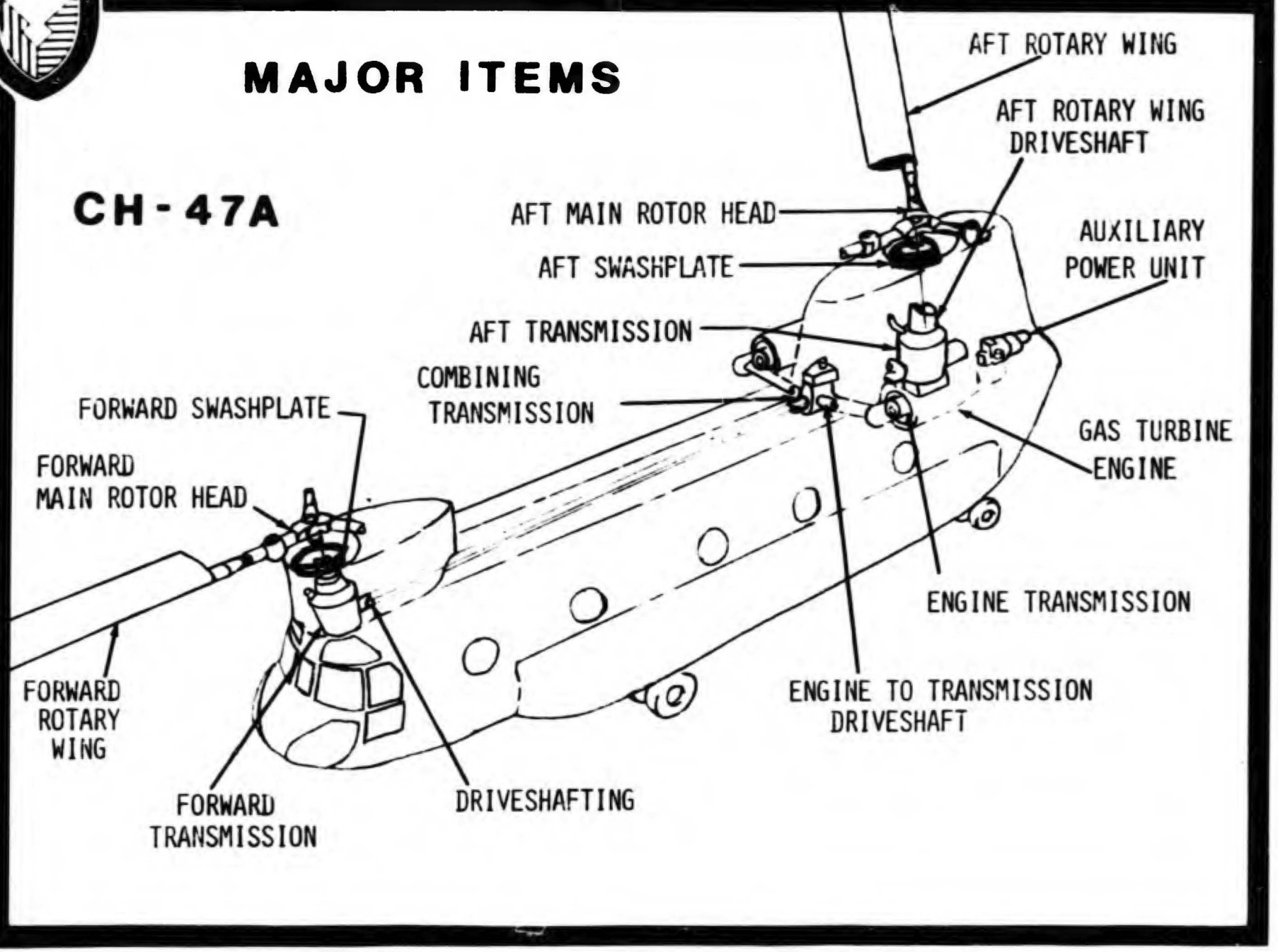
ILLUSTRATION 19

CH-47A, FG 18, AUX POWER UNIT
LARGEST COMPONENT FIELD OPERATING COST
PERIOD OF DATA APRIL 71 THRU MARCH 73

	$ COST PER FLIGHT HOUR							
COMPONENT	TOTAL	STOCK	PEMA	NEW	O/H	MMH	NO. OF REPLACE	NO. OF MMH
GAS TURBINE POWER	44.445	---	43.914	43.914	---	.532	290	2349.2
HYDRAULIC MOTOR PUMP	1.026	---	.931	.931	---	.095	48	419.8

MAJOR ITEMS

CH-47A



MAJOR ITEMS

All Time Between Overhaul (TBO) and finite life items (major items) that require historical data when used on Army aircraft are listed in Technical Bulletin, TB 55-1500-307-25.

The TAMMS data system, generated by the authority of TM 38-750, stipulates that such items requiring historical data be reported on DA Form 2410 for every installation or removal of the item from an aircraft. This does not include items that were removed and reinstalled on the same aircraft.

Illustrations 1 and 2 list the major items, the average operating hours at first removal of new items removed because of failure of the part, the dominant reason (failure mode) for removal and the percentage of all removals that were made for this reason.

Illustrations 3 and 4 present cost of operation data for the major items assuming first, that all replacements require new parts and, second, that all replacements are made with overhauled parts. The savings resulting from making the replacement with overhauled parts is shown. The frequency of replacement in this illustration is the average installed operating hours at removal for both new and overhauled parts and includes removals because of scheduled maintenance.

ILLUSTRATION 1
CH-47A MAJOR ITEMS
(TBO, FINITE LIFE & INTENSIVELY MANAGED ITEMS)
FIRST REMOVAL OF NEW ITEMS

NOUN	P/N	% REMOVED FOR IND FAIL MODE	AVG OPER HOURS	FAILURE MODE
SUBMERGED PUMP	114P41112	76.8	445	INTERNAL FAILURE
SERVOCYLINDER	114H400032	76.6	344	LEAKING
SERVOCYLINDER	114H400031	75.0	333	LEAKING
HYD ENG STARTER	EA10300703A	71.7	281	LEAKING
ALTERNATING GENERATOR	31220002	60.5	405	INTERNAL FAILURE
DRIVE ARM	114R34145	57.0	435	WORN EXCESSIVELY
AFT SWASHPLATE	114R33058	46.5	381	WORN EXCESSIVELY
TURBINE ENGINE	376880	42.3	193	INTERNAL FAILURE
ROTARY WING BLADE	114R100258	32.3	194	BROKEN
COMBINING TRANSMISSION	114D500118	31.5	452	WORN EXCESSIVELY
ELEC MECH ACTUATOR	114CS1141	30.1	477	INTERNAL FAILURE
ELEC MECH ACTUATOR	114CS1142	29.9	441	WORN EXCESSIVELY
ACTUATING CYLINDER	114H650014	27.3	481	LEAKING

DATA PERIOD: JAN 1, 1964 TO JULY 1, 1973

ILLUSTRATION 2

CH-47A MAJOR ITEMS (CONT'D)

(TBO, FINITE LIFE & INTENSIVELY MANAGED ITEMS)

FIRST REMOVAL OF NEW ITEMS

NOUN	P/N	% REMOVED FOR IND FAIL MODE	AVG OPER HOURS	FAILURE MODE
ROTARY WING BLADE	114R100228	26.6	332	CRACKED
ROTARY WING BLADE	114R100257	26.5	288	BROKEN
ROTARY WING BLADE	114R100242	26.1	234	BROKEN
AFT SHAFT	114D30706	26.0	556	VIBRATION EXCESSIVE
AFT SHAFT	114D30028	24.7	565	WORN EXCESSIVELY
SYNCHRO SHAFT	114D30487	22.4	632	SCORED
SHOCK ABSORBER	114R21004	21.3	324	INTERNAL FAILURE
FWD ROTARY HEAD	114R200113	20.8	375	LEAKING
TURBINE ENGINE	200003012	19.8	237	F.O.D.
ENGINE TRANSMISSION	114D600119	19.6	252	WORN EXCESSIVELY
SYNCHRO SHAFT	114D30721	17.4	748	VIBRATION EXCESSIVE
SYNCHRO SHAFT	114D30486	16.3	465	SCORED
AFT ROTARY HEAD	114R20022	15.6	362	LEAKING
ENGINE DRIVESHAFT	114D30031	15.6	401	VIBRATION EXCESSIVE

DATA PERIOD: JAN 1, 1964 TO JULY 1, 1973

FIELD SERVICE REPORTS

Field Service Reports (FSRs) consist of Maintenance Performance Reports (MPRs), Deficiency Information Reports (DIFs), and Manufacturer Field Service Reports (MFSRs). The MPRs and DIRs are the reports from the field prepared by Department of the Army civilian representatives. The MFSRs are reports from the field prepared by manufacturer's representatives. These reports are prepared and forwarded to AVSCOM for the purpose of informing AVSCOM of field deficiencies and/or problems relating to quality of design, fabrication and maintenance. Each report contains the date of occurrence, aircraft serial number, federal stock numbers and part numbers of deficient/problem items and type model series (TMS) of aircraft followed by a brief description of the problem.

The FSR program utilizes automated data processing to record, store and disseminate maintenance data from field activities and provides a historical data bank of all field problems for use as a management tool.

Illustration 1 presents a summary of problems reported through this data system.

Illustrations 2 thru 8 summarize the deficiencies observed within each functional group.

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ILLUSTRATION 1

CH-47A FIELD SERVICE REPORT SUMMARY
29 JAN 73 - 15 DEC 73

NUMBER OF REPORTS RECEIVED - 123

55.3% OF REPORTS WERE IN FUNCTIONAL GROUP 04 (ROTOR & TRANSMISSION SYSTEM).

28% INDICATED DETERIORATED PACKING IN THE AXIAL PISTON PUMP.

21% OF ISIS INDICATORS SHOWED AIR PRESSURE/INDICATOR MALFUNCTION.

20.3% OF REPORTS WERE IN FUNCTIONAL GROUP 03 (POWER PLANT)

NO ESTABLISHED TREND WAS INDICATED IN THESE REPORTS.

