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IDENTIFICATION AND ANALYSIS OF ARMY HELICOPTER RELIABILITY AND MAINTAINABILITY PROBLEMS AND DEFICIENCIES

VOLUME II

UTILITY, ATTACK, AND TRAINING HELICOPTERS (UH-1, AH-1, TH-1)

By

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William K. Krauss

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April 1972

EUSTIS DIRECTORATE

U. S. ARMY AIR MOBILITY RESEARCH AND DEVELOPMENT LABORATORY

FORT EUSTIS, VIRGINIA

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AMERICAN POWER JET COMPANY

RIDGEFIELD, NEW JERSEY

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Utility, Attack, and Training Helicopters (UH-1, AH-1, TH-1)

American Power Jet Company Report 670-3

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FORT EUSTIS, VIRGINIA

ABSTRACT

This volume presents discussions of a series of reliability and maintainability problems related to Army Utility, Attack, and Training Helicopters (UH-1, AH-1, TH-1). A detailed discussion of the standard format used for problem presentation and of the various analysis elements within the standard format is provided in Volume I.

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Helicopter TMS: UH-1B,C,D,H
Problem No.: 01-1*

Problem Title: Transmission Pylon Mount Dampers

Problem Description:

A. Component Identification -

	P/N	A/C
Damper	204-031-920-1	B
	204-031-920-3	C,D,H
Retaining Clip:		
Left Hand	204-031-919-43	B,C
Left Hand	205-030-163-187	D,H
Right Hand	204-031-919-45	B,C
Right Hand	205-030-164-187	D,H

B. Description of Failure -

1. Dampers do not function properly. They transmit shocks directly to the damper mount retaining clip. In particular, the 205-030-163-187 (UH-1D,H) damper retaining clip is subject to frequent failure along the corner radius of the channel extrusion from which it is made.

2. Dampers malfunction and produce excessive helicopter vibration during certain flight maneuvers.

C. Cause of Failure -

1. Water, oil and other contaminants enter the dampers, resulting in freezing, damper wear and weakened dampers which contribute to excessive stress placed on the damper retaining clips.

2. Retaining clips crack and break due to metal fatigue resulting from excessive stress.

D. Period and Duration of Problem -

1. Damper malfunctioning - 1965 to present
2. Damper mount clips - 1967 to present

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* Although the dampers are listed in TM -34P for the UH-1 under Functional Group 04, they are listed in Group 01 for the AH-1. The problem is reported here under Group 01 for consistency and convenience.

Problem No.: 01-1 (Continued)

E. Failure Rate Data -

The following MTBRs are based on usage at the Aviation School at Ft. Rucker during the year ending 30 April 1971.

	P/N	A/C	MTBR (hours)
Damper	204-031-920-1	B	974.0
	204-031-920-3	D,H	740.9

F. Mission and Deployment Factors -

Common to all missions and deployments.

Problem Impact:

A Safety Factors -

Problems with dampers and retaining clips do not constitute a safety hazard. During the period January 1967 - March 1971, only a small number of precautionary landings were recorded and attributed to damper material failures, and none for maintenance error.

B. Maintenance Workload Factors -

Replacement of dampers is accomplished at the direct support maintenance level and requires 3.5 - 5.0 manhours.

C. Aircraft Availability Factors -

Downtime for replacement of dampers will range from 4 to 8 hours.

Remedial Action:

1. February 1966 - Use of improved wave washer on production aircraft by Bell Helicopter Company in friction dampers.

2. TB 750-992-3 (1969) EIR Digest provided remedial action for failed damper mount clips. Action recommended included the replacement of all failed damper mount clips made from FSN 9540-147-5175, 7075-T6 channel extrusion.

Data Sources:

3,7,8,12,15,33,34,36,39,43,44.

Problem No.: 01-1 (Continued)

Cross References:

TMS	Problem Number
UH-1	-
AH-1	01-1
CH-47	-
CH-54	04-10
OH-6	02-2
OH-58	01-1, 01-2

Helicopter TMS: UH-1A,B,C,D,H
Problem No.: 01-2

Problem Title: Windshield and Cabin Roof Windows

Problem Description:

A. Component Identification -

	P/N	A/C
Windshield Assembly,		
Left Hand	204-030-666-19	A
Left Hand	204-030-666 43	B,C,D,H
Right Hand	204-030-666-20	A
Right Hand	204-030-666-44	B,C,D,H
Window Assembly,		
Left Hand	204-030-673-3	A,B,C
Left Hand	205-030-673-23	D,H
Right Hand	204-030-673-23	A,B,C
Right Hand	205-030-673-24	D,H.

B. Description of Failure -

1. Windshield crazed and scratched. This limits visibility, sometimes restricts flying to daylight hours, and can result in distortions when repaired by polishing.

2. Cabin roof cracked and crazed.

C. Cause of Failure -

1. Contaminants (dirt, dust, sand, etc.) on windshield act as abrasives when wiper is operated. The abrasive action of contaminants is aggravated when wipers are operated on dry windshields.

2. Sun and heat.

3. Original wiper specification was incorrect, resulting in excessive pressure of the wiper blade against the windshield.

4. Use by maintenance personnel of cabin roof for stepping and body support, subjecting panel to excessive external forces.

D. Period and Duration of Problem -

1964 to present

Problem No.: 01-2 (Continued)

E. Failure Rate Data -

1. The following MTBRs have been computed for failures which required replacement. They do not include unscheduled maintenance requiring repair only. MTBRs are based on failure and replacement data at the Aviation School, Ft. Rucker during the period May 1970 - April 1971.

	P/N	A/C	MTBR (hours)
Windshield Assembly,			
Left Hand	204-030-666-1	A	1594
" "	204-030-666-43	B, D, H	1515
Right Hand	204-030-666-20	A	1457
" "	204-030-666-44	B, D, H	1368
Cabin Roof Window Assembly,*			
Left Hand	204-030-673-3	A, B	1874
" "	205-030-673-23	D, H	2196
Right Hand	204-030-673-15	A	3643
" "	204-030-673-23	A, B	2176
" "	204-030-673-24	D, H	1742

F. Mission and Deployment Factors -

Common to all missions and deployments, but aggravated by hot-dry, dusty environments. Environments which combine dust and dirt with heavy dew also aggravate the problem since the accumulation of such dirt during the day acts as an abrasive when dew is removed the following morning by wiper operation.

Problem Impact:

A. Safety Factors -

Scratching and crazing of windshields, as well as crazing and cracking of cabin roof window assemblies, do not constitute a safety hazard as far as mechanical failures are concerned. Only one case was reported in the period January 1967 - March

* It was stated at ARADMAC (Pre-Induction Branch) that roof glass replacement during overhaul amounts to almost 100%.

Problem No.: 01-2 (Continued)

1971 of a mishap (incident) occurring as a result of window failure, when a window assembly (P/N 204-030-673-3) broke during flight. Nevertheless, it is clear that the impaired visibility of windshields can, under certain lighting conditions, constitute a major hindrance to flight safety and can also severely restrict the mission availability of the aircraft.

B. Maintenance Workload Factors -

Replacement of windshields and cabin roof window assemblies is performed at the organizational maintenance level. Maintenance requirements are as follows:

		Manhours
1.	Replace windshield -	12.0 - 15.0
2.	Repair windshield in accordance with TM 55-405-4 (depending on severity)	2.0 - 8.0
3.	Replace cabin roof windows	1.7 - 2.6
4.	Repair cabin roof windows in accordance with TM 55-405-4	1.0 - 2.0

C. Aircraft Availability Factors -

Downtime for replacement of windshields will normally range from 2 - 3 days assuming a two-man crew. Replacement of roof windows required 3 - 4 hours downtime, as does repair of windshilds and roof windows.

Remedial Actions:

A number of studies have been made of the problem and proposals submitted for improved overhead window and windshield components. However, remedial action in this area has been extremely limited.

The EIR Digest for the issues listed below cited the windshield scratching problem, and included references to TM 55-405-3 for proper cleaning instructions and TM 55-405-4 for windshield repair procedures:

a. TB 750-992-1 (1969)
b. TB 750-992-1 (1970)
c. TB 750-992-2 (1971)

Problem No.: 01-2 (Continued)

Data Sources:

3, 7, 8, 9, 10, 12, 15, 21, 31, 33, 35, 36, 38, 39, 41, 42.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	01-3
CH-47	01-2
CH-54	-
OH-6	01-2
OH-58	-

Helicopter TMS: UH-1 All Series
Problem No.: 01-3

Problem Title: Doors, Door Latches, Door Windows, Door Posts, Tracks, and Associated Hardware

Problem Description:

A. Component Identification -

	P/N	A/C
Door Assembly, Crew:		
Left Hand	204-030-853-119	A, B, C, D, H
Right Hand	204-030-853-120	A, B, C, D, H
Latch Assembly, Crew:		
Left Hand	H481-1	A, B, C, D, H
Right Hand	H481-2	A, B, C, D, H
Crew Door Window Assembly:		
Left Hand	204-030-770-1	A, B, C, D, H
Right Hand	204-030-770-2	A, B, C, D, H
" "	204-030-799-1, -3	A, B, C, D, H
Door Assembly, Crew:		
Left Hand	204-030-669-141	A, B, C
" "	205-031-669-15	D, H
Right Hand	204-030-669-142	A, B, C
" "	205-031-669-16	D, H
Cargo Door Slide Assembly	204-030-220-1	A, B, C, D, H

B. Description of Failure -

1. Cargo doors:
   a. Door latches broken.
   b. Door race fails to retain door, resulting in loss of door.
   c. Wear and damage to nylon stops, particularly on D and H models.
   d. Excessive wear of lower aft nylon roller, resulting in breaking and loss of entire roller assembly.
   e. Cargo door slider wears excessively, causing door to bind and center tracks to crack.

Problem No.: 01-3 (Continued)

2. Crew door
   a. Door latches and handles broken.
   b. Forward door post corners damaged where hinges (P/N 204-031-658-1, -2) are attached to fuselage.
   c. Door posts cracked loose at top, particularly on B model gunships.
   d. Door hinges twisted and broken.
   e. Door windows cracked and broken.

C. Cause of Failure -

1. Overall causes of failure include the following:
   a. Design inadequacies; e.g., failure to include door stops.
   b. Equipment usage outside the limits or in a manner not envisioned in the original design; e.g., flying with doors open.
   c. Rough usage; e.g., slamming crew doors.
   d. Material inadequacies.
   e. Excessive vibration.
   f. Operating and maintenance environment (see 2.f below).

2. Among the causes of failure which have been identified for specific problems are the following:
   a. Failure of the cargo door race to retain the door was caused by the absence of stops; in some cases, doors would slide off the race and be lost.
   b. Damage to door tracks are primarily due to the practice of flying with doors open. The rear bearing or wheel on the door vibrates within the track, causing chafing and excessive wear, failure of the door stop, or in some cases, failure of the track itself.
   c. Damage to nylon stops results from inability of the nylon to withstand the stresses placed on it.
   d. Forward door post corner failures are largely due to design, which incorporates door stops, upper and lower, affixed to the door mount of the forward doors. During exit, the door is subject to slamming against these stops; the stops and remainder of the mounts are twisted within the A/C structure and result in failures of the corner posts.

Problem No.: 01-3 (Continued)

e. Failure to rotate cargo door sliders to compensate for the greater wear on the lower sliding surfaces (due to door weight) as compared to upper sliding surfaces.

f. Crew door hinges and windows are broken and cracked when doors opened for maintenance are slammed shut by rotor downwash from nearby hovering aircraft.

g. Crew door hinges and windows break and crack, and hinges loosen, due to excessive wear of hinge pivot bushings.

D. Period and Duration of Problem -

1964 to present

E. Failure Rate Data -

Failure data in these problem areas provide MTBRs only for those components and parts requiring removal and replacement. They do not include those failures requiring only repair or adjustment. As such, therefore, the MTBRs given are higher than rates which would reflect all unscheduled maintenance actions, whether part replacement was required or not.

Failure data reflect parts issued to specific aircraft of the UH-1 fleet (A,B,D,H) at the Aviation School at Ft. Rucker during one year of operation (April 1970 - March 1971). Total flying time of the combined fleet for this period was approximately 290,000 hours.

	P/N	A/C	MTBR (hours)
Cargo Door Assembly	205-031-669-15,-16	D,H	1263
Cargo Door Assembly	204-030-669-141,-142	A,B	991
Cargo Door Slide Assy.	204-030-220-1	A,B,D,H	466
Cargo Door Roller	205-030-437-5,-7	D,H	81
Cargo Door Bracket	204-030-004-1	A,B,C	94
Crew Door Assembly	204-030-853-119,-120	A,B,D,H	1949
Crew Door Latch Assy.	H 481-1,-2	A,B,D,H	849
Crew Door Handle	AR 133	A,B,D,H	210

Problem No.: 01-3 (Continued)

	P/N	A/C	MTBR (hours)
Crew Door Window Assembly	204-030-459-1,-2	A,B,D,H	1416
Crew Door Window Assembly	204-030-799-1,-3	A,B,D,H	630
Crew Door Window Assembly	204-030-770-1,-2	A,B,D,H	364
Crew Door Hinge Assembly: Upper Right Hand	204-031-837-8 204-031-837-12 204-031-658-2	A,B,D,H	890
Crew Door Hinge Assembly: Lower Right Hand	204-031-467-8 204-031-467-12 204-031-468-2	A,B,D,H	1688
Crew Door Hinge Assembly: Upper Left Hand	204-031-837-7 204-031-837-11 204-031-658-1	A,B,D,H	1423
Crew Door Hinge Assembly: Lower Left Hand	204-031-467-7 204-031-467-11 204-031-468-1	A,B,D,H	1544

F. Mission and Deployment Factors -

Common to all deployments and missions. However, damage to cargo door assemblies and associated hardware, particularly tracks, sliders, and stops, is more severe where aircraft are operated in hot and hot-humid climates, such as Vietnam, due to the practice of flying the aircraft with doors open.

Problem Impact:

A. Safety Factors -

During the period January 1967 - March 1971, there were a total of 37 mishaps worldwide, with the exception of USAREUR, involving cargo doors. No crew doors were reported involved. Of these 37 mishaps, 1 was a total loss (UH-1D), 35 were incidents (class 4), and 1 was a precautionary landing. Twenty-two of the mishaps were attributed to maintenance error, and 16 to material failures. UH-1D,H aircraft accounted for 30, or 81.1%, of the recorded mishaps.

Problem No.: 01-3 (Continued)

In general, mishaps were caused by failure and/or loss of cargo doors in flight. The most common reasons for cargo door failures were:

1. Flying with doors open
2. Retaining pins missing, or improperly installed, or not utilized
3. Doors improperly installed

Most of the mishaps involving cargo door failures occurred in Vietnam, including the UH-1D loss.

B. Maintenance Workload Factors -

Corrections of door malfunctions do not present major individual maintenance problems but cumulatively can take up a disproportionate amount of maintenance manhours. Following are some average manhours for maintenance related to door repairs, adjustments, and replacements:

Action	M/H	Level of Maint.
Replace Door	.5	Organizational
Repair Door (minor)	1.5	Organizational
Repair Door (extended)	1.0- 5.0	Direct Support
Adjust Door	1.0	Organizational
Replace Latch	1.0	Direct Support
Repair Latch	1.0- 2.0	Direct Support
Replace Handle	1.0	Direct Support
Replace Hinge	1.0	Organizational
Repair Cargo Door Track	4.0- 5.0*	Direct Support

C. Aircraft Availability Factors -

Downtime will normally range from one to eight hours for any one action, depending on the particular maintenance action required.

Remedial Actions:

1. MWO 55-1520-207-34/31, 7 March 1963 - replacement of crew doors on UH-1A.

2. October 1964 - improved door stop installed on production UH-1D aircraft.

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*Repair is normal method of correcting track problems. Replacement is difficult and requires excessive maintenance manhours.

Problem No.: 01-3 (Continued)

3. MWO 55-1500-200-20/1, 22 December 1965 - modification of cargo door roller assembly (UH-1A,B,D) to include a new slider utilizing a metal frame for a nylon insert which slides on the track. This improved slider assembly was incorporated on production UH-1D aircraft beginning with Serial Number 64-13662 by Bell Helicopter Company, Product Change Authorization PCA 204-2762, in December 1964. This PCA was subsequently modified to become effective with Serial Number 64-13598. This problem was reopened by the M&R Committee in January 1968. In September 1968, Bell Helicopter Service Engineering Memo SEM UH-01-08-13, "Rotation of Cargo Door Slider, P/N 204-030-220-1", for maximum wear benefits was released to the field. This memo contained instructions for rotating the cargo door slider to equalize wear on the upper and lower sliding surfaces.

4. MWO 55-1520-210-20/15, 12 November 1965, and Change 1, 8 March 1966 - installation of cargo door brackets.

5. ECP UH-1B,D,E - 253R for the addition of cargo door retention devices approved for UH-1E production and retrofit July 1966.

6. At ARADMAC, current practice is to replace the stops on the slide tracks of the D and H models with stainless steel inserts because of extensive damage to the original nylon stops.

Data Sources:

3,7,8,9,12,21,33,34,35,36,37,38,39,41,42,43,44.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	01-6
CH-47	01-4, 01-5
CH-54	-
OH-6	01-4
OH-58	-

Helicopter TMS: UH-1A,B,C,D,H
Problem No.: 01-4

Problem Title: Honeycomb Bonded Panels (Sandwich Panels)

Problem Description:

A. Component Identification -

A large number of honeycomb panels are used on UH-1 aircraft. Applications include the engine deck, transmission deck, cabin top work decks, bulkheads, and fuel cell panels. Aluminum sandwich construction panels are used, for example, in floorboards and transmission bulkheads, while titanium sandwich construction panels are used in fire hazard areas, such as the engine, engine work area, fuel cells, and other critical areas.

B. Description of Failure -

Bonded panels crack; they also experience soft spots, weakness, bonding separation, and corrosion. This problem has occurred particularly on the UH-1D and H models. The principal problem is with titanium skinned panels, although all types of honeycomb panels have been affected.

C. Cause of Failure -

1. Bonding inadequacy.
2. Rough usage and damage to surface of honeycomb panels, allowing the penetration of corrosive elements - water, lubricants, etc.
3. Inadequate manufacturing specifications and/or quality control for the cleaning treatment utilized in the bonding process. (Thus, several instances have been experienced at ARADMAC of new panels suffering skin separation while still packaged during shelf storage.)
4. Other factors cited by maintenance personnel as contributing factors are aircraft vibration, aircraft flexing during flight, and harder-than-normal landings.

D. Period and Duration of Problem -

1966 to present

Problem No.: 01-4 (continued)

E. Failure Rate Data -

1. At Ft. Rucker, as of August 1970, 157 aircraft of the 397 aircraft UH-1 fleet had been inspected, resulting in the grounding of 59 aircraft with sandwich panel problems serious enough to warrant repair before further flight. Over 50% of the remaining aircraft which had been inspected for this problem revealed some degree of panel deficiencies requiring repair at the next TIMS inspection period.

2. Approximately 75% of all aircraft inducted at ARADMAC had problems with honeycomb panels. This includes aircraft from worldwide sources. A series of Navy UH-1 helicopters recently processed at ARADMAC all required removal and replacement of titanium panels (at an average of 368 manhours per aircraft).

3. Analysis of panel issues to UH-1 aircraft at Ft. Rucker, during the period May 1970 - April 1971, provides the following MTBRs for replacement of bonded panels (these MTBRs do not include failures requiring only repair):

	P/N	A/C	MTBR (hours)
Floor Assembly	204-030-173-37	A,B	2227
Floor Assembly	204-030-173-38	A,B	2704
Deck Assembly	204-031-197-95	B,C	944
Roof Panel Assembly	204-031-622-3	B	2230
LH Fuel Cell Cover (Titanium)	205-030-173-3	D,H	1041
RH Fuel Cell Cover (Titanium)	205-030-173-4	D.H	1530
RH Service Deck (Titanium)	205-030-279-33	D,H	962
LH Service Deck (Titanium)	205-030-280-29	D,H	765
Bulkhead	205-030-407-286A	D,H	1443
Bulkhead (Titanium)	205-030-407-301	D,H	918
Bulkhead (Titanium)	205-030-407-329	D,H	1148
Center Roof Panel	205-030-601-125	D,H	2020
LH Roof Panel	205-030-602-49	D,H	1530
RH Roof Panel	205-030-602-50	D,H	1486
Deck Assembly	205-031-197-127	D,H	628

Problem No.: 01-4 (continued)

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
Panel failures did not of themselves constitute a problem in aircraft safety; i.e., there have been no mishaps attributable to bonded panel failures. Nevertheless, since panel failures are sufficient to be deadline aircraft, they can have a major negative effect on availability due to the safety hazards they impose.

B. Maintenance Workload Factors -
1. Almost all of the bonded panels which have experienced failures are repaired or replaced at either the direct support or the general support maintenance level (the center roof panel, P/N 205-030-601-125 however, is a depot level maintenance item). The following are replacement manhours for panels and are based on Ft. Rucker experience:

Panel	Manhours
Transmission work deck	24
Engine deck (R,L)	18
Center engine deck	230
Transmission work deck (R,L)	30
Center transmission work deck	32
Fuel cell covers	2

2. Repair of panels using the fix described in the March 1971 TM 55-1520-210-35 requires approximately 32 to 48 manhours (2 to 3 men) and can be done in about 2 days.

C. Aircraft Availability Factors -
Downtime for panel maintenance will vary extensively with the type of maintenance (repair or replace) and panel(s) involved. Minimum downtime will range from 2 - 3 hours for replacement of fuel cell covers to an average of 1.5 - 2.0 days for most panel replacements. The center engine deck, requiring 230 manhours for replacement, is an obvious exception to these figures. Downtime for panel repair ranges from 2 - 3 days.

Problem No.: 01-4 (continued)

Remedial Action:

1. 1965 - Cabin roof panel walkway skin thickness increased from 0.012 to 0.025 aluminum, commencing with production of UH-1D number 65-9811.

2. 1966 - Bell Helicopter Company Service Engineering Memo SE 204-65-37 and SE 204-65-50 released to the field containing information and instructions for field repair of bond voids.

3. 1967 - Information in the above Service Engineering Memos included in the June 1967 revision of TM 55-1520-210-35.

4. 1967 - a. Bell Helicopter Company Process Specification BPS FW 4352 changed to provide an improved cleaning treatment for titanium surfaces to be bonded.

   b. Bell Helicopter Company provided additional testing and acceptance criteria for service deck assemblies (Engineering Orders EO 205FA-1121, -1122).

5. 1971 - Current procedure for fixing bonded panel failures presented in change 7 to TM 55-1520-35, March 1971.

The effectiveness of the remedial actions taken for this problem is difficult to ascertain. The MTBRs range from 627 to 2704 hours, and there is a considerable lag time between fix and possible continuing failure. It was not possible to determine whether the panels used to compute MTBRs had been fabricated prior or subsequent to the remedial actions noted above.

Data Sources:

3,4,7,8,9,10,12,33,34,38,39

Cross References:

TMS	Problem Number
UH-1	-
AH-1	01-7
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: UH-1 All Series
Problem No.: 01-5

Problem Title: Fastener Failures

Problem Description:

A. Component Identification -

Most part numbers for half grommets (Camlocks) and full grommets (Dzus fasteners) used on UH-1 aircraft.

B. Description of Failure -

Fasteners are damaged, are broken, and fall off, and some are ingested by the engine. Among the assemblies which have had and continue to have this problem are:

1. Air induction screen assembly
2. Induction baffle and brace assembly
3. Bellmouth assembly
4. Particle separator and inlet air filter
5. Forward drive shaft access door
6. Aft drive shaft access door
7. 42° gearbox cover
8. Tail fin drive shaft access door
9. Cowls

C. Cause of Failure -

Fasteners are lost due to effects of vibration on worn or damaged items; damage to fasteners also occurs due to forced closure when misaligned.

D. Period and Duration of Problem -

1966 to present

E. Failure Rate Data -

Data not available, due to commonality of types and general application. Additionally, TAERS reporting does not normally pick up failures of these items. This problem, however, was frequently cited in interviews at Ft. Rucker, Hunter Army Airfield, and ARADMAC.

F. Mission and Deployment Factors -

Common to all missions and deployments.