ILLUSTRATION 2

CH-47A DEFICIENCIES FROM FIELD SERVICE REPORTS

29 JAN 73 - 15 DEC 73

FUNCTIONAL GROUP	ITEM	PROBLEM
01 - AIRFRAME	FITTING	CRACKED
	ENGINE MOUNT PAD	COLLAPSED
02 - ALIGHTING GEAR	LINK ASSY	BROKEN DUE TO MISHANDLING
	SPACER	INTERNAL FAILURE
	WHEEL	EXTENSIVE WEAR
03 - POWER PLANT	INSERT	PULLED FROM MOUNT PAD
	STARTER	SPRAGUE CLUTCH DISINTEGRATED IN USE.
	ENGINE	HOLE BURNED IN STRUT ASSEMBLY
		LEAKING AIR
		BLEED BAND POPPED
		FOD
		DAMAGED COMPRESSOR BLADES
		CHIP DETECTOR LIGHT CAME ON
		BEARING FAILURE

ILLUSTRATION 3
CH-47A DEFICIENCIES FROM FIELD SERVICE REPORTS
29 JAN 73 - 15 DEC 73

FUNCTIONAL GROUP	ITEM	PROBLEM
03 - POWER PLANT (CONT'D)		COMPRESSOR SPACERS WORN
		DIFFUSER WORN FROM CHAFFING ON VANE ASSEMBLY
		ENGINE DISC ASSEMBLY (SPECIFIC NOT RECORDED)
		DIFFUSER HOUSING LEAKING (WELD AT F FITTING).
		STARTER HOUSING CORRODED
		ROTOR BEARING FAILURE
		SYNCRO TRANSMITTER FAILURE (INTERNAL)
		FUEL CONTROL (SPECIFIC NOT RECORDED)
		FUEL CONTROL OVERHEATING
		FUEL CONTROL FAILED INTERNAL
	ENGINE TURBINE	FOD DAMAGED COMPRESSOR SECTION
	ACTUATOR-ELECTRICAL	INTERMITTENT OPERATION
	GENERATOR-TACH	CONNECTOR PLUG RIVETS LOOSE

ILLUSTRATION 4
CH-47A DEFICIENCIES FROM FIELD SERVICE REPORTS
29 JAN 73 - 15 DEC 73

FUNCTIONAL GROUP	ITEM	PROBLEM
04 - ROTOR & XMSN SYS	MOUNT-RESILIENT	BROKEN
	PUMP-HYDRAULIC	OVERHEATED
	SEAL	LEAKING
	STRAINER	LUBE IN STRAINER
	XMSN	THREADS DAMAGED ON VERTICAL SHAFT
		SUSPECTED PLUG HAD FALLEN INTO TRANSMISSION
		METAL IN OIL
		GENERATOR DRIVE SHAFTS SHEARED (2 REPORTS)
		SLIDER ASSY DAMAGED
		PLATE RETAINER BOLTS SHEARED
		ROTOR DRIVE BEARING FAILED
		ROTOR DRIVE FAILED
		SHAFT BEARING FAILURE
		EXCESSIVE VIBRATION
		WORN (NO DETAILS)

ILLUSTRATION 5

CH-47A DEFICIENCIES FROM FIELD SERVICE REPORTS
29 JAN 73 - 15 DEC 73

FUNCTIONAL GROUP	ITEM	PROBLEM
64 - ROTOR & XMSN SYS (CONT'D)	XMSN	EXCESSIVE VIBRATION/INTERNAL FAILURE
	PUMP AXIAL PISTON	BOLTS SHEARED
		OIL LEAK-DETERIORATED PACKING (19 REPORTS)
	ROTOR BLADES	AIR LEAKS (OR INDICATOR MALFUNCTION) (14 REPORTS)
		CRACK IN TRAILING EDGE
		INBOARD TRANSITION CAP UNBOUND
		TOP FLANGE CRACKED OFF RIB.
	HEAD ASSY	BEARING FAILURE
		MAINT DAMAGE-NO DETAILS
		PITCH LINK BEARING FAILURE
		BEARING FAILURE
	SHAFT-FORWARD	LEAKING
	NUT PLATE	LOOSE

ILLUSTRATION 6

CH-47A DEFICIENCIES FROM FIELD SERVICE REPORTS

29 JAN 73 - 15 DEC 73

FUNCTIONAL GROUP	ITEM	PROBLEM
04 - ROTOR & XMSN SYS (CONT'D)	SWASHPLATE	FAILED (NO DETAILS)
		EXCESSIVE CLEARANCE BETWEEN BEARING AND CONTROL
		DAMAGED ON RECEIPT
	DAMPER, FLUTTER	UNSTABLE - LOGGED OTHER BLADES
	GENERATOR A.C.	INTERNAL FAILURE
		INTERMITTENT OPERATION
06 - HYDRAULIC SYSTEM	VALVE, SAFETY	FAILED - NORMAL USE
		LEAKING
	ACTUATOR	INTERMITTENT OPERATION
	SERVOCYLINDER	LEAKING
	MOTOR HYD	INTERNAL FAILURE
	VALVE-LINE	UNKNOWN DEFICIENCY
	MANIFOLD-HYD	INOPERATIVE

ILLUSTRATION 7

CH-47A DEFICIENCIES FROM FIELD SERVICE REPORTS

29 JAN 73 - 15 DEC 73

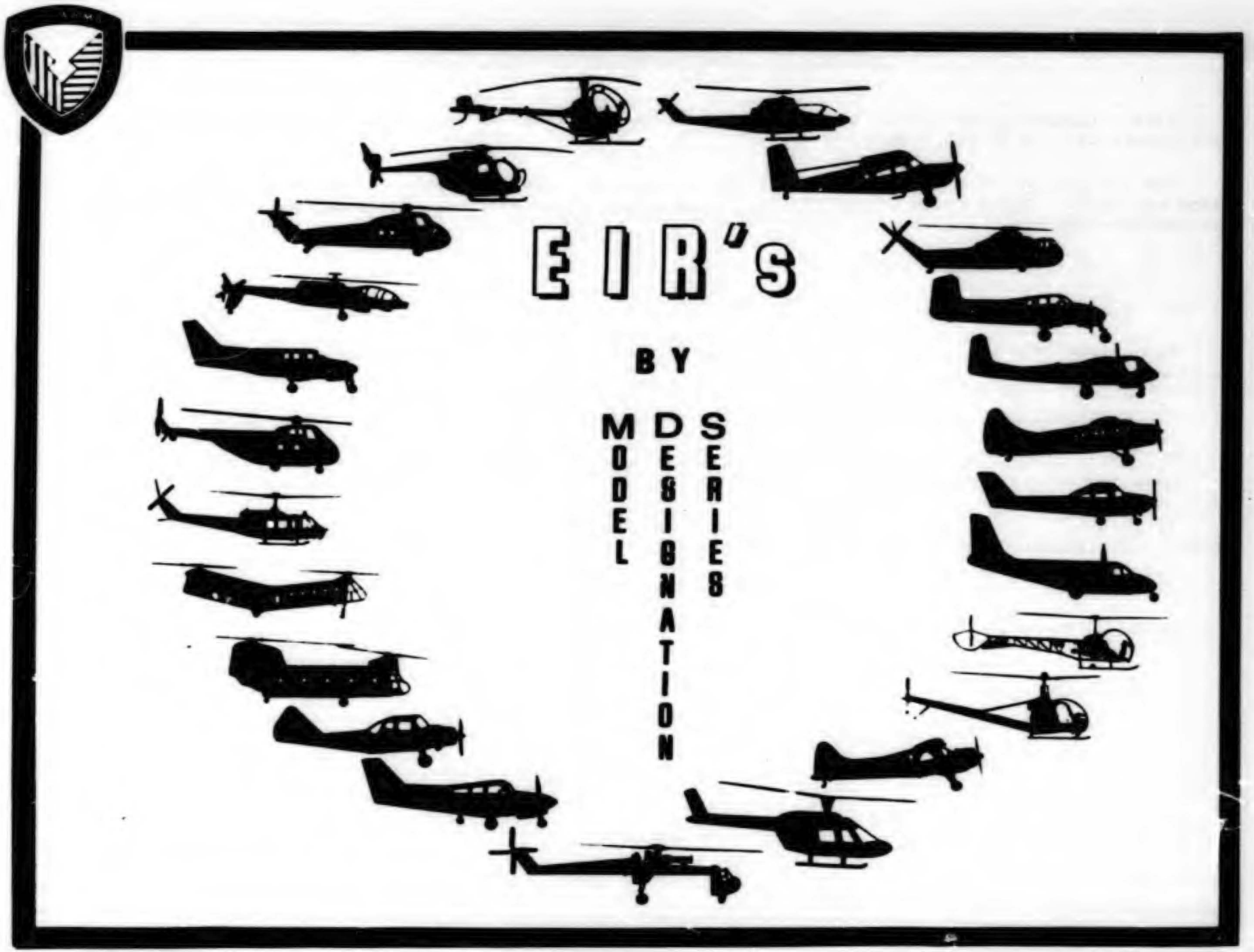
FUNCTIONAL GROUP	ITEM	PROBLEM
09 - ELECTRICAL	RELAY	WOULD NOT CLOSE
	SWITCH	OPERATED INTERMITTENTLY
	CONTROL BOX	INTERNAL CORROSION
		INTERNAL FAILURE
	SPEED TRIM BOX	INTERNAL FAILURE
	PROTECTION PANEL	BURNED OUT RESISTOR (GEN LITE)
10 - FUEL SYS	SWITCH, FLOAT	STUCK IN CLOSED POSITION
11 - FLIGHT CONTROL	ACTUATOR	DEFECTIVE
	HINGE PEDAL	EXCESSIVE WEAR
	FITTING PEDAL	EXCESSIVE WEAR
	TRANSDUCER ASSY	IMPROPER OPERATION

ILLUSTRATION 8

CH-47A DEFICIENCIES FROM FIELD SERVICE REPORTS

29 JAN 73 - 15 DEC 73

FUNCTIONAL GROUP	ITEM	PROBLEM
18 - APU	PUMP MOTOR	HYDRAULIC LEAK
	COMBUSTOR HOUSING	FUEL LEAK
	GEARSHAFT, SPUR	BROKEN SHAFT
	APU	UNIT SIEZED
	GAS TURBINE	OVERSPEED WARNING LIGHT CAME ON


EIR'S
BY
MODEL DESIGNATION SERIES

EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIRs)

EIRs - Equipment Improvement Recommendations - are submitted to this Command from the field in accordance with TM 38-750, the TAMMS system.

The EIR program is a field reporting procedure for identifying a fault or deficiency when found in Army equipment. The purpose of the EIR reporting system is to encourage field personnel to participate in recommending improvements of equipment which will result in a more effective performance.

EIRs have three classifications:

a. Emergency EIRs on unsafe conditions which, if not corrected, could result in serious injury.

b. Urgent EIRs on potentially hazardous conditions, which, if not corrected, could result in serious injury.

c. Routine EIRs for any other condition pertaining to improvement of equipment or procedures.

For those EIRs received furing a reporting period, an accounting of case assignments and a tally of those components most frequently reported against is kept for program monitoring purposes.

Illustration 1 shows the required response time by which the cognizant office must respond to the three classifications of EIRs and the current results thereof.

Illustration 2 shows the 10 most reported failed items on the CH-47A aircraft.

Illustration 3 is self explanatory.

ILLUSTRATION 1

CH-47 AIRCRAFT

SUMMARY OF UNANSWERED EIRS AS OF 30 SEP 74

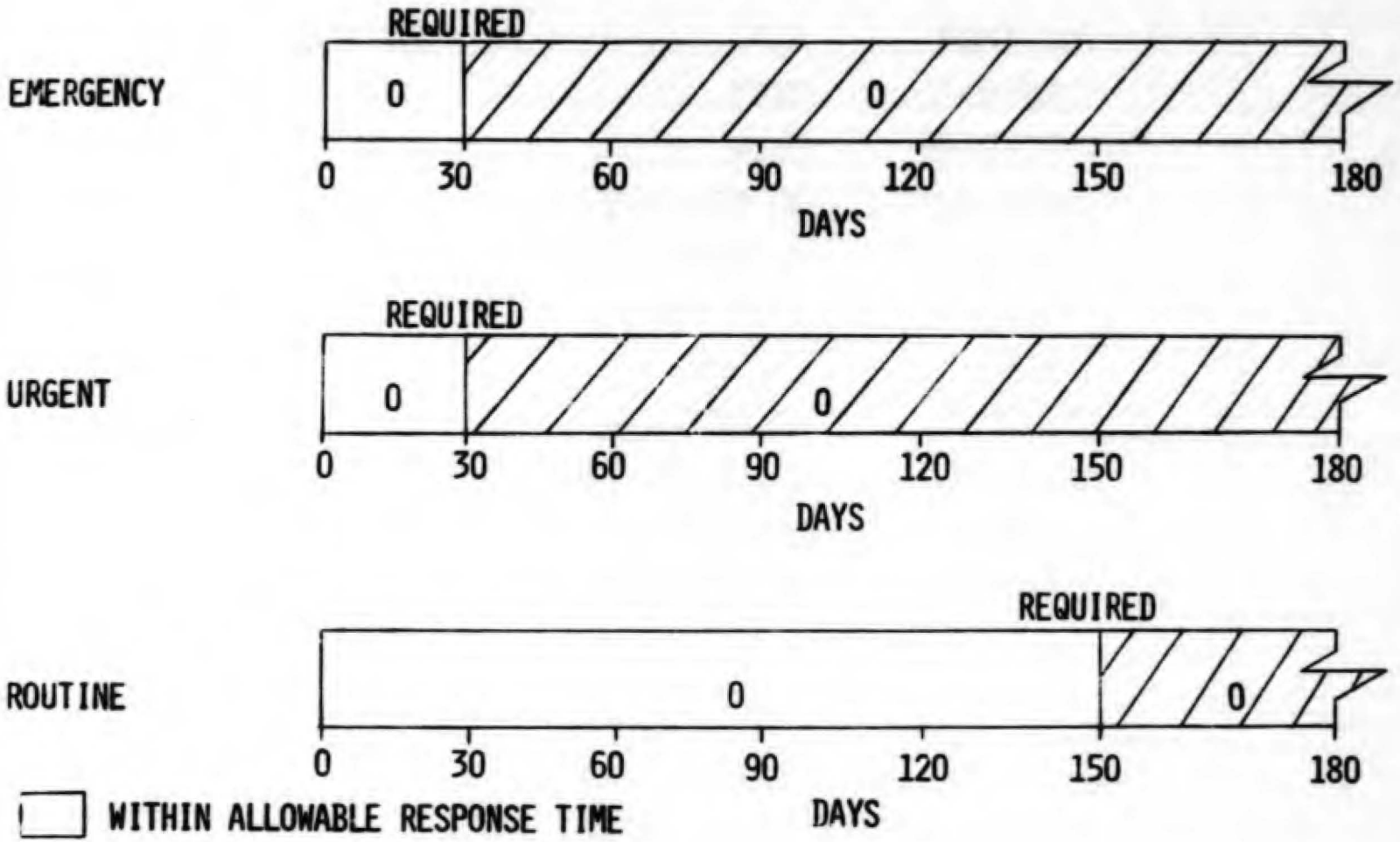


ILLUSTRATION 2

CH-47A TOP TEN ITEMS
1 JAN 74 TO 26 AUG 74

PART NUMBER	NOUN	EIR TOTAL
2-000-030-22	ENGINE	19
2-001-020-05	ENGINE	19
114R1002-122	AFT ROTOR BLADE, A	15
114R1002-107	AFT ROTOR BLADE, A	14
114D6001-20	ENGINE XMSN	12
114H6800-3	LAG DAMPER	8
114R1502-34	AFT ROTOR BLADE	7
114ES237-2	OIL PRESSURE TRANSDUCER	6
114R3611-1	LINK ASSY	4
114R1502-33	AFT ROTOR BLADE, HC	4

INTRODUCTION TO

ARMY OIL ANALYSIS PROGRAM

(AOAP)

This program is designed to provide the Army aircraft user with rapid dissemination of information on incipient failures of oil wetted components as used on Army aircraft with a resultant decrease in accident, potential accidents, and mission aborts.

To accomplish this the Army maintains six laboratories in the United States, each with a capability of evaluating 5,000 oil samples per month, and reporting significant findings to using organizations.

Oil analysis reports used in this program reflect data which is the basis for advising user organizations of impurities contained in their oil samples. These samples are taken from the various oil housing/sumps of aircraft components at predetermined time intervals and in a prescribed manner to preclude further contamination. Analysis of these samples consist of detection, measurement, comparing previous readings, and recording the chemical/metallic contamination in the system lubricant oils using spectral emission and absorption type testing instruments/equipment.

The individual aircraft user organizations are responsible for maintaining an effective oil analysis program. Oil samples are taken, identified, and expedited to a designated laboratory for analysis. Samples are required to be processes within 24 hours of receipt and when eminent problems are recognized because of excessive changes in metal contamination. The user organization is then advised of recommended actions by telephone with subsequent documented follow-up. The laboratory is subsequently advised by the user of actions taken which was based on their analysis and recommendations. Teardown and analysis of removed components is accomplished at designated overhaul facilities. The Aviation Systems Command monitors significant data from major assemblies removed as a result of oil analysis and laboratory findings recommendations.

In 1972, the Army, Navy, and Air Force approved an interservice agreement for standardization and uniformity in oil analysis service and laboratory utilization. This system was designed to predict component failure by using oil analysis equipment subsequent to standardization of functions, techniques, instruments, and procedures. Additional research, development, and standardization is being conducted to improve the analysis/sampling techniques and maintenance practices.

The following illustration lists typical metallic elements that show up in CH-47A, B, & C aircraft oil samples submitted to laboratories. Also shown on the illustration are normal and marginal/high quantities of these elements found in oil samples from selected major items of these fleets.

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ELEMENTS

Fe = IRON	Cr = CHROMIUM	Ag = SILVER	Cu = COPPER
Al = ALUMINUM	Mg = MAGNESIUM	Si = SILICONE	

AIRCRAFT/COMPONENTS

THE FOLLOWING VALUES ARE REPRESENTATIVE OF GUIDELINES AND USED IN CONJUNCTION WITH FACTORS OF THE EVALUATION PROCESS WHERE DATA IS COMPARED WITH BASELINE OIL CONTAMINANTS.

	Fe	Al	Ag	Cu	Cr	Mg	Si
ENGINE							
NORMAL	17	13	3	5	7	9	23
MARGINAL/HIGH	33	28	7	11	15	19	53
FORWARD AND AFT TRANSMISSION (XMSN)							
NORMAL	52	21	7	8	14	27	16
MARGINAL/HIGH	106	46	16	18	32	58	31
ENGINE XMSN AND COMBINING XMSN							
NORMAL	35	10	4	7	6	19	20
MARGINAL/HIGH	90	22	9	20	13	37	45

CRITICAL PARTS–ASSESSMENT OF FIELDED SYSTEMS

(ITEMS CAUSING ABORTS/CATASTROPHIC MISHAPS)

PHASE I



PHASE II

FAILURE MODES
EFFECTS, &
CRITICALITY ANALYSIS

PHASE III

PRODUCTION
CONFORMANCE
REQUIREMENTS

DEFINITION: A CRITICAL PART IS DEFINED AS A PART, ASSEMBLY, OR PRODUCTION SYSTEM WITH ANY CHARACTERISTICS WHICH, IF NOT CONFORMING TO THE DESIGN DATA AND/OR QUALITY REQUIREMENTS, COULD RESULT IN AN UNSAFE CONDITION IN THE COMPLETED PRODUCT.

CRITICAL PARTS

The critical parts program identifies those parts that have been proven to be critical to flight safety and to determine those characteristics of the part that should be closely controlled during manufacture.

A critical part is a part, assembly, installation, or production system with any critical characteristic (s) which, if not conforming to the design data and/or quality requirements, could result in an unsafe condition in the completed product. Unsafe condition is defined as a condition which could cause loss of the aircraft or any of its major components, loss of control, unintentional release of, or inability to release any armament store, or a condition which could cause significant injury to occupants of the aircraft or ground support personnel. A classification of characteristics will be applied to any dimension, tolerance, finish, material, process, assembly, or electrical, chemical, or mechanical value that conforms to the definition of critical.

The following illustrations are the preliminary results of our critical parts analysis for the CH-47 utilizing the feedback of information approach and presents our efforts towards Phase 1 (Identification of Critical Parts). Specifically, Technical Reports of US Army Aircraft Accident (DA Form 2397) which includes the degree of damage, the cause of mishap, and the components or systems suspected of being contributing factors to the mishap, were analyzed to obtain and point out trends. The results represent the screening of 770 DA Form 2397's on the CH-47 aircraft for the period 2 July 1969 through 24 February 1974. From the screening, a total of 595 incidents were determined to be a result of definite material causes. The chip detector (C/D) indications with no failure are included, since a mission abort resulted from those cases. Phase I for the CH-47 is scheduled to be completed by 31 January 1975.

CH-47A, B, and C DEFINITE MATERIAL CAUSES OF MISHAPS (PRELIMINARY)

FY 70, 71, 72, 73, 74*

FUNCTIONAL GROUP AND COMPONENTS	SAFETY & MISSION RELATED							ALL SAFETY & MISSION RELATED
	SAFETY RELATED						PRECAUTIONARY LANDINGS	
	TOTAL LOSS	MAJOR ACCIDENT	MINOR ACCIDENT	INCIDENT	FORCED LANDING	ALL SAFETY		
01 AIRFRAME								
TUNNEL COVER				2		2	3	5
SHAFT COVER							3	3
LATCH				4		4		4
VENT						1		1
OTHER	1			3		3	4	7
FG 01 TOTALS	1			9		10	10	20
02 LANDING GEAR								
SHOCK STRUT CAP ASSY		1				1		1
WHEEL DISC							1	1
ELBOW TUBE							1	1
OTHER								
FG 02 TOTALS		1				1	2	3

* Through 2-24-74

CH-47A, B, and C DEFINITE MATERIAL CAUSES OF MISHAPS (PRELIMINARY)

FY 70, 71, 72, 73, 74*

FUNCTIONAL GROUP AND COMPONENTS	SAFETY & MISSION RELATED							ALL SAFETY & MISSION RELATED
	SAFETY RELATED						PRECAUTIONARY LANDINGS	
	TOTAL LOSS	MAJOR ACCIDENT	MINOR ACCIDENT	INCIDENT	FORCED LANDING	ALL SAFETY		
03 POWER PLANT								
ENGINE	3	1	1	2	1	8	80	88
ENGINE FUEL CONTROL	2	2				4	25	29
BLEED BAND		1		1	1	3	10	13
ELECTRIC ACTUATOR							9	9
TRANSDUCER							5	5
SHAFT ASSEMBLY	1			1		2	1	3
CHIP DETECTOR-NO FAILURE							44	44
OTHER	1			1	1	3	36	39
FG 03 TOTALS	7	4	1	5	3	20	210	230
FG 04-XMNS & ROTORS								
TRANSDUCER							24	24
FORWARD XMSN							11	11
ENGINE XMSNS							12	12
COMBINING XMSN	1					1	11	12
AFT XMSN							2	2
UNIDENTIFIED XMSNS							10	10
GENERATOR					1	1	17	18
BLADE ASSY	2	1		1		4		4
OIL COOLER							4	4
CLUTCH	1					1		1
FWD ROTOR HEAD	1					1		1
CHIP DETECTOR-NO FAILURE							31	31
OTHER		1		4	2	7	27	34
FG 04 TOTALS	5	2		5	3	15	149	164

* Through 2-24-74

CH-47A, B, and C DEFINITE MATERIAL CAUSES OF MISHAPS (PRELIMINARY)

FY 70, 71, 72, 73, 74*

FUNCTIONAL GROUP AND COMPONENTS	SAFETY & MISSION RELATED							
	SAFETY RELATED							
	TOTAL LOSS	MAJOR ACCIDENT	MINOR ACCIDENT	INCIDENT	FORCED LANDING	ALL SAFETY	PRECAUTIONARY LANDINGS	ALL SAFETY & MISSION RELATED
FG 06 -HYDRAULICS								
TUBE ASSY'S							52	52
PUMPS	2					2	14	16
VALVES							9	9
COOLER							7	7
HYDRAULIC MOTOR							6	6
OTHER				1	1	2	42	44
FG 06 TOTALS	2			1	1	4	130	134
08 INSTRUMENTS								
SWITCH ASSYS							2	2
XMSN OIL PRESS.INDICATOR							2	2
TORQUE INDICATOR							1	1
TORQUEMETER DRIVE							1	1
XMSN PRESSURE SWITCH							1	1
SAS SYSTEM							1	1
FG 08 TOTALS							8	8