Problem No.: 01-5 (Continued)

Problem Impact:

A. Safety Factors -

Failure of fasteners does not constitute a serious safety problem to the extent that such failures can be specifically identified to aircraft mishaps. During the period 1 January 1967 - 31 March 1971, 14 mishaps were attributed to fasteners. All but one of these caused engine failures, the exception being a case of the throttle bell crank being jammed by a cowl fastener.

Sixteen of the 18 reported mishaps were in classes 4-6. Two, however, were class 1 mishaps (total losses). It is worth noting that a large number of mishaps in all classes, are attributable to engine failure, either cause unknown or foreign object damage with source unknown. Since two total losses occurred from fastener ingestion, it seems reasonable to infer that the safety hazard imposed by fastener failures is probably much higher than the level indicated by identified fastener-caused mishaps.

B. Maintenance Workload Factors -

Replacement of individual fasteners requires little time; the maintenance impact of this problem results from large-scale replacement requirements and/or the nonavailability of personnel with the requisite sheet metal skills.

C. Aircraft Availability Factors -

The impact of this problem on aircraft availability is variable. In most cases, fastener replacements cause little unscheduled downtime, but can extend inspection downtime if the maintenance can be deferred until such times.

Remedial Action:

1. June 1967 - MWO 55-1520-210-30/18 for the Installation of Engine Air Inlet Filters.

2. November 1967 - MWO 55-1520-211-30/35 for Installation of Air Inlet Filters; Change 1, Dec 1967, Change 2, May 1969.

3. June 1968 - MWO 55-1520-210-30/17 for Installation of Particle Separator and Inlet Air Filter.

Problem No.: 01-5 (Continued)

4. February 1969 - EIR Digest TB 750-992-1 report on foreign object damage from Dzus fasteners after accomplishment of MWOs 55-1520-211-30/35 or 55-1520-210-30/17. Reference is made to Change 1 of MWO -30/17 and Change 5 of MWO -30/35 for installation of foreign object damage screens as appropriate. Standard procedure at ARADMAC.

5. October 1968 - ECP 439 approved for a Bleed Airline Installation for Improved GFE Particle Separator (P/N 1-010-500-7) which included a screen (P/N 1-010-680-1) installed around the periphery of the separator to eliminate the entry into the engine of small foreign objects from the cowl area.

6. Standard current procedure at ARADMAC is to remove and replace all half-grommets with full grommets on rework of cowling.

Data Sources:

3,7,8,12,15,20,33,34,35,38,39.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	01-4, 01-5, 01-8
CH-47	01-1
CH-54	-
OH-6	01-1, 01-4, 01-5
OH-58	01-3

Helicopter TMS: UH-1B,D,H
Problem No.: 01-6

Problem Title: Structural Failures: Tail Boom Assembly, Aft Battery Shelf Assembly, and Aft Bulkhead Installation

Problem Description:

A. Component Identification -

	P/N	A/C
Tail Boom Assembly	204-030-800-433, -435	B
Shelf Assembly Battery, Aft	205-075-114-1	D
Bulkhead Installation (Aft, Center Fuselage)	205-030-713-17,-23,-33, -35,-53,-63,-65	D,H

B. Description of Failure -

1. Tail Boom Assembly - cracking failures occurred in original production UH-1B upper left-hand tail-boom aluminum attaching fittings when helicopters were operated at high gross weights. Fittings cracked aft of the tail boom bulkhead.

2. Shelf Assembly, Battery, Aft - Aft relocation of the battery was accomplished by MWO 55-1520-210-30/3 (June 1965) in conjunction with MWO 55-1520-210-30/2 - installation of protective armor kit (Sep 1965). The longeron to which the shelf was attached cracked in the vicinity of the left attaching bolt (P/N HL20-6-8).

3. Bulkhead Installation - Bulkhead cracks in areas where tail boom attachment fittings and spare plates are located. In some cases, fittings and spacer plates have also been damaged.

C. Cause of Failure -

1. Tail Boom Assembly- uneven tail boom load distribution resulted in excessive stress on attaching fittings.

2. Shelf Assembly, Battery - Longeron failure due to chafing between battery shelf and mounting bracket.

3, Bulkhead Installation - Metal fatigue resulting from twisting and flexing of aircraft during flight.

Problem No.: 01-6 (Continued)

D. Period and Duration of Problem -
   1. UH-1 tail boom assembly and fitting - 1961 to 1967
   2. Battery shelf assembly and longeron - 1965 to about 1968; the exact duration could not be determined.
   3. Bulkhead assembly - 1969 to present

E. Failure Rate Data -

Failure rate data are not available. Most remedial actions consisted of sheet metal and structural repairs rather than component replacement. However, considerable aircraft downtime resulted from MWO and TBO compliance.

F. Mission and Deployment Factors -

Common to all missions and deployments, except for the longeron problem, which was largely restricted to Vietnam where armor protection kits were installed.

Problem Impact:

A. Safety Factors -

1. Tail boom attachment fittings - almost entirely safety-of-flight groundings, and not in recorded mishaps.

2. The battery-shelf/longeron problem was potentially a very serious safety problem. After the total loss of a UH-1D in Vietnam in 1967 due to failure of the lower left longeron (station 243.8), the entire UH-1D fleet (with aft battery locations) was grounded until a fix was made.

B. Maintenance Workload Factors -

1. Repair of tail boom attachment fittings required approximately 16 manhours at DS level.

2. Longeron repairs - approximately 15 to 20 manhours at DS level.

3. Manhours for repair of bulkhead assembly cracks are quite variable. Repairs range from standard sheet metal work to actions requiring removal of bulkhead assembly and parts (fittings, rivets, etc.) and fabrication of new fittings. Estimated range is from 4 to 16 manhours at DS level.

C. Aircraft Availability Factors -

Downtime generally ranged from 1 to 1.5 days.

Problem No.: 01-6 (Continued)

Remedial Action:

A. Tail Boom Assembly:

1. Dec 1962 - MWO 55-1520-207-34/50 - replacement of upper left-hand tail boom attachment fitting, UH-1, UH-1A

2. Mar 1963 - MWO 55-1520-208-34/23, Ch. 1, Dec 1963 - installation of tail boom stiffener, all UH-1, UH-1A

3. May 1963 - MWO 55-1520-207-34/58 - installation of tail boom stiffener, all UH-1, UH-1A

4. Jan 1965 - ECP UH-177 - retrofit of improved tail boom attachment bolts, UH-1D,H

5. Apr 1965 - ECP UH-1B,E - 124 - improved upper left-hand tail boom longeron

6. Jun 1965 - MWO 55-1520-211-40/1, Ch. 1, Jul 1966 - installation of tail boom fitting on UH-1B with 540 rotor system (superseded MWO 55-1520-211-34/28 Sep 1964)

7. Dec 1965 - MWO 55-1520-210-30/4 - improved tail boom attachment bolts, UH-1D,H

8. Dec 1965 - MWO 55-1520-211-30/1, Ch. 1, Apr 1966 - incorporation of tail boom attachment bolts, UH-1A/C 60-3546 through 63-12952

B. Battery Shelf Assembly and Longeron:

1. Feb 1967 - TB 55-1500-206-20/6 for inspection of battery shelf and supporting longerons (urgent), UH-1D

2. Feb 1967 - ECP UH-1D 211R - retrofit modification of aft battery shelf

3. Feb 1967 - MWO 55-1520-210-20/17, Ch. 1 Feb 1968 - modification of aft battery shelf, all UH-1D having complied with MWO 55-1520-210-30/3

Data Sources:

1.2,3,9,12,15,20,21,29,33,35,37,38,43,44.

Problem No.: 01-6 (Continued)

Cross References:

TMS	Problem Number
UH-1	-
AH-1	-
CH-47	01-6
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: UH-1A,B C,D,H
Problem No.: 02-1

Problem Title: Landing Gear Assembly Failures

Problem Description:

A. Component Identification -

	P/N
Skid Tube Assembly	204-050-152 and 205-050-152 series
Cross Tube Assembly	204-050-152 and 205-050-152 series
Cap Assembly	204-030-291 and 205-030-291 series
Skid Shoe Assembly	205-050-179 series and 204-050-241 series

B. Description of Failure -

All components subject to cracking, breaking, wearing, bending, and collapsing.

C. Cause of Failure -

Problem is primarily at Ft. Rucker. Failures result from running landings on concrete and hard landings in training operations, particularly practice autorotations and practice landings.

D. Period and Duration of Problem -

1965 to present

E. Failure Rate Data -

Bell Helicopter Company monitored UH-1C helicopters at Ft. Rucker and UH-1D helicopters in Vietnam in 1966-1967 and reported the following MTBFs in mid-1967, based on 11,500 UH-1C and 28,000 UH-1D flying hours:

	Ft. Rucker	Vietnam
Skid Tube Assembly	250 hours	1160 hours
Skid Shoe Assembly	55 hours	Not Shown
Cross Tube Assembly	1920 hours	1075 hours
Cap Assembly	460 hours	875 hours

Problem No.: 02-1 (Continued)

Ft. Rucker demand data for the one-year period April 1970 - March 1971 provide MTBRs as follows:

	hours
Skid Tube Assembly	495
Skid Shoe Assembly	33
Cross Tube Assembly	1025
Cap Assembly	140

As can be seen, the failure rate at Ft. Rucker is very high and closely approximates the 1967 MTBF rates.

F. Mission and Deployment Factors -
Primarily a problem at training centers

Problem Impact:

A. Safety Factors -
No mishaps are recorded by USABAAR resulting from these failures.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace Skid Tube Assembly	1.0 - 2.0	Organizational
Replace Skid Shoe Assembly	.5 - .8	Organizational
Replace Cross Tube Assembly	1.5 - 2.5	Organizational
Replace Cap Assembly	.3 - .5	Organizational

C. Aircraft Availability Factors -
Downtime for any one replacement ranges from 1.0 - 4.0 hours.

Remedial Action:

Most parts and components originally used on the aircraft have been superseded by later versions. Thus, the P/N 205-030-292-1 and -9 cap assemblies were replaced by a -11.

Problem No.: 02-1 (continued)

Thi- pattern was followed for most parts, components and assemblies.

MWO 55-1520-207-34/26, October 1961, and 55-1520-211-34/16 provided for replacement of the aft cross tube on the UH-1A,B, and C. MWO 55-1520-208-34/5 provided for full-length skid shoes on UH-1B numbers 60-3546 through 60-3590 and MWO 55-1520-207-34/26, October 1961, provided for full-length skid shoes on UH-1A aircraft. These actions have produced little benefit in terms of increased reliability at the Aviation Center.

Data Sources:

3,7,8,12,33,34,36,37,38,39,41,42.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	02-1
CH-47	-
CH-54	-
OH-6	02-1, 02-2, 02-3
OH-58	-

Helicopter TMS: UH-1A,B,C,D,H
Problem No.: 04-1

Problem Title: Tail Rotor Part and Component Failures

Problem Description:

A. Component Identification -

	P/N	A/C
Drive Shaft Hanger Assembly Bearing	204-040-623-1	A,B,C,D,H
Tail Rotor Link Assembly	204-011-762-7	A,B,C,D,H
Tail Rotor Link Bearing	204-011-763-1	A,B,C,D,H
Crosshead Assembly	204-011-711-1	A,B,C,D,H
Tail Rotor Yoke Assembly	204-011-781-5,9	A,B,C,D,H
	204-011-722-5	A,B,C,D,H
Safety Pin	MS16562-28	A,B,C,D,H

B. Description of Failure -

1. Drive shaft hanger assembly bearing wearing excessively.
2. Tail rotor link assembly bearing wearing excessively.
3. Tail rotor link assembly gouging the crosshead assembly.
4. Tail rotor yoke assembly cracking in the threaded spindle area; safety pin breaking or dislodged, causing loss of yoke assembly and blades.

C. Cause of Failure -

1. Hanger bearings - inadequate lubrication and misalignment.
2. Link assembly bearing - excessive wear from sand and dust abrasive action.
3. Crosshead assembly - improper alignment of pitch change link bearings, often as the result of maintenance. Frequently, maintenance personnel do not have the equipment for proper measurement of the offset angles for these bearings, and resort to visual approximations.

Problem No.: 04-1 (continued)

4. Yoke assembly - inadequate design, since loads were permitted to travel from the hub grips through the grip bearings into the threads on the end of the yoke spindle. The threaded area of the yoke has a hole for the safety pin, which reduces the spindle load capacity.
5. Safety pin - fatigue caused by vibration and stress. Losses of pins occurred when spindle cracking encompassed the safety pin hole.