* Through 2-24-74

CH-47A, B, AND C DEFINITE MATERIAL CAUSES OF MISHAPS (PRELIMINARY)
FY 70, 71, 72, 73, 74*

FUNCTIONAL GROUP AND COMPONENTS	SAFETY & MISSION RELATED							ALL SAFETY & MISSION RELATED
	SAFETY RELATED							
	TOTAL LOSS	MAJOR ACCIDENT	MINOR ACCIDENT	INCIDENT	FORCED LANDING	ALL SAFETY	PRECAUTIONARY LANDINGS	
09 ELECTRICAL								
BEEP BOX CONTROL							2	2
BEARING							2	2
ELECTRICAL SYSTEM							1	1
D.C. POWER SYSTEM							1	1
QUADRANT CONTROL				1		1		1
A.C. GENERATOR							1	1
OTHER							5	5
FG 09 TOTALS				1		1	12	13
10 FUEL SYSTEM								
FUEL LEAK							2	2
QUICK DISCONNECT							1	1
FG 10 TOTALS							3	3

* Through 2-24-74

CH-47A, B, AND C DEFINITE MATERIAL CAUSES OF MISHAPS (PRELIMINARY)

FY 70, 71, 72, 73, 74*

FUNCTIONAL GROUP AND COMPONENTS	SAFETY & MISSION RELATED							
	SAFETY RELATED						PRECAUTIONARY LANDINGS	ALL SAFETY & MISSION RELATED
	TOTAL LOSS	MAJOR ACCIDENT	MINOR ACCIDENT	INCIDENT	FORCED LANDING	ALL SAFETY		
11 FLIGHT CONTROLS								
TRIM							3	3
ROD BEARING	1					1		1
FWD CYCLIC				1		1		1
CYCLIC PEDALS					1	1		1
MAGNETIC BRAKE							2	2
UNKNOWN							3	3
OTHER							3	3
FG 11 TOTALS	1			1	1	3	11	14
12 UTILITY SYSTEMS								
SENSING ELEMENT							2	2
FIRE DETECTION							1	1
TOTALS FG 12							3	3
19 AVIONICS								
ACTUATOR,SPEED TRIM							2	2
BULB, NOSE BOX TEMP							1	1
FG 19 TOTALS							3	3
TOTAL ALL FG	16	7	1	22	8	54	541	595

* Through 2-24-74

CH-47A, B, and C TEN HIGH DEFINITE MATERIAL CAUSES OF MISSION ABORTS (PRELIMINARY)

COMPONENT (FG)	5 YR QTY OF FAILURES	FY 70	FY 71	FY 72	FY 73	FY 74*
ENGINE (03)	88	23	29	18	8	10
TUBE ASSY'S (06)	52	9	26	10	4	3
C/D NO FAILURE (03)	44	2	22	12	6	2
C/D NO FAILURE (04)	31	7	10	8	3	3
ENGINE FUEL CONTROL (03)	29	13	8	2	3	3
TRANSDUCER (04)	24	8	8	1	4	3
GENERATOR (04)	18	9	5	4	0	0
HYDRAULIC PUMPS (06)	16	7	5	0	3	1
ENGINE BLEED BAND (03)	13	6	7	0	0	0
ENGINE XMSNS (04)	12	4	5	1	1	1
COMBINING XMSN (04)	12	6	4	1	0	1

* Through 24 Feb 74

C/D = CHIP DETECTOR

CH-47A, B, AND C TEN HIGH DEFINITE MATERIAL CAUSES OF MISSION ABORTS

PER 100,000 FLIGHT HOURS

(PRELIMINARY)

COMPONENT (FG)	5 YR QTY OF FAILURES	FY 70	FY 71	FY 72	FY 73	FY 74*
ENGINE (03)	13.37	6.79	14.79	15.74	14.50	33.90
TUBE ASSY'S (06)	7.90	3.44	13.26	8.75	7.25	10.17
C/D NO FAILURE (03)	6.69	.76	11.22	10.49	10.88	6.78
C/D NO FAILURE (04)	4.71	2.68	5.10	7.00	5.44	10.17
ENGINE FUEL CONTROL (03)	4.41	4.97	4.08	1.75	5.44	10.17
TRANSDUCER (04)	3.65	3.06	4.08	.87	7.25	10.17
GENERATOR (04)	2.74	3.44	2.55	3.50	0	0
HYDRAULIC PUMPS (06)	2.43	2.68	2.55	0	5.44	3.39
ENGINE BLEED BAND (03)	1.98	2.29	3.57	0	0	0
ENGINE XMNS (04)	1.82	1.53	2.55	.87	1.81	3.39
COMBINING XMNS (04)	1.82	2.29	2.04	.87	0	3.39
FLIGHT HOURS	656,813	261,663	196,138	114,351	55,160	29,501

* Through 24 Feb 74

C/D = CHIP DETECTOR

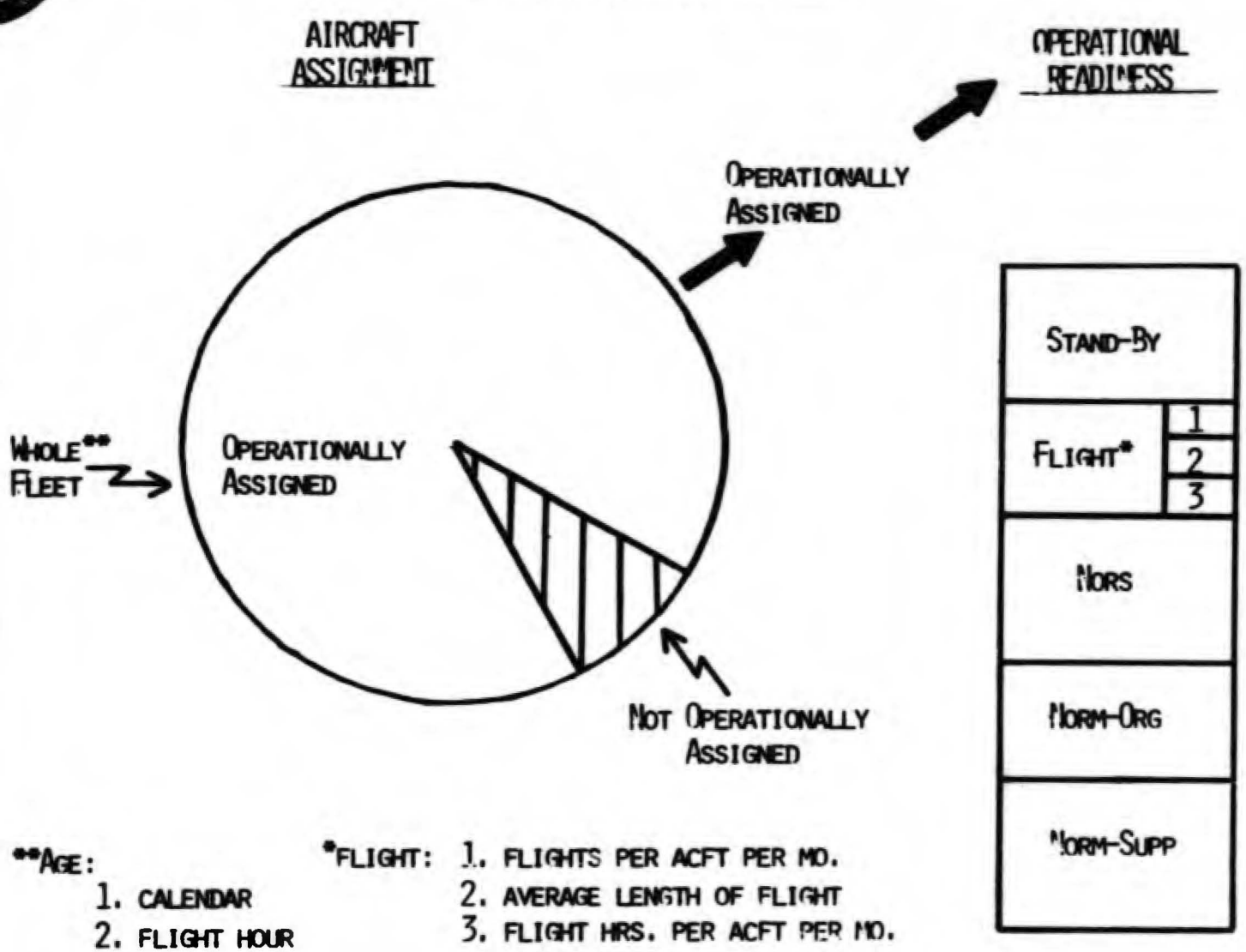
CH-47A, B, AND C LARGEST DEFINITE MATERIAL CAUSES OF ACCIDENTS OR POTENTIAL ACCIDENTS - FY 70, 71, 72, 73, 74*
(PRELIMINARY)

COMPONENT (FG)	5 YR TOTAL	FY 70	FY 71	FY 72	FY 73	FY 74*
ENGINE (03)	8	4	0	1	0	3
ENGINE FUEL CONTROL (03)	4	2	2	0	0	0
BLADE ASSY (04)	4	1	0	3	0	0
LATCH (01)	4	1	2	0	0	1
BLEED BAND (03)	3	1	2	0	0	0
TUNNEL COVER (01)	2	0	1	1	0	0
SHAFT ASSY (03)	2	0	2	0	0	0
PUMPS (06)	2	1	1	0	0	0

* Through 24 Feb 74

COMPARATIVE EVALUATIONS

FLEET UTILIZATION COMPARISON



**AGE:
1. CALENDAR
2. FLIGHT HOUR

*FLIGHT:
1. FLIGHTS PER ACFT PER MO.
2. AVERAGE LENGTH OF FLIGHT
3. FLIGHT HRS. PER ACFT PER MO.

FLEETS UTILIZATION COMPARISON

Fleets of aircraft are procured to be utilized for particular by different missions. At any point in time the major portion of each fleet will be utilized in performing their missions. This portion of each fleet is referred to as being Operationally Assigned. The remaining portions of each fleet, which consists of aircraft in transit, at depot, awaiting disposition, etc., is called Not Operationally Assigned. The portion operationally assigned of each of the first line helicopter fleets is shown in Illustration 1, column three.

As Operational Readiness (availability) rate is determined for that portion of each fleet which is Operationally Assigned. An aircraft is considered Operationally Ready when it is flying or is capable of safe flight and essential equipment necessary for performance of its primary mission is performing or ready to perform. An aircraft is Not Operationally Ready (NOR) whenever the current status symbol is a red "X" as recorded on DA Form 2408-3. If parts are not available to repair the aircraft, it is carried as Not Operationally Ready Supply (NORS) until the parts become available. While the aircraft is being repaired, it is carried as Not Operationally Ready Maintenance (NORM). If personnel are not available to work on the aircraft, but parts are available, it remains in the NORM category. That portion of the total NORM time consumed by organization and by direct and general support maintenance is separately reported. Also shown on Illustration 1 for each of the first line helicopter fleets in columns 4, 5, 6, 7, and 8 respectively, are the percentages of time that each fleet was Operationally Ready (OR), Not Operationally Ready due to Supply (NORS), Not Operationally Ready due to Maintenance (NORM), NORM because of organization maintenance and NORM because of direct and general support maintenance.

Illustration 2, columns 3 and 4 respectively list the average flight hour age and average calendar age in months of each of the first line helicopter fleets.

Also shown in Illustration 2, columns 5 and 6 respectively, is the present usage rate (flight hours per aircraft per month) and the length of an average flight (in minutes) of each of the first line helicopter fleets.

Column 7 of Illustration 2 provides statistics on the average number of flights made per aircraft during a month by each of these helicopter fleets.

Data for these illustrations was taken from the Army Aircraft Inventory Status and Flying Time Reporting System (AR 95-33). This reporting system requires that a DA Form 1352 be submitted to AVSCOM each month by all Army units owning Army aircraft.



ILLUSTRATION 1
FLEET UTILIZATION COMPARISONS
1 APR 1973 THRU 31 MAR 1974

MDS	SIZE OF FLEET	% OF FLEET OPER. ASSIGNED	% OF TIME				
			OR	NORS	NORM TOTAL	NORM ORGANIZATION	NORM DS&GS
UH-1H	2944	85.5	75.6	8.1	16.3	8.5	7.8
OH-58A	2094	78.8	73.5	11.1	15.5	5.9	9.6
AH-1G	734	64.0	62.1	25.7	12.2	5.3	6.9
OH-6A	428	60.9	67.6	11.9	20.6	9.1	11.5
CH-47A	172	64.2	64.2	14.6	21.6	8.2	13.4
CH-47B	80	77.9	70.0	11.3	18.7	7.1	11.6
CH-47C	185	60.2	69.1	11.0	19.9	9.9	10.0
CH-54A	48	69.4	61.0	12.5	26.5	13.0	13.5
CH-54B	29	82.8	65.3	20.7	14.1	6.0	8.1

ILLUSTRATION 2
FLEET UTILIZATION COMPARISONS
1 APR 1973 THRU 31 MAR 1974

MDS	SIZE OF FLEET	QTY OPER ASSIGNED	AVG FLT HR AGE	AVG CALENDAR AGE (MONTHS)	FLT HRS/ ACFT/ MONTH	LENGTH OF AN AVG FLT (MIN)	FLTS/ACFT/ MONTH
UH-1H	2944	2195	2295	62	22.0	22.1	60
OH-58A	2094	1557	479	30	16.1	21.3	46
AH-1G	734	583	1333	59	9.9	25.8	23
OH-6A	428	267	1665	65	10.8	21.2	31
CH-47A	172	111	2520	104	11.3	24.2	28
CH-47B	80	62	2444	78	15.9	15.1	63
CH-47C	185	111	1239	57	13.0	23.8	34
CH-54A	48	33	1390	68	10.9	26.8	25
CH-54B	29	24	558	47	11.9	20.5	35

SAFETY RELIABILITY

Safety reliability is the probability that no accident caused by the systems or components failing or malfunctioning will occur. The parameter will be designated as Rs (material).

Other factors than material failures causing accidents are personnel, environment, weather, etc. When all factors causing accidents are included, safety reliability will be designated as Rs (all).

The source of data for this compilation was the USAAAVS Aircraft Accident Experience Report. An evaluation of the total losses, major and minor accidents, incidents, and forced landings reported was constructed in this evaluation. Precautionary landings were not included.

Illustration 1 contains comparative values of the mean time between safety related aborts for all causes and material causes, and Rs (all) for the length of an average flight.

Illustration 2 contains comparative values of Rs (all) and Rs (material) for a one and two hour mission.

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ILLUSTRATION 1

WORLD WIDE

AIRCRAFT ACCIDENT EXPERIENCE

SELECTED AIRCRAFT

JUNE 71 THRU MAY 74

A/C	AVERAGE INVENTORY	NO. OF FLIGHTS	TOTAL FLT HRS	MTB ALL (*) SAFETY RELATED ABORTS (HOURS)	MTB(**) MATERIAL FAILURES (HOURS)	AVERAGE FLIGHT DURATION (MINUTES)	FLIGHT SUCCESS FOR AVERAGE FLT DURATION Rs (ALL)
AH-1G	685	731014	345995	1517.5	3359.2	28.40	99.97
CH-47A	201	226190	73576	3678.8	4905.1	19.52	99.99
CH-47B	70	132570	43183	2688.9	5337.9	19.54	99.99
CH-47C	183	275458	108110	2002.0	3487.4	23.55	99.98
CH-54A	48	32204	15052	3763.0	7526.0	28.04	99.99
OH-6A	472	708135	234796	1248.9	3504.4	19.89	99.97
OH-58A	1662	2956314	967650	2665.7	6451.0	19.64	99.99
UH-1H	2804	6865400	2434920	3523.8	9511.4	21.28	99.99

*INCLUDES ALL TOTAL LOSSES, MAJOR AND MINOR ACCIDENTS, INCIDENTS AND FORCED LANDINGS.

**INCLUDES ALL TOTAL LOSSES, MAJOR AND MINOR ACCIDENTS, INCIDENTS AND FORCED LANDINGS FROM MATERIAL CAUSES.

ILLUSTRATION 2

SAFETY RELIABILITY COMPARISONS: FIELD EXPERIENCE

JUNE 71 THRU MAY 74

A/C	% 1 HOUR MISSION		% 2 HOUR MISSION	
	NO ABORTS Rs (ALL)	NO MATERIAL FAILURES Rs (MATERIAL)	NO ABORTS Rs (ALL)	NO MATERIAL FAILURES Rs (MATERIAL)
AH-1G	99.93	99.97	99.87	99.94
CH-47A	99.97	99.98	99.95	99.96
CH-47B	99.96	99.98	99.93	99.96
CH-47C	99.95	99.97	99.90	99.94
CH-54A	99.97	99.99	99.95	99.97
OH-6A	99.92	99.97	99.84	99.94
OH-58A	99.96	99.98	99.93	99.97
UH-1H	99.97	99.99	99.94	99.98

MISSION RELIABILITY

Mission Reliability is the probability of non-failure of the system during the duration of a mission, given that the system was operating at the beginning of the mission. This parameter will be designated as Rm (material).

Other factors than material failures causing mission aborts are personnel, environment, weather, etc. When all factors causing mission aborts are included, Mission reliability will be designated as Rm (all).

The source of data for this compilation was the USAAAVS Aircraft Accident Experience Report. An evaluation of the total losses, major and minor accidents, incidents, forced landings, and precautionary landings reported was constructed.

Illustration 1 contains comparative values of the Mean Time Between Mission effective aborts for all causes and for material causes, and Rm (all) for the length of an average flight.

Illustration 2 contains comparative values of Rm (all) and Rm (material) which is calculated for a one and two hour mission.

Illustration 3 shows the percentage of flight aborts by mishap category.

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ILLUSTRATION 1

WORLD WIDE

AIRCRAFT MISSION ABORT EXPERIENCE

SELECTED AIRCRAFT

JUNE 71 THRU MAY 74

A/C	AVERAGE INVENTORY	NO. OF FLIGHTS	TOTAL FLT HRS	MTB ABORT ALL CAUSES (HOURS)	MTB MATERIAL FAILURE (HOURS)	AVERAGE FLIGHT DURATION (MINUTES)	FLIGHT SUCCESS FOR AVERAGE FLT DURATION Rm (ALL)
AH-1G	685	731014	345995	417.9	797.2	28.40	99.89
CH-47A	201	226190	73576	406.5	668.9	19.52	99.92
CH-47B	70	132570	43183	445.2	799.7	19.54	99.93
CH-47C	183	275458	108110	391.7	702.0	23.55	99.90
CH-54A	48	32204	15052	519.0	752.6	28.04	99.91
OH-6A	472	708135	234796	597.5	1467.5	19.89	99.94
OH-58A	1662	2956314	967650	768.0	1629.1	19.64	99.96
UH-1H	2804	6865400	2433920	791.3	1487.4	21.28	99.96

ILLUSTRATION 2

MISSION RELIABILITY COMPARISONS: FIELD EXPERIENCE

JUNE 71 THRU MAY 74

	% 1 HOUR MISSION		% 2 HOUR MISSION	
A/C	NO ABORT R_M (ALL)	NO MATERIAL FAILURE R_M (MATERIAL)	NO ABORT R_M (ALL)	NO MATERIAL FAILURE R_M (MATERIAL)
AH-1G	99.76	99.87	99.52	99.75
CH-47A	99.75	99.85	99.51	99.70
CH-47B	99.78	99.88	99.55	99.75
CH-47C	99.75	99.86	99.49	99.72
CH-54A	99.81	99.87	99.62	99.73
OH-6A	99.83	99.93	99.67	99.86
OH-58A	99.87	99.94	99.74	99.88
UH-1H	99.87	99.93	99.75	99.87



ILLUSTRATION 3

% FLIGHT ABORTS BY MISHAP CATEGORY

FLEET COMPARISONS

MAY 71 THRU MAY 74

A/C	MAJOR ACCIDENT TOTAL LOSS	MAJOR ACCIDENT	MINOR ACCIDENT	INCIDENT	FORCED LANDING	PRECAU LANDING	OTHER	TOTAL MISHAPS
AH-1G	2.7%	5.3%	1.4%	13.5%	4.6%	71.6%	.9%	828
CH-47A	1.6%	0	.5%	8.8%	0	88.5%	.6%	182
CH-47B	2.1%	0	0	13.4%	1.0%	83.5%	0	97
CH-47C	.7%	1.1%	.4%	14.5%	2.9%	79.7%	.7%	276
CH-54A	3.4%	0	0	6.9%	0	89.7%	0	29
OH-6A	5.1%	15.5%	.8%	15.0%	11.5%	51.3%	.8%	393
OH-58A	3.6%	3.0%	.6%	10.8%	10.9%	70.9%	.2%	1260
UH-1H	2.7%	2.9%	.5%	10.9%	5.5%	77.3%	.2%	3077

OPERATIONAL R&M COMPARISONS

In conducting reliability (R) and maintainability (M) evaluations, it is often useful to select certain R and M characteristics and compare the data for these among several Army aircraft systems. Such comparison will put the results from any one aircraft in perspective and enable the user to better determine the significance of particular characteristics on the aircraft.

The basis for determining the following characteristics is discussed under the R&M Characteristics Chapter in the previous section of this report. All of the R&M characteristics have not as yet been determined for all of the aircraft systems listed. However, they will be determined and included in subsequent issues of this report.

Operational Reliability Data:

a. Maintenance Actions - total, scheduled, unscheduled, corrective, preventive, replace and repair.

b. Mean Time Between Type Maintenance Action - total, scheduled, unscheduled, corrective, preventive, replace, and repair.

Operational Maintainability Data:

a. Maintenance Manhours - total, scheduled, unscheduled, corrective, preventive, replace, repair.

b. Average manhours to perform type of action - total, scheduled, unscheduled, corrective, preventive, replace, repair, daily, intermediate, and periodic inspections. Also included are the total scheduled and unscheduled MMH per flight hour.

Related Operational R&M Data:

Other related R&M data is provided such as period during which data was taken, acceptable flight hours, size of fleet end of time frame, and sample size.

Illustration 1 compares the reliability parameters that have been determined for various fleets.

Illustration 2 compares the maintainability parameters that have been determined for various fleets.

Illustration 3 compares the scheduled inspection data that has been determined for various fleets.