D. Period and Duration of Problem -

1. Hanger bearings - 1967 to present.
2. Link assembly bearings - 1964 to present.
3. Crosshead assembly - this problem dates back to the -701 tail rotor, and is still a problem on the -801 tail rotor.
4. Yoke assembly - the emergence date of this problem is not available, but the problem was common to all UH-1 aircraft with the -701 tail rotor until replaced by the -801 tail rotor. Problem active until compliance with TB 55-1500-219-20/1 published in early 1970.

E. Failure Rate Data -

1. MTBR's based solely on part/component/assembly replacement at Ft. Rucker during the period 1 May 1970 - 30 April 1971 are as follows:

	P/N	A/C	No. of Replace.	MTBR (hours)
Hanger Bearing	204-040-623-1	A,B,C,D,H	1585	183
Link Assembly	204-011-762-7	A,B,C,D,H	1137	255
Link Bearing	204-011-763-1	A,B,C,D,H	211	1376
Crosshead Assy.	204-011-711-1	A,B,C,D,H	902	322
Yoke Assembly	204-010-781-5,-9	A,B,C,D,H	55	2360
Yoke Assembly	204-011-722-5 (replaces 781-5 and -9 assemblies)	A,B,C,D,H	68	

Problem No.: 04-1 (continued)

2. Available MTR data in the AVSCOM RIADS Report on the yoke assembly for all removals from UH-1C and D aircraft are as follows:

	P/N	A/C	Removals	MTR (hours)
Yoke Assembly	204-010-781-9	D	302	153
	204-010-781-9	H	31	168

F. Mission and Deployment Factors -
The above problems are common to all missions and deployments. Bearing wear is particularly aggravated by operations in sandy and dusty environments.

Problem Impact:

A. Safety Factors -
The tail rotor drive shaft and tail rotor assembly constitute one of the major safety hazard areas on UH-1 aircraft. A precise evaluation of the aviation mishaps attributable to specific failures in this area is precluded by the large number of major accidents and total losses identified only as tail rotor failures or suspected tail rotor failures. Among the components and parts cited in this problem area, hanger bearing failures present the greatest safety hazards. During the period 1 January 1967 - 31 March 1971, approximately 50 UH-1 mishaps were directly tied to hanger bearing failures. While 32 of these mishaps consisted only of forced and precautionary landings, 7 of these mishaps resulted in total loss of the aircraft (three UH-1D and four UH-1H aircraft) and two in major damage. These figures do not include mishaps attributed either to other parts of the hanger assembly or to the hanger assembly in general (including "suspected hanger assembly failure").

While the problem of the yoke cracking appears to have been overcome with the new yoke assembly, yoke failures due to identified cracking accounted for the total loss of one UH-1D and three UH-1H aircraft.

All these total losses were attributed to material failures rather than maintenance error.

Problem No.: 04-1 (continued)

Those mishaps specifically attributed to crosshead bearing, pitch change link, and link bearing failures resulted in class 4, 5 and 6 mishaps - incidents, forced landings, and precautionary landings, respectively.

B. Maintenance Workload Factors -

Corrective maintenance and replacement manhours applicable to this problem area are:

	M/H	Level of Maint.
Hanger Bearing	3.0 - 5.0	Direct Support
Link Rod End Bearing	1.5 - 3.0	Organizational
Crosshead Bushing and Crosshead Assembly	1.0 - 2.0	Direct Support
Pitch Link Assembly	3.4 - 4.5	Organizational
Yoke Assembly	1.4 - 3.5	Direct Support

C. Aircraft Availability Factors -

Downtime for maintenance of these components will normally range from two hours to one day, depending upon the extent of repair and/or replacement. Repairs in this area frequently require test flight and blade tracking, which result in approximately one day of aircraft downtime for all corrective action to be completed.

Remedial Action:

1. Hanger bearing and hanger assembly
   a. Hanger bearing - January 1967 - Pursuant to Bell Helicopter Engineering Order 204AMZ-61, hanger bearing 204-040-615-3 was replaced with the 204-040-623-1 bearing. This change was effective with production of UH-1D 66-16104 and UH-1C 66-15043 aircraft. The new bearing utilizes a new lubricant, Alpha-Molykote 343-X, and changes the amount of lubricant used in the bearing. The bearing is factory lubricated and sealed and does not require field servicing. The new lubricant was first applied on production models of UH-1D aircraft beginning with SN 66-971, before the 623-1 bearing change was implemented.

Problem No.: 04-1 (continued)

b. Hanger assembly 204-040-600-9 (UH-1A,B,C,D,H) replaces 600-5 and 600-7 assemblies (same application).

2. Pitch link assembly.

a. October 1968 - Pursuant to Bell Helicopter Engineering Order 209CA-2135, a new link assembly P/N 204-011-762-9 replaced the 762-5 link assembly on UH-1D aircraft. The 762-9 assembly incorporated Kacarb KSP 7009-1 and KSP 7007-3 bearings, replacing the 204-011-764-1 and 204-011-763-3 bearings respectively. A Kacarb link assembly P/N KSP 9003-5 was also established as a spares alternate to P/N 204-011-762-5.

b. TM 55-1520-210-34P-2 (October 1970) shows link assembly P/N 204-011-762-7 as currently applicable to UH-1A,B,C,D,H aircraft. This assembly replaces the 204-011-762-1 assembly, with bearing KSP 7007-1 replacing 204-011-763-1.

3. Crosshead assembly.

February 1970 - TB 55-1500-219-20/1 replaced crosshead assembly 204-010-773-5 on UH-1A and B models with P/N 204-011-711-1 applicable to UH-1A,B,C,D,H, and a new bushing 22-006-15-13-16 for the 204-010-794 bushing.

4. Yoke assembly

a. June 1966 TB 55-1500-200-20/9, inspection of all UH-1 tail rotor installations, tail rotor hub and blade assembly, and tail rotor hub assembly (urgent) P/N 204-011-701-7, -11, and 204-040-701-13 -- all UH-1A, all UH-1B aircraft through 65-9417 and all UH-1D aircraft through 65-9579.

b. June 1967 TB 55-1500-206-30/1; change 2 (Oct 1967), change 3 (January 1968), inspection of tail rotor assembly (urgent) - UH-1A,B,C,D, all AH-1G aircraft.

c. October 1967 MWO 55-200-30/35, installation of improved tail rotor yoke nut - UH-1B,D.

d. December 1968 - ECP 338 approved for an improved tail rotor hub assembly. Design included a new yoke assembly (P/N 204-011-722-5) replacing existing assemblies on UH-1A,B,C,D,H models. The new yoke configuration utilizes a grooved yoke and split ring

Problem No.: 04-1

arrangement inboard of the retaining nut which routes the loads into the yoke at the groove rather than into the threads on the spindle area as in the then existing yoke assemblies.

e. February 1970 - TB 55-1500-219-20/1, "Inspection of Installed Tail Rotor Hub (P/Ns 204-011-701-7, -11, -13, -19, -21, -23, -29; UH-1A,B,C/M,D/H Helicopters)", establishing P/N 204-011-722-5 as the replacement for existing yoke assemblies.

Data Sources:

3,4,7,8,9,12,18,24,36,37,38,39,41,42,43,44,45.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	04-1
CH-47	-
CH-54	04-2, 04-10, 04-11
OH-6	04-1, 04-2, 04-5
OH-58	04-1, 04-3

Helicopter TMS: UH-1A,B,C,D,H
Problem No.: 04-2

Problem Title: Main Rotor Blade Failures

Problem Description:

A. Component Identification -

	P/N	A/C
Main Rotor Blade Assembly	204-010-051-1	UH-1A
	204-011-001-15	UH-1B
	540-011-001-5	UH-1C
	204-011-250-5	UH-1D,H

B. Description of Failure -

1. Failures

Failures incurred by blades can be categorized as inherent and external. Inherent failures include excessive wear, corrosion, cracking, bonding separation, delamination, excessive vibration, etc. External failures include overstressing, denting, foreign object damage, punctures, tears, crash and battle damage, etc.

2. Maintainability

A principal problem in blade maintenance and replacement is matching of compatible blades. Blade mismatch produces severe vibration problems.

C. Cause of Failure -

1. Failures

Inherent failures result from material and design inadequacies. External failures result primarily from blade strikes and from foreign object, erosion, overspeed, combat, and crash damage.

2. Maintainability

UH-1 blade construction makes no provision for chordwise balance at the tip. The blade specification provides for a ± 15-minute deviation in blade twist. At ARADMAC it has been found necessary to resort to trial and error methods in the selection of matched pairs of blades for IROANed aircraft. The method consists of installation and testing on the aircraft of the matched blades before the pair can be accepted. In some

Problem No.: 04-2 (Continued)

instances 6 or 7 sets of blades have been changed on a single hub before an acceptable match was found.

D. Period and Duration of Problem -

Identifiable problems with UH-1 main rotor blades date back at least to 1960 and continue to the present.

E. Failure Rate Data -

1. Based on MIRF data, the following blade MTRs have been computed:

a. P/N 204-011-250-5 used on UH-1D helicopters - MTR is 376 blade hours, based on 5520 failures (does not include removals for non-blade maintenance, unnecessary removals, etc.).

b. P/N 204-011-250-5 used on UH-1B helicopters - MTR is 351 blade hours, based on 2973 failures (does not include removals for non-blade maintenance, unnecessary removals, etc.).

2. Based on data presented in USAAVLABS Technical Report 71-9, "UH-1 and AH-1 Helicopter Main Rotor Blade Failure and Scrap Rate Data Analysis" (January 1971), MTR and MTBF for the 540-011-001-5 UH-1C blades have been computed for CONUS and Vietnam combined.

a. MTR - 322 blade hours, based on 1341 removals.

b. MTBF - 667 blade hours, based on 289 removals.

3. MTBR for blades, requiring replacement at Ft. Rucker during the year ending April 1971 are as follows:

a. P/N 204-010-051-1 (UH-1A): 488 blade hours, based on 209 replacement.

b. P/N 204-011-001-15 (UH-1B): 569 blade hours, based on 486 replacements.

Problem No.: 04-2 (Continued)

c. P/N 204-011-250-5 (UH-1D and H): 629 blade hours, based on 321 removals.

4. The major causes of blade failure, as indicated by MIRF data, are external and are most heavily concentrated in 6 failure codes: cracked (code 190), dented (code 200), foreign object damage (code 301), punctured (code 540), battle damage (code 713), and torn (code 947). The following MTRs for P/N 204-011-250-5 have been computed based on data presented in MIRF and include MTRs for all failure causes constituting at least 1% of failure removals:

a. UH-1D P/N 204-011-250-5, MTR = 376 blade hours - 5520 failures.

Failure Code	Description	MTR	No. of Removals	% of Total Failures
020	Excessive Wear	564	215	3.9
116	Cut	318	143	2.6
154	Overstressed	272	72	1.3
190	Cracked	531	453	8.2
200	Dented	363	878	15.9
263	Poor Bonding	568	182	3.3
301	Foreign Object Damage	340	602	10.9
464	Overspeed	349	165	3.0
503	Sudden Stop	370	182	3.3
540	Punctured	295	640	11.6
561	Unable to Adjust Limits	303	61	1.1
690	Excessive Vibration	120	94	1.7
712	Crash Damage	382	138	2.5
713	Battle Damage	353	635	11.5
680	Bent	304	55	1.0
846	Delaminated	462	83	1.5
947	Torn	315	248	4.5

b. UH-1H P/N 204-011-250-5, MTR = 351 blade hours - 2973 failures

Problem No.: 04-2 (Continued)

Failure Code	Description	MTR	No. of Removals	% of Total Failures
020	Excessive Wear	681	64	2.3
070	Broken	413	59	2.0
116	Cut	277	63	2.1
154	Overstressed	248	71	2.4
170	Corroded	553	33	1.1
190	Cracked	429	208	7.0
200	Dented	357	472	15.9
263	Poor Bonding	476	77	2.6
301	Foreign Object Damage	313	226	7.6
464	Overspeed	350	68	2.3
503	Sudden Stop	281	71	2.4
540	Punctured	292	306	10.3
561	Unable to Adjust Limits	286	39	1.3
690	Excessive Vibration	250	41	1.4
712	Crash Damage	374	66	2.2
713	Battle Damage	315	523	17.6
780	Bent	315	35	1.2
846	Delaminated	442	29	1.0
910	Chipped	347	34	1.1
947	Torn	314	206	6.9

F. Mission and Deployment Factors -

A high incidence of blade problems is common to all missions and deployments. Problems are more severe in Vietnam, where battle damage, operating conditions, and the combat/natural environment induce higher failure rates.