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ILLUSTRATION 2

OPERATIONAL MAINTAINABILITY COMPARISONS

A/C	DATA TIME FRAME	QUANTITY OF TYPE MAINTENANCE MANHOURS						
		TOTAL	SCHED	UNSCHED	CORRECT	PREVENT	REPLACE	REPAIR
OH-58A	JAN 70-JUN 71	319,774	ND	ND	ND	ND	ND	ND
AH-1G	JUL 70-JUN 71	876,366	480,375	395,991	ND	ND	249,982	23,712
CH-54A	JUL 70-DEC 72	196,533	ND	ND	ND	ND	ND	ND
CH-47A	APR 71-MAR 73	765,999.2	350,844	415,155.2	204,888	512,852.2	172,866	84,274.7
UH-1H	---	---	---	---	---	---	---	---

A/C	MMH/FH	SCHED MMH/FH	UNSCHED MMH/FH	MMH/CORRECT	MMH/PREVENT	MMH/REPL	MMH/REPAIR	ACCEP. FLIGHT HOURS	SIZE OF FLEET END OF TIME FRAME
OH-58A	2.06	ND	ND	ND	ND	ND	ND	155,230	925
AH-1G	5.53	3.02	2.53	ND	ND	5.95	7.69	158,559	574
CH-54A	14.5	ND	ND	ND	ND	ND	ND	13,554	47
CH-47A	14.94	6.84	8.10	3.80	10.39	3.49	7.21	51,259	163
UH-1H	---	---	---	---	---	---	---	---	---

ND = NOT DETERMINED

ILLUSTRATION 3

COMPARISONS OF AVERAGE MANHOURS FOR SCHEDULED INSPECTIONS

AIRCRAFT	DAILY			INTERMEDIATE			PERIODIC		
	SCHEDULED FREQUENCY	SAMPLE SIZE	AVERAGE MANHOUR	SCHEDULED FREQUENCY	SAMPLE SIZE	AVERAGE MANHOUR	SCHEDULED FREQUENCY	SAMPLE SIZE	AVERAGE MANHOUR
CH-54A	WHEN FLOWN	5,791	13.0	25	400	34.3	100	148	247.7
CH-47A	WHEN FLOWN	16,037	9.4	25	308	30.1	100	505	258.9
UH-1H	WHEN FLOWN	163,381	2.9	25	1473	6.5	100	448	116.0
AH-1G	WHEN FLOWN	37,107	3.8	25	4433	11.2	100	1401	172.0
OH-58A	WHEN FLOWN	114,897	1.9	- NOT APPLICABLE -			300	941	40.9
OH-6A	WHEN FLOWN	81,387	1.8	- NOT APPLICABLE -			300	3785	37.8

FIELD OPERATING COST ANALYSIS (FOCA) COMPARISONS

In conducting an evaluation on any type of Army aircraft, it is often useful to know and compare the field operating cost of various aircraft systems.

The basis for determining the following characteristics is discussed under the FOCA Chapter in the previous section of this report.

The following illustration lists the values determined for two Army aircraft systems. The values for other aircraft systems will be determined and included in subsequent issues of this report.

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MAJOR ITEM COMPARISONS

All Time Before Overhaul (TBO) and finite life items that require historical data when used on Army aircraft are listed in Technical Bulletin, TB 55-1500-307-25.

The TAMMS/TAERS data system, generated by the authority of TM 38-750, stipulates that such items requiring historical data be reported on DA Form 2410 for every installation or removal of the item from an aircraft. This does not include items that were removed and re-installed.

Each significant major item for first line fleets has been analyzed in a Major Item Special Study (MISS) report to relate the mean time to removal to the component's reported dominant failure modes. These studies assume the hypothetical removal of these failure modes with a subsequent increase in mean time to removal with projected cost savings.

Illustration 1 thru 16 group and compare similar major items for first line helicopter fleets to indicate the potential cost savings to be realized by elimination of the dominant failure modes.

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ILLUSTRATION 1

MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

SWASHPLATE & SUPPORTS

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
OH-58A	719	EXCESSIVE WEAR	55.4	$ 937	$ 518	1 QTR 73
AH-1G	494	EXCESSIVE WEAR	37.0	1,261	467	1 QTR 72
UH-1D	721	EXCESSIVE WEAR BEARINGS	46.7	1,155	402	2 QTR 72
UH-1H	787	EXCESSIVE WEAR BEARINGS	35.4	1,155	402	2 QTR 72
CH-47A	643	EXCESSIVE WEAR	51.9	4,621	1,966	3 QTR 72

ILLUSTRATION 2

MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

90° TAIL ROTOR GEAR BOXES

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
OH-58A	516	LEAKING	49.4	$ 1,350	$ 798	4 QTR 74
OH-6A	317	LEAKING & INTERN.	38.6	1,111	650	3 QTR 74
AH-1G	552	LEAKING	34.6	1,538	416	3 QTR 73
UH-1D	685	OIL RELATED	28.9	1,538	408	3 QTR 71
UH-1H	649	OIL RELATED	33.9	1,538	408	3 QTR 71

ILLUSTRATION 3

MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

MAIN ROTOR BLADES

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
OH-58A	470	CRACKING-BONDING	13.6	2,012	1,100	4 QTR 72
OH-6A	295	EROSION	27.6	977	NONE	1 QTR 72
AH-1G 5400110015	294	ENVIRONMENT	16.5	3,408	580	3 QTR 74
AH-1G 5400112501	245	BREAKING CRACKING	6.4	3,408	580	2 QTR 73
UH-1D	386	ENVIRONMENT CRACKING-BONDING	40.2	3,239	736	3 QTR 71
UH-1H	377	ENVIRONMENT CRACKING-BONDING	10.5	1,747	288	2 QTR 73
CH-47A 114R100227	518	BREAKING CRACKING	10.1	10,959	3,977	3 QTR 73
CH-47A 114R100228	495	CRACKING-BONDING	18.6	14,571	6,150	1 QTR 74
CH-54A	443	EXCESSIVE WEAR	8.9	7,830	1,940	3 QTR 74

ILLUSTRATION 4

MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

MAIN ROTOR HUBS

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
OH-58A	703	LEAKING	32.8	$ 2,410	$ 1,424	4 QTR 72
OH-6A	462	EXCESSIVE WEAR BROKEN	40.8	4,803	3,440	2 QTR 74
AH-1G	318	BEARINGS EXCESSIVE WEAR	40.1	10,643	3,051	2 QTR 73
UH-1D	506	OIL LEAKS	37.6	3,609	1,458	3 QTR 71
UH-1H	525	OIL LEAKS	37.2	3,609	1,458	3 QTR 71
CH-47A	655	LEAKING & BRNGS.	45.8	28,000	14,020	1 QTR 74

ILLUSTRATION 5
MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

MAIN TRANSMISSIONS

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
OH-58A	696	LEAKING	19.2	$ 7,731	$ 2,997	1 QTR 73
OH-6A	382	METAL ON PLUG INTERNAL LEAKING	25.6	7,277	2,997	1 QTR 72
AH-1G	615	INTERNAL FAILURE LEAKING	9.4	11,620	2,488	4 QTR 73
UH-1D	750	OIL LEAKING	7.6	11,620	2,480	3 QTR 71
UH-1H	807	OIL LEAKING	6.3	11,620	2,480	3 QTR 71
CH-47A	390	OIL LEAKING	9.1	9,220	2,167	4 QTR 71

ILLUSTRATION 6

MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

TURBINE ENGINES

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
OH-58A 6874201	290	INTERNAL FAILURE LEAKING	20.7	17,675	9,218	4 QTR 72
AH-1G T53-L13	341	INTERNAL FAILURE	16.7	68,510	14,871	2 QTR 73
AH-1G T53-L13A	386	INTERNAL FAILURE	17.3	68,510	14,871	1 QTR 73
AH-1G T53-L13B	320	BURNED LEAKING	30.8	68,510	14,871	2 QTR 74
UH-1D	616	INTERNAL FAILURE	14.4	68,510	13,169	3 QTR 72
UH-1H	350	F.O.D. INTERNAL OIL-FUEL	60.9	68,510	12,759	3 QTR 71
CH-47A APU	256	INTERNAL FAILURE	45.8	9,070	5,677	3 QTR 74
CH-47A T55-L7	507	INTERNAL OIL-FUEL	29.6	69,606	20,184	4 QTR 73
CH-47A T55-L-7C	288	CRACKS LEAKING	31.3	69,606	20,184	2 QTR 74
CH-54A	456	INTERNAL FAILURE	11.7	204,172	67,394	3 QTR 73
OH-6A T63-A-5A	317	INTERNAL FAILURE	20.0	15,337	3,243	2 QTR 74

ILLUSTRATION 7

MAJOR ITEMS (TBO. FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

42° INTERMEDIATE GEAR BOXES

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
AH-1G	532	EXCESSIVE WEAR LEAKING	55.1	$ 1.144	$ 321	2 QTR 73
UH-1D	786	OIL RELATED	39.7	1.144	286	3 QTR 71
UH-1H	665	LEAKING	46.0	1.144	286	4 QTR 71

ILLUSTRATION 8
MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

TAIL ROTOR BLADES

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
OH-58A	403	EXCESSIVE WEAR	53.0	$ 238	$ NONE	3 QTR 73
OH-6A	181	EXCESSIVE WEAR EXCESSIVE VIB. CRACKS	50.6	1,353	NONE	2 QTR 74
AH-1G	250	ENVIRONMENT	35.3	286	NONE	1 QTR 73
UH-1D	415	ENVIRONMENT CRACKING	60.0	253	NONE	4 QTR 71
UH-1H	402	ENVIRONMENT	41.7	363	NONE	4 QTR 71
CH-54A	308	CRACKING	74.0	3,671	1,497	3 QTR 73

ILLUSTRATION 10

MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

SERVOCYLINDERS

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
AH-1G	321	LEAKING	64.0	$ 1,661	$ 280	1 QTR 73
UH-1H	387	LEAKING	78.4	419	175	2 QTR 72
CH-47A	571	LEAKING INTERNAL	91.5	2,314	995	1 QTR 74

ILLUSTRATION 11

MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

TAIL ROTOR HUBS

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
AH-1G	260	EXCESSIVE WEAR	37.5	$ 559	NONE	1 QTR 72
UH-1D	332	EXCESSIVE WEAR	23.5	682	NONE	2 QTR 72
UH-1H	214	EXCESSIVE WEAR	29.8	680	NONE	2 QTR 72
OH-6A	181	EXCESSIVE WEAR EXCESSIVE VIB. CRACKS	50.6	1,353	NONE	2 QTR 74

ILLUSTRATION 12

MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

DAMPER ASSEMBLIES

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
UH-1D	531	WORN EXCESSIVELY INTERNAL LEAKS	41.3	$ 120	$ 96	3 QTR 72
UH-1H	518	EXCESSIVE WEAR	19.6	55	44	3 QTR 72

ILLUSTRATION 13

MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

MAST ASSEMBLIES

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
OH-58A	780	EXCESSIVE WEAR	18.9	$ 707	$ 89	3 QTR 72
AH-1G	563	EXCESSIVE WEAR	17.0	1,473	435	4 QTR 73
UH-1D	816	EXCESSIVE WEAR	18.4	954	374	4 QTR 71
UH-1H	746	EXCESSIVE WEAR	13.2	954	374	3 QTR 71

ILLUSTRATION 14

MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

ENGINE TO TRANSMISSION DRIVESHAFTS

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
AH-1G 2040400107	288	EXCESSIVE WEAR	37.9	$ 1,464	$ 270	4 QTR 73
AH-1G 2050400043	331	LEAKING	32.9	1,464	270	4 QTR 73
UH-1D	375	EXCESSIVE WEAR OIL LEAKS	40.2	1,376	280	4 QTR 71
UH-1H	285	EXCESSIVE WEAR OIL LEAKS	43.9	1,376	280	3 QTR 71
CH-47A	493	UNBALANCE EXCESSIVE WEAR	25.2	652	300	3 QTR 72

ILLUSTRATION 15

MAJOR ITEMS (TBO, FINITE LIFE & INTENSIVE MANAGED ITEMS) COMPARISONS

SCISSORS AND SLEEVE ASSEMBLIES

MODEL DESIGN. SERIES	REMOVAL RATE (FLYING HOURS)	REASON GIVEN FOR REMOVAL	PERCENT OF ALL REMOVALS	NEW COST $	OVERHAUL COST $	REPORT DATE
AH-1G	527	EXCESSIVE WEAR	46.7	$ 1,420	$ 391	1 QTR 72
UH-1D	770	EXCESSIVE WEAR BEARINGS	46.3	676	352	4 QTR 72
UH-1H	677	EXCESSIVE WEAR BEARINGS	35.4	676	352	3 QTR 72

APPENDIX A

DESCRIPTION OF RAMMIT REPORTS

RELIABILITY AND MAINTAINABILITY MANAGEMENT IMPROVEMENT TECHNIQUES

(RAMMIT)

This appendix is designed to display data available through other RAMMIT reports. Due to the interrelationships among these various reports, the data and analyses found in one report may be presented in much greater detail in another report. In many cases, other reports must be consulted to determine influencing factors or to obtain related data elements. Therefore, due to these relationships among the various reports, a person utilizing any of the reports should also have an understanding of what information is available in other outputs. To supply this basic understanding, the following paragraphs briefly describe the basic RAMMIT reports which are available.