Problem Impact:

A. Safety Factors -

Main rotor blade failures have not constituted a safety problem, since almost all incipient failures can be detected before a major failure occurs in flight. Blade failures resulting during aircraft operation generally result in precautionary landings.

Problem No.: 04-2 (Continued)

B. Maintenance Workload Factors -

Most main rotor blade maintenance is accomplished at the organizational level, including repairs and replacement. Average replacement requirements range from 4 to 7 manhours, while repair requirements at this level generally range from 2 to 4 manhours. Where tracking and balance are required, an additional 2 to 3 manhours are required.

C. Aircraft Availability Factors -

Downtime for blade replacement ranges from .5 to 1.5 days depending on the number of maintenance personnel used. Repairs will, in general, impose downtime of 3 hours to one day.

Remedial Action:

1. October 1960 - MWO 55-1520-207-20/9, Inspection of Main Rotor Blade Tip Cap Assembly: all UH-1 aircraft.

2. May 1961 - MWO 55-1520-207-20/19, Rotor Overspeed Damage Inspection (Organizational Maintenance Instruction): all UH-1A aircraft.

3. April 1961 - MWO 55-1520-207-34/16, Modification of Main Rotor Blade Ballast Retention: P/Ns 204-010-050-17, 204-010-051-1.

4. August 1963 - MWO 55-1520-211-34/22, Modification of Main Rotor Blade (urgent): P/N 204-011-001-15.

5. September 1964 - MWO 55-1520-211-34/27, Modification of Main Rotor Blades: P/N 204-011-001-15.

6. May 1965 - ECP 216 added cobalt abrasive strip to main rotor blade (UH-1F) in place of stainless steel strip.

7. December 1966 - TB 55-1520-211-20/8, Inspection of UH-1C Blade: P/N 540-011-001-5 (urgent).

8. EIR Digest TB 750-992-4 (1968)

   a. Reports of numerous skin bonding failures - P/Ns 204-010-051, 204-011-001, 204-011-250 and 540-011-001. Remedial action limited to repair/replacement criteria and instructions in the then current manuals.

Problem No.: 04-2 (Continued)

b. Reports of sand erosion of main rotor blades - P/Ns 204-010-051-1, 204-011-001-15 and 204-011-250-5. Addition of nickel to the blade abrasion strip undergoing tests at the time problem was reported, but program results unavailable.

9. February 1969 - ECP 450 provided for improved main rotor blades for UH-1C, AH-1G, incorporating a stiffer trailing edge.

10. December 1969 - ECP 480 provided improved tip cap for 204 main rotor blades - UH-1D, H.

11. December 1969 - ECP 481 provided for improved tip cap on 540 main rotor blades - UH-1C, M and AH-1G.

Data Sources:

3, 4, 7, 8, 9, 12, 15, 17, 19, 33, 34, 35, 36, 37, 38, 39, 41, 42, 43, 44, 46.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	04-3
CH-47	04-1
CH-54	04-1
OH-6	04-5
OH-58	-

Helicopter TMS: UH-1B,D,H
Problem No.: 04-3

Problem Title: Main Rotor Hub Radius Ring and Seal Failures and Malfunctions

Problem Description:

A. Component Identification -

	P/N
Radius Ring	204-012-116
Seal	204-011-131-5
Grip Butt Plate	204-011-139-1
Channel Seal	S-12560-341

B. Description of Failure -

1. UH-1B,D,H radius ring (P/N 204-012-116) experiences excessive groove wear in the seal (P/N 204-011-131-5) area. This grooving results in loss of seal effectiveness, oil leakage, and return of rotor heads for overhaul considerably short of the 1100-hour TBO. Leakage in this area produces major problems in other areas: oil gets into the swashplate and head assembly, damages bearings, enters the air inlet, and produces high EGT and compressor stalls from oil and dirt accumulated on the compressor blades.

2. UH-1D,H - Excessive wear of channel seal.

3. Grip butt plate leaking excessively. Butt plate leaking may allow oil to enter yoke spindle around main rotor straps. Inboard plate leakage may also produce lateral imbalance of hub assembly.

C. Cause of Failure -

1. Radius ring grooving: inappropriate material specification for the surface coating of the seal area.

2. Dust Seals: deterioration of the rubber bond between the concentric steel sleeves of the seal.

3. Channel Seal Wear: seal material (PTFE) not sufficiently durable.

4. Butt Plate Leakage: sealant inadequate.

D. Period and Duration of Problem -
All problems - early deployment to present

Problem No.: 04-3 (continued)

E. Failure Rate Data -

Failure rates for the individual parts and components listed are not available. Data for failure of the main rotor hub, many of which have resulted from these problems, are as follows:

1. AVSCOM Major Item Removal Frequency Report for the period 1 January 1964 - 30 June 1970 shows a mean time to removal of 369 hours for new hubs (based on 408 removals) and 308 hours for hubs with one previous overhaul (139 removals). Leaking accounted for 35% of new and 39% of overhauled hub failures.

2. Ft. Rucker data show a mean time between replacement of 702 hours for the hub on the UH-1D,H based on 144 replacements and 254 hours on the UH-1B hub (201 replacements). These data do not include failures corrected by maintenance.

F. Mission and Deployment Factors -

Common to all missions and deployments

Problem Impact:

A. Safety Factors -

The problems associated with the main rotor hub assembly do not of themselves constitute a recognizable primary safety hazard. Accident data for the period January 1967 - March 1971 show only a few forced landings attributable to difficulties with the main rotor hub assembly. Nevertheless, the secondary problems originating with oil leakage are quite extensive as noted above, and undoubtedly constitute a larger safety hazard than the available accident data indicate.

Problem No.: 04-3 (continued)

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace radius ring	1-2	Depot *
Replace dust seal, channel seal or butt plate	6-8 per repair	GS*

C. Aircraft Availability Factors -

Aircraft downtime represents only the time required at organizational level to remove and replace the hub and blade assembly - 1/2 to 1 day with 2-man crew.

Remedial Action:

1. Radius ring (P/N 204-011-107-1) replaced by P/N 204-012-116-1, which still presented grooving and leakage problems.

In 1969 - 1970, ARADMAC established a procedure to machine down the grooves (.020 - .040 in., depending on groove depth) and applying a detonation gun - flame-plated coating of tungsten carbide with a cobalt binder, AMS 2435 (LW-1). After coating, the radius ring was ground to the original diameter with a diamond grinding wheel to an 8/16 RMS finish.

The above fix appears to have overcome the seal leakage problem. Coated rings with approximately 1100 hours showed no evidence of wear and were returned to service "as is" during the overhaul of rotor heads. The extent to which the coated rings are incorporated in the worldwide aircraft fleet, however, is not ascertainable.

2. Grip butt plate: The EIR Digest for the 1st Quarter FY 1969 (TB 750-992-4, 1968) recommended a fix consisting of the application of a sealant, an adhesive, and two rivets to prevent leakage.

* The manhours shown assume that the hub assembly is received at the GS or Depot maintenance activity with attaching parts and components removed. It does not include time for removal from the aircraft, removal of rotor blades, etc., nor the reinstallation of the blades, replacement of the complete hub and blade assembly on the aircraft, balancing, etc.

Problem No.: 04-3 (continued)

3. Channel seal failures - July 1965: seal P/N S-12561-341 replaced S-12560-341 effective with production of UH-1D 65-9565. The new seal utilizes a filled plastic material in contrast to the PTFE construction of the replaced seal. The problem still continues as noted in EIR Digest, 4th Quarter, FY 1970 (TB 750-992-3, 1970).

Data Sources:

3,4,7,8,9,15,17,33,34,36,38,39,41,47.

Cross References:

TMS	Problem Number
UH-1	04-4, 04-5
AH-1	04-4
CH-47	04-5
CH-54	04-3, 04-8
OH-6	04-2
OH-58	04-2

Helicopter TMS: UH-1C
Problem No.: 04-4

Problem Title: Main Rotor Hub Grip Bearing Failures

Problem Description:

A. Component Identification -

	P/N
Grip Bearings, Outboard	540-011-110-3,-7
Seal	540-011-168-1

B. Description of Failure -

1. Excessive bearing wear, bearing seizing on main rotor extension, producing vertical vibration.

2. Failure of dust seal to act as barrier against external contaminants.

C. Cause of Failure -

1. Excessive bearing wear - destruction or damaging of PTFE lining from sand, dirt, and dust contamination resulting from dust seal failure.

2. Dust seal failure - inadequate design, material.

D. Period and Duration of Problem -

Early deployment to present

E. Failure Rate Data -

Bell Helicopter Company reports to the Project Manager's M&R Committee in 1967 showed an MTBF at Ft. Rucker of 126 hours based on 13,000 flying hours over approximately a 14-month period. The same report, covering 9400 hours of flying over a 5-month period in Vietnam, showed a 260-hour MTBF.

The AVSCOM "Aircraft Component Time Since Installation, Overhaul or New" for the UH-1 fleet shows a mean time to removal for failure causes of approximately 275 hours, based on 642 removals of hubs not previously overhauled. About 23% of the removals were for bearing failures, 17.5% for excessive wear. The report covered removals over the January 1964 - June 1970 period.

Problem No.: 04-4 (Continued)

As reported in AH-1G Problem 04-4, the same hub in the AH-1G was shown in the AVSCOM Major Item Removal Frequency report to have a mean time to removal of 312 hours.

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
Only four mishaps (all precautionary landings) from main rotor hub failures are recorded by USABAAR. However, main rotor hub failures present potential safety hazards.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace grip bearing	20 - 25 *	Direct Support

C. Aircraft Availability Factors -

Aircraft downtime - 2 - 3 days, assuming a 2-man crew.

Remedial Actions:

ECP 294 was submitted October 1966 and approved for the addition of a sand deflector (P/N 540-011-174-1) and change in the seal and radius ring in the 540 main rotor hub. MWO 55-1520-211-30/23, November 1966 and Change 3, July 1967 provided for fleet retrofit of the ECP, including the sand deflector, replacement of the 540-011-168-1 seal by a -3 seal and replacement of the 540-011-169-7 radius ring by a -13 radius ring. The problem was not solved, however, as seal failures are still a problem on both the UH-1C and AH-1G.

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* Including removal from aircraft and necessary hub and blade disassembly, reassembly, replacement on aircraft, balancing, etc.

Problem No.: 04-4 (Continued)

Data Sources:

3,4,7,8,12,15,17,21,33,34,35,36,38,39,42,43.

Cross References:

TMS	Problem Number
UH-1	04-3, 04-10
AH-1	04-4
CH-47	04-6
CH-54	04-11, 18-1
OH-6	04-3, 04-5
OH-58	-

Helicopter TMS: UH-1 All Series
Problem No.: 04-5

Problem Title: Input Quill, Main Transmission: Seal Leakage

Problem Description:

A. Component Identification -

	P/N	A/C
Quill Assembly	205-040-263-3	B,C,D,H(New)
	204-040-363-3	B,C,D,H(Old)
	204-040-203-11	A
Seal	55576J	A(Old)
	455942H	A,B,C,D,H(new)
Race	204-040-191-7	A,B,C,D,H

B. Description of Failure -

1. Seal fails, resulting in oil leakage from the transmission. Oil ingestion in the engine resulting from this leakage has resulted in compressor stalls and engine failures.

2. Grooves worn in the quill assembly race (P/N 204-040-191) where the seal contacts the race. This condition prevents seal replacements from stopping the leaks.

3. Corrective sleeve which was incorporated in the quill assembly backs off.

C. Cause of Failure -

1. Shaft speeds to which seal is exposed exceed design specifications,i.e., shaft speeds in excess of 6000 RPM versus design maximum of 3600 RPM application.

2. It is felt by some people interviewed that the silicon in the seal (composed of a silicon rubber base material) is a primary agent of shaft wear, although this was not substantiated.

3. Bonding failures.

4. Bumping of the quill end as it is inserted into the transmission sometimes results in chipping of the seal with consequent leakage and repetition of seal replacement maintenance. Chipping is not normally detected until the quill has been installed in the transmission and the transmission reinstalled in the aircraft and the aircraft run up. Chipping is

Problem No.: 04-5 (Continued)

then manifested by oil leakage. Poor lighting under field operations contributes to the chipping problem.

D. Period and Duration of Problem -
Early 1966 to present

E. Failure Rate Data -

1. MTR, as reported in AVSCOM Major Item Removal Frequency Report for quill assembly failures on P/N 204-040-363-3 is 493 hours for the UH-1D aircraft (based on 49 removals) and 367 hours for the UH-1H (based on 21 failures). The combined MTR for both D and H applications is 455 hours.

Removals for leaking (code 381) accounted for 73.5% of removals from UH-1D aircraft and 61.9% of removals from UH-1H aircraft.

Failure data on P/N 205-040-263-3, which replaces the 363-3 assembly, is not available.

2. Mean time between replacements of quill assemblies for UH-1B,D,H aircraft at Ft. Rucker during the period 1 May 1970 - 30 April 1971 (excluding failures corrected by maintenance):
   a. 2884 hours for the 205-040-263-3 assembly on UH-1B,D and H aircraft.
   b. 4250 hours for the 204-040-203-11 assembly on UH-1A aircraft.

3. The mean time between replacement of quill assembly seal P/N 455942H, applicable to UH-1A,B,D,H models at Ft. Rucker for the same period is 364 hours, based on 798 seal replacements.

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
The safety implications of this problem, as evidenced by USABAAR accident data, are of a minor order, consisting of a small number (less than 10) of precautionary landings, incidents and forced landings during the period 1967 - 1971.

Problem No.: 04-5 (Continued)

B. Maintenance Workload Factors -

1. Correction of seal failures involves removal of the quill assembly and replacement of the seal. This is a direct support level maintenance action, requiring approximately 12 to 14 manhours. It should be noted that maintenance personnel at Ft. Rucker have developed a locally-designed special tool which reduces quill seal replacement manhour requirements to approximately 4 manhours. As noted above, the sequence of maintenance actions involved when a seal is chipped increases manhour requirements by the time required for quill replacement, transmission replacement, aircraft run up, and disassembly to repeat the seal replacement.

2. Replacement of quill assembly - 8-10 manhours.

This problem was considered by maintenance personnel at Ft. Rucker to be one of the three most serious maintenance problems in the UH-1 support program.

C. Aircraft Availability Factors -

Downtime for quill seal replacement is approximately one aircraft day when 12 to 14 manhours are required to perform the task, assuming a 2-man crew.

Remedial Actions:

1. ECP 329 for improved quill assembly, P/N 205-040-263-3 to replace P/N 204-040-363-3, was approved in April 1968 for production incorporation on UH-1D,H and AH-1G aircraft, and for future procurement and spares with retrofit by attrition.

2. Publication in EIR Digest, TB 750-992-4 (1968), of the problem with details of corrective action and notice that P/N 205-040-263-3 was being introduced into the supply system.

3. The improved quill assembly includes a new seal P/N 455942H which replaces P/N 55576J; the new seal includes a drain line and a wear ring to prevent damage to the quill race. As noted above, however, problems have been reported with the wear ring, or sleeve, backing off the quill assembly due to bonding failures.

4. ARADMAC is currently testing a third bonding technique to prevent this mode of failure, two other bonding techniques having been tried previously.

Problem No.: 04-5 (Continued)

Data Sources:

3, 4, 7, 8, 9, 12, 15, 18, 33, 34, 35, 36, 38, 39, 43, 44.

Cross References:

TMS	Problem Number
UH-1	04-3
AH-1	04-5
CH-47	-
CH-54	04-3, 04-8, 04-11
OH-6	04-3
OH-58	04-2

Helicopter TMS: UH-1B,C,D,H
Problem No.: 04-6

Problem Title: Stabilizer Bar Tube Assembly

Problem Description:

A. Component Identification -

		P/N	A/C
Tube Assembly	-	204-011-328-1	B,C,D,H
Stabilizer Bar Assembly	-	204-011-326-7	B,D,H
	-	540-011-300-9	C

B. Description of Failure -

Tube assemblies are experiencing rust and corrosion inside the tube which lead to cracking of the tube. Corrosion and cracking of stabilizer bars on UH-1 aircraft have resulted in a 30 to 40% rejection rate at ARADMAC. This is evidenced by a high-frequency vibration in the tail boom. In the past, the tie rod assemblies (P/Ns 204-011-314-1 and 540-011-306-1) have failed shortly after tube failures, resulting in a total loss of the tube.

C. Cause of Failure -

1. Corrosion and subsequent cracking of the tube result from corrosion pits where the tubes are welded.

2. Inadequate preservation coating inside the tube; frequently the cadmium plating is not properly penetrating the inside of the tube, leaving it susceptible to corrosive action. It was not established whether this was basically a problem in procedures or manufacture quality control.

D. Period and Duration of Problem -

1. Stabilizer bar tube corrosion and cracking - 1966 to present

2. Loss of the rod assembly and stabilizer bar tube - 1966 to 1969

E. Failure Rate Data -

1. The stabilizer bar assembly P/N 204-011-326-1 had a MTR of 619 hours as presented in the RAMMIT RIADS Report, based on 1189 failures on UH-1D aircraft. This part was

Problem No.: 04-6 (continued)

changed to P/N 204-011-326-7 by MWO 55-1500-206-30/2 (10 Oct 1968), which replaced the rod assembly (P/N 540-011-306-1) with wire rope assembly P/N 204-011-329-1. MTBR of the 326-7 assembly based on 114 replacements for failures at Ft. Rucker during the period May 1970 - April 1971 is 886 hours.

2. Stabilizer bar assembly P/N 204-010-370-9 (UH-1A) has an MTBR of 217 hours based on 235 replacements for failure at Ft. Rucker in the same period.

3. The MTBR of stabilizer bar tube assembly P/N 204-011-328-1 is 2296 hours based on 44 replacements for failure on B,D,H models in the same period.

F. Mission and Deployment Factors -

Common to most missions and deployments, particularly where high humidity and high atmospheric salt content are environmental factors.

Problem Impact:

A. Safety Factors -

Stabilizer bar assembly and components do not constitute a safety problem. Only two mishaps were attributed to failures in this area during the period January 1967 - March 1971.

B. Maintenance Workload Factors -

Replacement of the stabilizer bar assembly is accomplished at the organizational level of maintenance. Repair and replacement of the outer tube assembly and wire rope assembly are accomplished at the direct support level.

The following manhour requirements are applicable to stabilizer bar assembly maintenance:

Action	Manhours	Level of Maint.
Repair	1.5 - 3.3	Direct Support
Replace	2.0 - 3.0	Organizational

C. Aircraft Availability Factors -

Aircraft downtime for repair and/or replacement of the stabilizer bar assembly will generally range from 2 to 4.5 hours.

Problem No.: 04-6 (continued)

Remedial Action:

1. October 1967 - ECP 351 approved for the installation of a stainless steel cable assembly in lieu of the tie rod assembly in stabilizer bar extension tubes on UH-1 B,C,D,H. Production incorporation on the D and H models, and retrofit incorporation on C,D and H models.

2. October 1968 - MWO 55-1500-206-30/2 incorporated retrofit of safety cables for the stabilizer bar extension tube on UH-1B,C,D,H models. This does not deal with the corrosion problem itself, but serves only to prevent the loss of the tube should the tube break due to corrosion, cracking, etc.

3. Field maintenance and ARADMAC utilize zinc chromate paste to reduce corrosive action. At ARADMAC, the small parts shop paints the end of the stabilizer bar and the steel sleeve which slides over it with zinc chromate, and assembles the two parts while the chromate is still wet. This is designed to prevent any scratching of the zinc chromate coating during assembly.

Data Sources:

3,7,8,9, 12,18,21,33,34,35,36,38,39,41,42,43,44.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	-
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: UH-1B,C,D,H
Problem No.: 04-7

Problem Title: Drive Shaft Assembly, Main (Short Shaft)

Problem Description:

A. Component Identification -

	P/N	A/C
Drive Shaft Assembly, Main	204-040-005-27,	A
	205-040-004-3	B,C,D,H
Packing, Preformed (O-Ring)	204-040-640-1	B,C,D,H

B. Description of Failure -

1. Excessive leakage of grease, resulting in damage to the coupling P/N 204-040-687-3, teeth and shaft P/N 204-040-686-1) (improper lubrication and/or loss of lubrication can result in the short shaft failure).

2. Lubrication of the main drive shaft assembly, requiring replacement of preformed packing, is time consuming and constitutes a maintainability problem. It is necessary to assure that the "bits and pieces" (washers, pins, cotter keys, etc.) are replaced in the proper order and are properly aligned and not damaged during reassembly, particularly the O-ring seal. The proper alignment of the shaft between the transmission and the engine is critical to the UH-1, since the proper working of the shaft depends on precise alignment.

C. Cause of Failure -

1. O-rings damaged during assembly and/or reassembly result in loss of lubricant, overheating, excess wear, pitting, etc.

2. Lubricant inadequate - tends to deteriorate at the operating temperatures encountered.

3. Design inadequacy - there is a lack of a coupling to prevent misalignment (maintainability); and the design of the shaft is such that it allows backward installation which results in inadequate cooling.

4. Short repacking interval.

5. Incorrect lubricants being used in the field.

Problem No.: 04-7 (Continued)

D. Period and Duration of Problem -
1964 to present.

E. Failure Rate Data -

The following MTBRs are based on replacements only at Ft. Rucker during the year ending 30 April 1971.

	P/N	A/C	MTBR (hours)
Drive Shaft Assembly, Main	204-040-005-27	A	534
Drive Shaft Assembly, Main	205-040-004-3	B,C,D,H	524

MTRs for main drive shaft assemblies installed on UH-1D,H aircraft, as reported in the AVSCOM RIADS Report, covering the six and one-half year period from 1 January 1964-30 June 1970 are as follows:

P/N	A/C	Hours	Removals
204-040-010-3	D	319	17
204-040-010-7	D	334	4592
205-040-004-3	D	307	990
205-040-004-3	H	277	3126

Failure analysis of drive shaft assemblies (P/N 205-040-004-3) in the AVSCOM MIRF Report shows that a large percentage of removals are caused by excessive wear and leakage. For new assemblies, 44.7% of removals were due to leakage (code 381) and 14.2% to excessive wear. MTRs for these causes are 321 hours for leakage and 339 hours for excessive wear.

Comparable figures for assemblies with one previous overhaul are:

	%	MTR (hours)
Removal for leakage	25.0	162
Excessive wear	12.5	119

Spurious removals (code 645) accounted for 53,6% of removals of assemblies with one previous overhaul, and no-defect removals (799) accounted for 32.8% of removals of new assemblies. These high percentages also indicate a need for improved maintenance diagnostic techniques and/or training in this area.

Problem No. 04-7 (Continued)

F. Mission and Deployment Factors -

Covers all missions and deployments. Maintainability problems - particularly as regards transmission/engine alignment - are aggravated by conditions in the field.

Problem Impact:

A. Safety Factors -

During the period 1 January 1967 - 31 March 1971, 103 mishaps were caused worldwide by short shaft assembly failures, distributed as follows:

Class	Maint. Error	Material Failure	Total
1	4	7	11
2	2	9	11
3	-	1	1
4	5	12	17
5	4	44	48
6	5	10	15
	20	83	103

Mishaps were caused by inadequate or incorrect lubrication, wear, transmission-engine misalignment, shaft broken in flight, and failure of coupling retaining nuts. A small number of mishaps were classified as "suspected short shaft failures". All except two (on UH-1Bs) of the reported mishaps occurred with UH-1D,H aircraft - 43 on the D model, and 58 on the H model.