EIR FLEET QUARTERLY SUMMARY

This operational program is basically an accountability system of EIRs received into the Command during each month of the preceding quarterly time frame. The number of EIRs received for each TMS fleet and the action office to which they were assigned is defined. For each TMS fleet and action office, the following categories are displayed for each month within the quarter: Number of EIRs received; number assigned to that action office; those that were answered, and by what method; those that were assigned to cases; those that were not answered or assigned from that time frame; the backlog at the beginning of the quarter; of that beginning backlog; those that were answered or assigned that quarter; and finally, the backlog at the end of each quarter. For the ending backlog, a dated 30 day histogram is provided to indicate the age of those in the ending backlog.

ACTION - AIRCRAFT COMPONENT TIME SINCE INSTALLATION, OVERHAUL, OR NEW

This report is initiated by request for selectec time change, finite life, or condition components which are included in the DA Form 2410 reporting system. Included in the report for a specific FSN and part-numbered component is a display of average time to removal for each and all failure codes. Further, the average time to removal for each failure code is presented for components which have had zero prior overhauls, one prior overhaul, and two or more prior overhauls. Therefore, each report displays the average time to removal, causes or removal, and the effects of overhauls on average times to removal and reasons for removal.

RIADS - REPORTABLE ITEMS ACTION DATA SORTS

This report is initiated on a scheduled basis for selected time change, finite life, or condition components which are included in the DA Form 2410 reporting system. RIADS is designed to summarize and allow for a rapid comparative analysis of the reliability and maintainability characteristics of the detailed information included in the ACTION (Aircraft Component Time Since Installation, Overhaul, or New) report. Included in the report for each part number - federal stock number combination of a TMS (Type, Model, Series) are manhours required for installation, dominant failure code, reliability index (average operating hours per installation), and a maintainability index (average manhours required to install the component divided by the average operating hours per installation).

MIRF - MAJOR ITEM REMOVAL FREQUENCY

This is a scheduled report which reflects frequency of removals for those components which are included in the DA Form 2410 reporting system. A breakdown by fail code of the number of removals per

flight hour interval is tabulated for each specific FSN and part-numbered component. Listings for those components with no prior overhauls and those with one prior overhaul are included. The average time since new or average time since overhaul is listed for each reported fail code. The total number of removals as well as percent of total removals is carried for each flight hour interval. The report is further divided with respect to failures (actual failed components) and non-failures (time change, removals to facilitate other maintenance, etc.).

CYCLIC OVERHAUL ANALYSIS

This is a special report initiated to analyze the current UH-1D and UH-1H helicopter cyclic overhaul methods. The Cyclic Overhaul Report consists of five interim reports providing aircraft downtime time analysis, part number identification, maintenance trend analysis, conditional return philosophy, and recommendations and conclusions.

MIT - MAJOR ITEMS TRENDS

This report is initiated on a scheduled basis for selected time change, finite life, or condition items which are included in the DA Form 2410 reporting system. MIT is designed to summarize and allow for a rapid trend analysis of the reliability and maintainability characteristics of the detailed data presented in the ACTION (Acircraft Component Time Since Installation, Overhaul, or New), RIADS (Reportable Items Action Data Sorts), and MIRF (Major Item Removal Frequency) reports.

QAMS - QUALITY ASSESSMENT MANAGEMENT SUMMARY

This report is scheduled for publication on a quarterly basis. The data is summarized by subject rather than by aircraft TMS (type, model, series) and presents an assessment of quality primarily related to the production and depot overhaul phases of the life cycle and fielded data pertaining to quality overview of an in-depth assessment ranging from the quality of repair parts, the level of quality attained by cognizant contractors, the quality of AVSCOM material in depots, through assessment of quality data generated in the field.

ASOAP MASTER INDEX

The ASOAP Master Index by aircraft serial number is an index used to locate data on the ASOAP files. It consists of a listing by aircraft serial number of the aircraft TMS, component type and serial number, laboratory control number, and date. The Master Index can be used to identify the oil-wetted components in applications such as determining configuration, time since new (TSN), time since last overhauled (TSLO), etc.

ASOAP PARTICIPATION SUMMARY

The ASOAP Field Participation Program summarizes SOAP related data on oil-wetted components for a selected time period sorted by unit identification code (UIC). Information that is presented includes aircraft TMS and serial number, component type and serial number, lab control number, number of samples, hours and date the last sample was received, and response days. This information can be used in areas such as determining the degree of participation by UIC because this is essentially a record of the unit's oil sample submitted during the selected time period.

ASOAP SUMMARY BY COMPONENT

The ASOAP Summary Report by Component summarizes ASOAP related data for a given component and calendar year. By aircraft model, the data is summarized uncer headings of Maintenance Evaluation/Feedback Data, Number of Samples Analyzed, Reason Why Sample Was Taken, Laboratory Action, and subheadings for further clarification. Examples of these subheadings are; Number of Components Sent to Depot, Special Lab Samples Analyzed, Samples Taken After Aircraft Crashed, Number of Resamples Requested, and Sample Taken Prior to Component Being Removed. Counts against each subheading are made by quarters and a total given for each year.

A similar report, ASOAP Summary Report by Laboratory, is also available. It contains essentially the same information but is sorted by SOAP laboratory. Both of these reports are avaiable on an "As Requested" basis.

AIRCRAFT SERIAL NUMBER AND TMS LIST

The aircraft serial number and TMS list provides:

a. A numberical listing by aircraft serial number, beginning with the lowest serial number in the Army inventory and increasing to the highest. Along side each serial number is the TMS for that particular number.

b. The second listing is a sort by particular TMS which lists in numerically increasing order each serial number for the aircraft within that specific TMS.

c. Another report is also generated identical to the one above except for a third column which is added to give a five digit date. The first two digits of which gives the year, while the other three give the Julian date. This date represents the last date reported on DA Form 1352 for this particular serial number and TMS. The existence of this column also makes the report confidential.

CRASH FACTS

Pertinent information concerning aircraft crashes will be published monthly or on demand by TMS fleet. The information included relates to the degree of damage, causes of the accident, and components or systems suspected as being contributing factors.

MAINTENANCE ACTION SUMMARY

The purpose of this program is to delineate by Work Unit Code all maintenance performed for a selected TMS fleet and time frame. It is applied to the Maintenance Action File, a comprehensively edited file of all maintenance at the organizational and support echelons. The Work Unit Code developed as an in-house effort to identify and subordinate to its lowest possible level all maintenance reported for an aircraft. The Maintenance Action Summary defines maintenance on the end item level, functional group, section, installation, assembly, subassembly, and part. For each number of occurrences, high three fail modes and count, and maintenance manhour totals and average are reported. Appropriate summarizations are provided at different levels. This document is presently an in-house tool for RAM and Product Assurance assessments.

VALIDATION STATISTICS

This program is applied to an edited Maintenance Action File, its purpose being to indicate the quantity and quality of maintenance reporting at the individual aircraft and fleet levels. It essentially generates a flight hour base to be used in evaluating the maintenance statistics in the file, which is for a selected TMS fleet and time frame. The parameters displayed include the flight hour base for the time frame, the number of "gap" (or voids in reporting) flight hours, number of maintenance actions at organizational and support echelons, and the maintenance manhours expended at the two echelons. Computations from these fields provide Maintenance Manhours per Flight Hour and Mean Time Between Maintenance Actions for each aircraft and the fleet for each time interval.

TALCMOR - THE AIRCRAFT LIFE CYCLE MAINTENANCE AND OWNERSHIP RECORD

A chronological listing, starting with the acceptance of an aircraft into the Army Inventory, comprised of all maintenance actions performed on the aircraft, transfers of ownership, and scrappage or salvage actions which occur during the life cycle of the aircraft, was developed to provide a historical record of maintenance and ownership for each aircraft in the Army Inventory. The arrangement od data in this listing, termed "The Aircraft Life Cycle Maintenance and Ownership Record (TALCMOR), facilitates the application of validation procedures and allows numerous other analyses to be performed; such as, reconstruction of lost records, establishment of failure trends, detection of design deficiencies, etc. This listing is available for each serial-numbered aircraft on request. Although

the original TALCMOR reports included much coded information, the current TALCMOR format is easily read and understood. This has been accomplished by rearranging and labeling the various data elements and by the inclusion of descriptions for coded information.

TASIR - THE AIRCRAFT SELECTED ITEMS RECORD

This report is initiated by request for information pertaining to installations and removals of "All or Selected" time change, finite life, or condition components on one serial-numbered aircraft. The selected components must be those included in the DA Form 2410 reporting system. Thus, a TASIR for a given serial-numbered aircraft consists of a chronological history of removals and installations of selected types of components (transmissions, gearboxes, rotor blades, etc.). Each record in the chronological listing is presented in a paragraph format which can be read and understood without the use of codes or special knowledge of the TAERS 2410 system or reporting form.

CASIR - CHRONOLOGICAL ANALYSIS OF SELECTED ITEMS RECORD

This report is initiated by request for selected serial-numbered finite life, time change, or condition items included in the DA Form 2410 reporting system. The purpose of the report is to develop the maintenance history of each of the selected serial-numbered components. This includes the individual aircraft on which the components have been installed and the removal and overhaul history of each component. Thus, the maintenance history and Army Organizations responsible for this history are displayed. This information is displayed in a paragraph format which can be read and understood without the use of codes or special knowledge of the TAERS 2410 system or reporting form.

CHAOS - CHRONOLOGICAL, HISTORICAL AIRCRAFT OWNERSHIP SUMMARY

This is a special report initiated by a request for information pertaining to an individual aircraft's owning unit, usage, and operating time per month. The CHAOS Report summarizes the information on DA Form 1352 into a month by month history of the aircraft indicating the total flight hours; the description of aircraft usage; the aircraft type, model, and series, and the owning unit at the end of each month.

ACPU - AIRCRAFT OPERATIONAL UTILIZATION

This report is designed to present some of the factors influencing the utilization of a fleet and its aircraft by geographical (Army) areas. Data from this report can be used to analyze flight hour and calendar age since new, assignment-functional categories and quantities of operationally and not operationally assigned aircraft, operational readiness and related data, flight hours per aircraft,

and landing data. Utilizing the DA Form 1352 reporting system, reports will be published quarterly to present data for the last twelve month period.