Of Class 1 and 2 accidents (total losses and major accidents), 13 occurred with the D model and 9 with the H model. All of the reported mishaps took place in Vietnam except for two Class 1 mishaps (total losses), which took place in a CONUS training base. Class 1 and 2 mishaps were distributed as follows:

	No. of Mishaps				
A/C	Class 1	Class 2	Cause	Location	Period
UH-1D	3	-	Mat. Failure	VN	'67-'68
	1	-	Mat. Failure	CONUS	'68
	3	-	Maint. Error	VN	'67-'68
	1	-	Maint. Error	CONUS	'68
	-	5	Mat. Failure	VN	'67-'68

Problem No.: 04-7 (Continued)

A/C	No. of Mishaps Class 1	Class 2	Cause	Location	Period
UH-1H	3	-	Mat. Failure	VN	'67-'69
	-	4	Mat. Failure	VN	'68-'70
	-	2	Maint. Error	VN	'68-'70
TOTALS	11	11	Mat. Failure: 16 Maint. Error: 6	VN: 20 CONUS: 2	

B. Maintenance Workload Factors -

Drive shaft assembly maintenance and repair is accomplished at organizational maintenance level. Average replacement times as reported in the RIADS Report range from 1.8 to 3.4 hours. Servicing, which requires removal, disassembly, reassembly and installation, takes approximately 8 manhours.

C. Aircraft Availability Factors -

Downtime requirements for replacement range from 3 to 5 hours, while servicing ordinarily requires approximately 1 aircraft day.

Remedial Action:

1. March 1965 - New lubricant, 204-040-755-3, established by the contractor to replace the 204-040-755-1 lubricant then being installed in drive shafts procured by the contractor. Effective with all procurements subsequent to 25 March 1965.

2. September 1965 - Change in the manufacturing process to preclude damage (cutting) to the 640-1 seal during assembly.

3. March 1967 - Approval of ECP for incorporation of improved drive shaft assembly (P/N 205-040-004-3) in production models of UH-1D aircraft, beginning with SN 67-17145. The new drive shaft assembly provided for:

a. An elastomeric boot assembly to retain lubricant and exclude contaminants.
b. An improved coupling and lubricant to reduce the probability of scarring and pitting.

The 205-040-004-3 drive shaft assembly also replaced the 204-040-010-3 and -7 assemblies, which were applicable to the B,C,D,H models.

Problem No.: 04-7 (Continued)

4. Servicing requirements for the drive shaft assembly were decreased from every 100 hours applicable to P/N 204-040-010 to every 600 hours applicable to P/N 204-040-004. However, in view of the MTRs reported for this item, it is clear that maintenance and replacement are required considerably before 600 hours have elapsed.

Data Sources:

3,4,7,8,9,12,17,18,21,30,33,34,35,36,38,39.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	-
CH-47	-
CH-54	04-3, 04-8, 04-11
OH-6	04-3
OH-58	04-2

Helicopter TMS: UH-1 All Series
Problem No.: 04-8

Problem Title: Swashplate and Support Assembly Failures

Problem Description:

A. Component Identification -

	P/N	A/C
Swashplate & Support Assembly	204-010-475-5, -9	A
	204-011-400-1, -3, -5, -7, -9, -11	B, D, H
	540-011-450-3, -5, -7	C
Ring Assembly, Inner	204-010-484-5	A
	204-011-402-1, -5, -9, -13, -15	B, D, H
	540-011-403-5, -9	C
Trunnion Assembly	204-010-490-1	A
	204-011-451-1, KSP 9001	B, D, H
Support Assembly	540-011-452-5	C
Washer	AN970-5, 204-011-457-1	B, D, H

B. Description of Failure -

1. UH-1A, B, D, H:

   a. Cracks developed in the swashplate inner ring horn where trunnion bearings are mounted. In some instances, loss of cyclic control resulted from these cracks.
   b. AN 970-5 washers cupped under constant torque, causing the gimbal-to-swashplate bolt (P/N 204-011-461-1 on B, D, H models, NAS 464-5-19 on A models) to loosen and fret due to excess play between the gimbal and support.
   c. Internal wear of the trunnion assembly, resulting in excessive axial play and end chuck in the trunnion bearings.

Problem No.: 04-8 (Continued)

2. UH-1C

   a. Swashplate developed vertical play on the top of the support assembly (uniball).
   b. Swashplate inner ring lateral horn clevis grooved, worn, and gouged by the rod ends of the hydraulic servo cylinder control tubes.

C. Cause of Failure -

1. UH-1A, B, D, H

   a. Inner ring assembly horn crack - stress and inadequate finish specification in the area which cracked.
   b. AN 970-5 washer and 461-1 bolt failures - washer material too soft, bolts inadequately secured.
   c. Internal wear of trunnion assembly - inadequate lubrication resulting in internal corrosion.

2. UH-1C

   a. Swashplate play on support assembly - wear of the surface of the swashplate PTFE bearings which seat against the outer surface of the uniball.
   b. Swashplate inner ring lateral horn clevis gouging - inadequate sized bushings, allowing rod ends to contact clevis surfaces.

D. Period and Duration of Problem -

1. UH-1A, B, D, H

   a. Inner ring horn cracking - this problem was recognized as early as 1964. Corrective action was taken in 1966 and continued at least into 1968 by the issuance of MWOs on this problem.
   b. Washer and bolt failures - washer failures were reported on FY 1962-1963 production aircraft. The last corrective action was taken in early 1967.
   c. Trunnion assembly wear - 1964 to present.

Problem No.: 04-8 (Continued)

2. UH-1C
   a. Vertical play of swashplate on support assembly - 1966 to present.
   b. Lateral horn clevis gouging - early 1966 - 1968.

E. Failure Rate Data -

1. Mean times between replacement based on failures requiring replacement at Ft. Rucker in the year ending 30 April 1971 are as follows:

	P/N	A/C	No. of Replacements	MTBF (hours)
Swashplate Assembly	204-010-470-5, -7	A	108	490
Swashplate Assembly	204-011-400-11	B,D,H	321	746
Trunnion Assembly	204-010-490-1	A	104	490

2. Analysis of failure data presented in the MIRF reports on UH-1D and H aircraft for the period 1 January 1946 - 31 June 1970 shows that swashplate assembly problems still continue. Swashplate assembly P/N 204-011-400-11 has a combined mean time to removal (for failures only) of 497 hours, for UH-1D and UH-1H aircraft on 174 removals from UH-1D aircraft and 383 removals from UH-1H aircraft. MTR for this assembly on the D model is 456 hours and 515 hours on the H model.

Mean time to removal of the 400-9 swashplate assembly is 544 hours, based on 273 removals for failures on UH-1D aircraft. The three major causes of swashplate failures (exclusive of crash and battle damage) shown in the UH-1D and H MIRF reports are as follows:

Failure	P/N	A/C	% Total Failures	MTR (hours)
Excessive wear	204-011-400-11	UH-1D	33.9	573
Sudden stop			14.4	203
Bearing failure			12.1	486
Excessive wear	204-011-400-11	UH-1H	27.9	587
Sudden stop			13.8	376
Bearing failure			7.3	627
Excessive wear	204-011-400-9	UH-1D	28.6	500
Sudden stop			11.7	553
Bearing failure			19.4	544

Problem No.: 04-8 (Continued)

3. Bell Helicopter Reliability and Maintainability Program Data on unscheduled maintenance, either replacement or repair, provides MTBFs for swashplate assemblies on aircraft at Ft. Rucker and Vietnam as follows:

A/C	Location	Period	Failures	MTBF (hours)
UH-1D	Ft. Rucker	1967	5	1081
	Vietnam	1967	23	664
UH-1C	Ft. Rucker	1966-67	105	124
	Vietnam	1967	25	468

F. Mission and Deployment Factors -

Common to all missions and deployments

Problem Impact:

A. Safety Factors -

Swashplate assembly failures do not constitute a safety problem. During the period 1 January 1967 - 31 March 1971 only a small number of precautionary landings were attributed to failures in this area.

B. Maintenance Workload Factors -

1. Replacement of the UH-1 swashplate assembly can be accomplished at the organizational level and requires 5 to 8 manhours to accomplish.

2. Some minor repairs including replacement of washers, nuts, spacers and the trunnion assembly can also be accomplished at the organizational level. Almost all other maintenance must be performed at the direct and general support level, including the support assembly and swashplate rings. Repairs in this area will generally require 5 to 7.5 manhours.

C. Aircraft Availability Factors -

Aircraft downtime for swashplate replacement and/or repair ranges from .5 to 1.5 days, depending upon the nature and severity of the maintenance required.

Problem No.: 04-8(Continued)

Remedial Action:

A. UH-1A,B,D,H

1. Inner ring horn assembly cracking:
   a. June 1964 - finish specification changed for horn area of swashplate to include Pennsalt 2473A.
   b. July 1966 - ECP 288 approved for addition of plates to the horns to which the synchronized elevator control tube is attached. These plates serve to transfer the load on the horn, in the event the control cracks. Plate P/Ns are 204-011-458-1,-3,-5,-7 and 204-010-494-1, 204-010-494-1.
   c. August 1966 and February 1968 - retrofit of ECP 288 by MWOs 55-1500-200-20/4 and 55-1500-202-30/2.

2. Swashplate washer and bolt failure:
   a. 1963 - the use of lactite, CV4-10 incorporated on assembly of NAS 464-5-20 bolts to keep the bolt locked in position to prevent bolt fretting.
   b. Feb. 1966 - washer P/N 204-011-457 substituted for the AN 970-5 washer.
   c. Jan. 1967 - changes incorporated in appropriate technical manuals.

3. Trunnion assembly internal wear:
   a. Jan. 1966 - AVSCOM approved reduction of the lubrication interval from 50 to 25 hours, for incorporation in next technical manual revision.
   b. Trunnion assembly P/N 204-011-451-1 replaced by P/N KSP 9001.

B. UH-1C

1. Vertical play on support assembly - October 1968 - Bell Helicopter Service Engineering Memo SEM UH-(04-2) -8-5 established procedures for adjusting the swashplate (re-shimming and re-torquing upper bearing retaining nuts), which does not require removal of main rotor and hub assembly.

2. Inner ring lateral horn clevis damage -

Problem No.: 04-8 (Continued)

a. March 1967 - MWO 55-1520-211-30/16 and Change 1, Nov. 1967 provided an improved rotating control system, including replacement of bushing sleeve 540-011-421-21 by bushing sleeve 540-011-381-1.

b. July 1967 - a new inner ring assembly P/N 540-011-403-9 was developed to replace P/N 540-011-403-5, containing wide flange bushings P/N 540-001-421-29. The -9 inner ring assembly became effective with aircraft 66-15106. The new bushings preclude clevis wear by providing contact surfaces for the rod ends.

Data Sources:

3, 7, 8, 12, 17, 21, 33, 34, 35, 36, 38, 39, 41, 42, 43, 44.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	-
CH-47	04-6
CH-54	04-11, 18-1
OH-6	04-5
OH-58	-

Helicopter TMS: UH-1A,B,D,H
Problem No.: 04-9

Problem Title: Lever Assembly, Lower Section Pylon Installation

Problem Description:

A. Component Identification -

	P/N	A/C
Lever Assembly	204-011-438-1	B,D,H
Shim	120-008C28E20	B,D,H
Bearing and Liner Assembly	204-011-443-1	B,D,H
Pin	204-011-446-3	B,D,H
Bearing	MS20201KP8A	A,B,D,H
Bearing Sleeve	204-010-422-13	A,B,D,H

B. Description of Failure -

1. The 120-008C28E20 shims wear, resulting in excess play between the bearing and liner assembly, P/N 204-011-443-1, and the pin, P/N 204-011-446-3.

2. The MS20201KP8A bearing evidenced looseness and rotation in the 204-010-422-13 bearing sleeve, which in turn was rotating in the liner assembly.

C. Cause of Failure -

1. Inadequate shims, bearing specifications, and inspection requirements.

2. Use of brass instead of steel shims in the field.

D. Period and Duration of Problem -

Excessive shim wearing and bearing rotation were noted in 1965. Shim wear continues to the present. Bearing looseness was corrected in 1966. Associated failures of the entire lever assembly and the bearing and liner assembly continue.

E. Failure Rate Data -

1. Mean times between replacement during the year ending 30 April 1971 at Ft. Rucker are as follows:

Problem No.: 04-9 (continued)

	P/N	Removals	MTBR (hours)
Lever Assembly	204-011-438-1	303	790
Shim	120-008C28E20	1070	447*
Bearing and liner	204-011-443-1	240	997

2. Based on MIRF data covering UH-1D and H aircraft for the period 1 January 1964 - 30 June 1970, the following mean times to removal were computed for lever assembly 204-011-438-1:

UH-1D, 1203 hours, based on 100 removals.
UH-1H, 809 hours, based on 264 removals.