EMERGENCY EIR REGISTER (SPECIAL)

This is a manually prepared and maintained, register of Emergency EIRs (2407s and TWXs). All EIRs received which are classified as Emergency remain on this register until closed. Card columns are explained as follows:

SAV-HQ Form (No Number) (Explanation)

Column 1. This is the period of time longer than the authorized processing periods; i.e., 30 days, 150 days, etc.

Column 2. This is the date assigned from EIR Control (this is the date we use to establish processing periods, reporting and accountability).

Column 3. An unprofessional description of the problem.

Column 4. The Pre-printed Control Number assigned to DA Form 2407 EIRs.

Column 5. TWX Number - if received.

Column 6. Action Office; i.e., UH-1, Power Plants, General Items, Quality Assurance, etc.

Column 7. Type, model, and series; i.e., UH-1D

Column 8. Safety of Flight - yes or no.

Column 9. Any reportable (to machine) action taken prior to closing; i.e., downgraded, transferred, etc.

Column 10. Interim action - awaiting engineering decision, more information requested, exhibits desired, etc.

Column 11. Date all actions are completed.

LIST OF EMERGENCY EIRs

Listing No: 3EE2AMPI (Special). Special Listing: This printout functions as an index to all Emergency EIRs, and includes those which have been downgraded. It is sorted by the date entered on an alpha-numeric basis by EIR pre-printed number, and can be used to locate the action office responsible for the Emergency EIR when only the EIR Control Number is known. There are six action date code columns available to show actions taken. The printout shows the following data: EIR Control Number, Action Office, Date Assigned, Case Number, Case Code, Priority Code, Action Date and Manufacturer's Code.

MASTER EIR FILE

Listing No: EPL-26. This printout is a master index of all EIRs received within the Command. It is sorted in alpha-numeric order by the pre-printed EIR Control Number. The following data is shown on the printout: EIR Control Number, Action Office Assigned and Date Assigned; Case Number, Type Case (Action or Record), Status of EIR (Open or Closed), Date of Case, and type of closing action taken on the EIR.

MASTER EIR CASE FILE

Listing No: EPL-27. This printout functions as an index to all open and closed cases. It includes all the EIRs assigned to each case; the Action Office and if the EIR is open or closed. It is sorted alpha-numerically by EIR Case Number. The following data is shown on the printout: Case Number, Case Code, Priority Code, Date of Case, EIR Control Number, Action Office Date Assigned, and Date Closed.

MASTER EIR OPEN FILE

Listing No: EPL-28. This printout functions as an index to all open EIRs. It is sorted on an alpha-numeric basis by EIR pre-printed number, and can be used to locate the action office responsible for an open EIR if only the EIR Control Number is shown. There are six action date code columns available to show actions taken. The following data is shown on the printout: EIR Control Number, Action Office, Date Assigned, Case Number, Case Code, Priority Code, Action Code, Action Date, and Code Number of Manufacturer.

MASTER EIR FILE BY PART NUMBER

Listing No: EPL-29. This printout functions as an index of defects or discrepancies reported against specific parts or components and is sorted on an alpha-numeric basis by part number and includes open and closed EIRs. The following data is shown on the printout: Defective Part Number, Case Number, Case Code, Priority Code, EIR Control Number, Defective FSN, End Item FSN, Action Office,

Date assigned Office, Date Closed, and UIC Submitter.

OPEN EIRS BY ACTION OFFICE

Listing No: EPL-30. This printout functions as a quick reference to the total count of open EIRs only and is sorted by action office. There are six action columns available to show the action taken. The following data is shown on the printout: Action Office, EIR Control Number, Date Assigned Office, Case Number, Case Code, Priority Code, Action Code, Action Date, and the Manufacturer's Code Number.

OPEN EIRS HELD BY MANUFACTURER

Listing No: EPL-31. This printout functions as an index to EIRs being investigated by the contractor and also shows length of time since it was transmitted. The printout is sorted by the manufacturer's code. The following data is shown on the printout: Manufacturer's Code, Action Code, Date sent ot Manufacturer, Case Code, Priority Code, Date of Case, EIR Control Number, and Defective Part Number.

OPEN EIRS BY STATION SUBMITTING

Listing No: EPL-33. This printout functions as a reference to the frequency of EIRs recieved by the activity and is sorted by the UIC of the unit submitting the EIR. The following data is shown on the printout: UIC Submitter, EIR Control Number, Date Submitted, Date Received, Action Office, Date Assigned, and Last Action Code and Date.

COMPLETED EIRS BY ACTION OFFICE NUMBER

Listing No: EPL-34. This printout functions as an index to completed EIRs which can be located by EIR Control Number by office assigned. The data on the printout is sorted by action office then sorted by EIR Control Number. The following data is shown on the printout: Action Office, EIR Control Number, Date Assigned, Case Number, Last Action Code, and Last Action Date.

COMPLETED EIR CASES BY ACTION OFFICE

Listing No: EPL-35. This printout functions as an index to closed EIR cases. The data is sorted by Action Office (primary sort) and then sorted by EIR Case Number. The following data is shown on the printout: Action Office, Case Number, Date of Case, Last Action Code, Last Action Date, and EIR Control Number.

EIR CASE HISTORY

Listing No: EPL-36. This printout furnishes a convenient summary of the defective component data which makes up each EIR case. All EIRs which make up the case are shown on this printout. This printout is sorted by each action office, then sorted by EIR Case Number. The individual action office sort is by system code, defective part number, failure code, type, model, and series. The following data is shown on this printout: Case Number, Case Date, Case Type, Priority Code, Case Subject, Digest/Date Submitted and Published, Date of EIRs (first/last), Action Office, Case Applicability, EIR Control Number, Date, EIR Type, Number of Defective Units Cited on EIR, Type, Model, Series, Aircraft Serial Number, Aircraft Total Time Component Serial Number, Component Total Time, Time Since Overhaul, Remarks, Last Action Code, Last Action Date.

EIR EXHIBIT CONTROL

Listing No: EPL-39: This printout is formatted in a sequential layout which is designed to indicate exhibit availability and highlight incomplete actions required to forward the exhibit to the investigating agency and also indicate delinquent action. The following action codes are used on the printout: Action Code 6 (exhibit available), 7 (exhibit not required), 8 (exhibit required), Code D (disposition instructions to Materiel Management) 2 (Material Management directed forwarding of exhibit), 3 (exhibit received by investigating agency), 4 (disposition received to dispose of exhibit), 5 (exhibit not received by the investigating agency). Further, this data is shown on the printout: EIR Control Number, Exhibit Available, Action Office, Defective P/N, Serial Number, Exhibit Not Required, Exhibit Required, Request Exhibit, Directed Forwarding of Exhibit, Record, Not Recorded, and Directed Disposal.

MASTER OPEN EIR CASE FILE

Listing No: EPL-40. This printout functions as an index to all open cases. It includes the case number and all the EIRs assigned to each case. The following data is shown on the printout: Case Number, Action Office, Date Assigned, EIR Control Number, Case Code (Action = A), (Record = R), Priority Code (O = Open), (C = Closed), Action Code: Alpha Code to describe action taken by action office, action date, and code number of manufacturer.

FG NUMBER INQUIRY

"FG Number" is the terminology given to dummy FSNs which are assigned to the noun nomenclature of an aircraft component. Some of these nouns may have a valid FSN, which is acceptable since it is the noun that is keyed upon. In this situation all maintenance action information to components of like nouns are consolidated under one FG Number.

A FG Inquiry is initiated by a request for failure information pertaining to specific aircraft components. This information is available in the TAMMS Data Bank, which record all 2407 and 2408-3 reported maintenance actions. The output information includes failure codes, item FSN/PN, if any, action code, aircraft SN and hours, report and repair UIC, and maintenance manhours. The FG Inquiry is an interim measure for getting this type of information for fleets which a WUC has not been assigned. Once WUCs are assigned, the WUC Inquiry is used.

WORK UNIT CODE INQUIRY

A "Work Unit Code" (WUC) is a nine-character, alpha-numeric code used to place an aircraft component or item in an appropriate block diagram of the aircraft into levels of functional hierarchy, i.e., functional group, section, installation, assembly, subassembly, and part levels. A WUC is assigned to every item reported in the RAMMIT Maintenance Actions File, which records all 2407, 2408, and 2410 reported maintenance actions.

A WUC Inquiry is initiated by a request for failure information pertaining to specific aircraft components. By keying on the WUC, this information is extracted from the RAMMIT Maintenance Actions File. The output information includes failure codes, item FSN/PN, if any, action code, aircraft SN and hours, report and repair UIC, and maintenance manhours.

MSR - RAM MANAGEMENT SUMMARY

The Army Maintenance Management Summary (TAMMS), as required by TM 38-750, was combined with other existing data sources to develop the Reliability and Maintainability Management Improvement Techniques (RAMMIT) system. The analysis of this data provides field maintenance and performance information for all Army aircraft and a means to measure costs and manhours utilized in operation and repair of specific equipment. At the same time, specific problems experienced with engines, drive trains and other components in the field, are presented with supporting data to initiate correction of the deficiencies.

It is intended forthis report to be utilized by top-level management concerned with planning for future development, designs and procurement of new aircraft and to permit timely improvements in maintenance, support and safety on a system/subsystem basis for the specific aircraft fleet represented in each report.

MISS - MAJOR ITEM SPECIAL STUDY

The Army Maintenance Management System (TAMMS) provides for reporting all maintenance actions accomplished on selected items or components which require intensive management by the National Maintenance Point (NMP). This Headquarters utilizes Technical Bulletin 55-1500-307-25, Aircraft

Components Requiring Maintenance Management and Historical Data, to specify those items for each aircraft fleet which must be controlled to assure that finite life, time before overhaul and condition change limitations are compiled with.

In the Reliability and Maintainability Management Improvement Techniques (RAMMIT) system, the MISS report is a detailed study of a specific part numbered component from the selected list of reportable items which is analyzed by flight hour intervals for the entire life span of the aircraft system. This analysis concerns removal frequencies; failure modes of the item; material or induced failures and non-failures reported as equipment removals for maintenance purposes. The study compares current new and overhaul costs for the item together with manhours and replacement costs with the present failure history. A computer program is used to remove and redistribute those failures to portray the same item in service without the particular deficiencies. This theoretical improvement of the equipment provides an extension of current Mean Time to Removal (MTR) and lowers costs for maintenance manhours and equipment replacements.

QUARTERLY RECORD OF FIELD EQUIPMENT IMPROVEMENT RECOMMENDATIONS

This is a quarterly report for each TMS fleet. Its primary purpose is to show the summation of Equipment Improvement Recommendations (EIRs) on each TMS fleet. The data will be tabulated according to the -35P manuals to show which items, assemblies, and functional groups are the subjects of the EIR reporting. The appendix of each TMS EIR report lists and answers certain questions which are designed to point out trends in the reporting.

QUARTERLY RECORD OF DEPOT-LEVEL MAINTENANCE

This type of report is comprised primarily of a well organized computer printout of reported maintenance and manhour expenditures on individual aircraft processed through depots and depot level activities for cyclic overhaul. Also included in the report are an index of applicable aircraft serial numbers and descriptions of all data elements included. This type of report establishes a record of exactly what maintenance was performed on each aircraft and can be used in some cases to: compare the maintenance performed by various depots; determine the effectiveness of lower echelons of maintenance; study the cost effectiveness of Army versus contractor-operated depots; and to investigate field complaints concerning aircraft returned from depot overhaul.