Major causes of failure (exclusive of accident and battle damage) on lever assembly removals are:

Cause/Code	% UH-1D	% UH-1H
Excessive Wear (020)	39.0	34.8
Overstressed (154)	6.0	4.2
Sudden Stop (503)	13.0	15.9
Bearing Failure (710)	11.0	4.5

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
The lever assembly does not constitute a safety problem. Mishap data for the period 1 January 1967 - 31 March 1971 show less than five mishaps (precautionary and forced landings) attributed to failures in this area.

B. Maintenance Workload Factors -
The lever assembly, shims, and bearing and liner assembly can be replaced at the organizational maintenance level. Approximately 2 manhours are required for each of these operations.

* Based on two shims per aircraft.

Problem No.: 04-9 (continued)

C. Aircraft Availability Factors -
Downtime for lever assembly maintenance will range from 2 to 3 hours.

Remedial Action:

1. 1966 - looseness and rotation of the MS20201KP8A bearing was corrected through a change in the Bell Process Specification BPS 4162 for the bearing and bearing sleeve. Revision of the specification included a more positive ring stake and tightened inspection requirements.

2. Replacement of the 422-13 bearing sleeve by P/N 204-010-422-19 bearing lever.

3. Remedial action in the case of shim wear consists of shim replacement.

Data Sources:

3,7,8,12,17,33,34,36,38,39,41,42.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	-
CH-47	04-6
CH-54	04-11, 18-1
OH-6	04-5
OH-58	-

Helicopter TMS: UH-1B,C,D,H
Problem No.: 04-10

Problem Title: Scissors and Sleeve Assembly Bearing Failures

Problem Description:

A. Component Identification -

	P/N	A/C
Scissors and Sleeve Assembly	204-011-401-5,-9,-11	B,D,H
Scissors and Sleeve Assembly	540-011-451-1,-3,-5	C
Ball Bearing	MS20201KP8A	B,D,H
Bearing Set	204-011-412-1	B,D,H
Bearing Roller	204-011-419-1	B,D,H
Bearing Set	204-011-409-1	B,D,H
Bearing, Plain, Self-Aligning	540-011-414-1	C
Bearing Assembly, Thrust	540-011-485-1	C
Bearing, Plain	540-011-415-1	C
Bushing, Sleeve	540-011-457-1	C

B. Description of Failure -

1. Excess play developed between the MS20201KP8A bearing and lever bore. This condition when unchecked led to excessive bearing looseness, bearing rotation and vibration.

MS20201KP8A experienced excessive wear resulting in axial play between the bearing ball and race.

2. The drive link lower bearing P/N 540-011-414-1 experienced excessive wear, resulting in control looseness and vibration.

3. The 540-011-485-1 bearing assembly was failing due to separation (unbonding) of the washer and bushing comprising the assembly, resulting in wear of adjacent parts.

4. The 540-011-415-1 plain bearing experienced excessive wear and on some occasions was reported frozen.

5. The 540-011-457-1 bushing sleeve experienced excessive wear, causing the MJH16121 bearing to damage the mast, or in some cases, to be damaged by the mast.

Problem No.: 04-10 (continued)

6. (a) 204-011-412-1 bearing set - excessive wear.
   (b) 204-011-419-1 bearing, roller - excessive wear.
   (c) 204-011-409-1 bearing set - excessive wear.

C. Cause of Failure -

1. MK20201KP8A bearing - both bearing looseness and bearing wear were essentially due to sand abrasion.

2. 540-011-414-1 bearing - failures were attributed in part to low service life on bearings obtained by Bell Helicopter Company from one of its vendors.

3. 540-011-485-1 bearing assembly - inadequate bonding between washer and bushing.

4. 540-011-415-1 PTFE bearing - reason for failure was not determinable; however, among the principal reasons for failure of uniball PTFE bearings is the deterioration of coatings due to vibration and/or sand erosion.

5. 540-011-457-1 sleeve bushing - material (hard anodized aluminum) used in bushing did not prove to be sufficiently wear resistant.

6. Data on the failure modes and cause of failure of the 412-1 bearing set, 419-1 roller bearing, and the 409-1 bearing set not available.

D. Period and Duration of Problem -

1. MS20201KP8A bearing - 1964-1967
2. 540-011-414-1 drive link bearing - 1966-1967
3. 540-011-485-1 bearing assembly - 1966-1968
4. 540-011-415-1 bearing - 1966-1968
5. 540-011-457-1 bushing - 1966-1968
6. (a) 204-011-412-1 bearing set - current problem, time of origin unknown.
   (b) 204-011-419-1 bearing, roller - current problem, time of origin unknown.
   (c) 204-011-409-1 bearing set - current problem, time of origin unknown.

Problem No.: 04-10 (continued)

E. Failure Rate Data -

1. Mean times between component/part replacement at Ft. Rucker during the year ending 30 April 1971 are as follows:

	P/N	A/C	MTBR (hours)
Scissors and Sleeve Assembly	204-011-401-11	B,D,H	950
Bearing Set	204-011-412-1	B,D,H	890
Roller Bearing	204-011-419-1	B,D,H	1287
Bearing Set	204-011-409-1	B,D,H	1899

2. Mean times to removal for failure of the 204-011-401-9 scissors and sleeve assembly based on data in the MIRF reports for the UH-1D and H are:

a. UH-1D - 529 hours, based on 248 removals of new items.

b. UH-1H - 556 hours, based on 114 removals of new items.

c. UH-1D and H combined - 538 hours, based on 362 removals of new items.

d. Major causes of failure presented in the MIRF are:

Cause	Code	UH-1D %	UH-1H %	Combined %
Excessive Wear	020	30.6	28.1	29.8
Sudden Stop	503	14.1	18.4	15.5
Bearing Failure	710	17.3	11.4	15.5

3. Mean time between failures as reported in the Bell Helicopter Company Reliability and Maintainability studies for unscheduled maintenance on the UH-1C scissors and sleeve assembly during 1966-67 was 461 hours at Ft. Rucker based on 25 failures and 11,531 flying hours. MTBF for unscheduled maintenance on the UH-1C scissors and sleeve assembly in Vietnam during 1967 was 493 hours based on 19 failures over 9360 flying hours.

F. Mission and Deployment Factors -

Common to all missions and deployments, but aggravated by aircraft in sand and dust environments.

Problem No.: 04-10 (continued)

Problem Impact:

A. Safety Factors -

Failures occurring in the scissors and sleeve assembly do not constitute a safety hazard, based on mishap data covering the period 1 January 1967 - 31 March 1971. During this time a small number of forced and precautionary landings were attributed to this assembly.

B. Maintenance Workload Factors -

The scissors and sleeve assembly can be replaced at organizational maintenance. All other maintenance, including scissors assembly and bearing and bushing replacement is accomplished at either direct or general support level. Replacement of the scissors and sleeve assembly requires from 5.5 to 8.5 manhours. Bearing replacement ranges from approximately 1 manhour to 5 manhours, and in most cases requires substantial disassembly.

C. Aircraft Availability Factors -

Aircraft downtime for scissors and sleeve assembly replacement ranges from .5 to 1.0 day. Most bearing replacements will take approximately 1 day.

Remedial Action:

1. December 1964 - MWO 55-1520-211-34/34 - modification of scissors assembly 204-011-401-5.

2. May 1965 - MWO 55-1500-200-40/1 provided for modification of all 204-011-406-5 assemblies. This MWO incorporated a steel sleeve (P/N 204-011-456-1) between the MS20201KP8A pivot bearing outer surface and the scissor lever bore. As a result of this MWO, a new scissors assembly 204-011-406-9 replaced the 204-011-406-5 scissors assembly. The 406-9 scissors assembly was in turn replaced by the 406-13 assembly.

3. October 1966 - Bell Helicopter Company procurement sources for the 540-011-414-1 bearing modified, since bearing from one vendor had limited service life.

4. March 1967 - MWO 55-1520-211-30/16 and change 1 November 1967 provided for a new scissors and sleeve assembly

Problem No.: 04-10 (continued)

P/N 540-011-451-3 in place of P/N 540-011-451-1. This MWO included a modification of scissors assembly P/N 540-011-406-5 into the 406-9 assembly. The improved assembly retained the 540-011-485-1 bearing assembly but replaced the NAS1312-104D shear bolt on which the 485-1 bearing was mounted to the 540-011-484-1 bolt. Other design changes were also incorporated, including the orientation of the bolt and associated hardware. This change also provided a bushing sleeve P/N 540-011-052-5 for the 540-011-415-1 plain bearing.

Scissors assembly 540-011-406-13 subsequently replaced the 406-9 assembly. This change replaced the 540-011-415-1 plain bearing with the 540-011-052-1 bearing assembly.

5. October 1967 - Bell Helicopter Engineering Order 204AMA-314A made the 540-011-457-1 bushing inactive and replaced it with P/N 209-010-452-1. The 452-1 bearing utilized stainless steel in place of the hard anodized aluminum used in the 457-1 bushing.

Data Sources:

3,7,8,9,12,17,21,33,34,36,38,39,41,42,43,44.

Cross References:

TMS	Problem Number
UH-1	04-4
AH-1	-
CH-47	04-6
CH-54	04-11, 18-1
OH-6	04-5
OH-58	-

Helicopter TMS: UH-1A,B,C,D,H
Problem No.: 06-1

Problem Title: Hydraulic Servo, Valve, Pump, Line Failures

Problem Description:

A. Component Identification -
The number of hydraulic components that fail is too great to identify each by part number. One major contributor to the problem is the irreversible valve, P/N 204-076-055-1.

B. Description of Failure -
Identical to AH-1G, described in AH-1G Problem 06-3.

C. Cause of Failure -
Material and design inadequate to withstand operating and natural environmental stresses.

D. Period and Duration of Problem -
From the initial production of the UH-1 to the present.

E. Failure Rate Data -
Not available for most hoses, tubes, and seals; however, failures are frequent. Failure rate data for some components which have presented reliability problems are presented below.

1. Antitorque hydraulic servo cylinder, P/N 204-076-053-11. Ft. Rucker demand data, based on 203 demands, shows a mean time between replacement of 498 hours. AVSCOM MIRF data shows a mean time to removal for the servo cylinder of about 500 hours for both the D and H models. Leaking accounted for 76% of 513 failures for the UH-1D with an average time to removal of 557.0 hours (first removal since new). Leaking accounted for 74% of 293 failures for the UH-1H with an average time to removal of 510 hours (first removal since new).

2. Irreversible valve, P/N 204-076-055-1.
Ft. Rucker demand data shows a mean time between replacement of 446 hours, based on 424 replacements. AVSCOM MIRF data for the UH-1D shows a mean time to removal of about 750 hours (128 first removals since new) with 61% removals occurring from leaking at 799 hours. Similar data for the UH-1H shows a mean time to first removal of 748 hours.

Problem No.: 06-1 (Continued)

3. Cyclic flight control hydraulic servo cylinder, P/N 205-076-038-7. Ft. Rucker demand data shows a mean time between replacement of 237 hours. AVSCOM MIRF data for the UH-1H shows a mean time to removal of about 365 hours (76 first removals since new). Leaking accounted for 65% of removals at an average time of 376 hours.

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
As with the AH-1G, hydraulic failures do not usually cause total losses and major mishaps. However, they are the principal source of precautionary landings. Of 1915 precautionary landings recorded by USABAAR in the 1 January 1967 - 31 March 1971 period, 740 or over 35% were the result of hydraulic failures of some sort. Of the 740 landings, 198 were the result of maintenance error, frequently chafing from improper securing of hoses. The irreversible valve caused 79 precautionary landings or more than 10% of the total. In total, 10 total losses, 4 major mishaps, 3 incidents and 14 forced landings were attributed to hydraulic failures in addition to the precautionary landings.

B. Maintenance Workload Factors -
Manhours required for any one item replacement are not great. The antitorque hydraulic servo cylinder, the cyclic flight control hydraulic servo cylinder, and most other hydraulic servo cylinders in the aircraft can be replaced at organizational level with 2-3 manhours of work. The irreversible valve requires 1.5 - 2.5 manhours (also at organizational level). The axial piston pump can be replaced with one manhour or less. The cumulative effect on maintenance workload from the high frequency of failure of these items is significant, even though individual replacement manhour requirements are not great. The Ft. Rucker maintenance activity estimates that about 8% of total maintenance manhours used in support of their UH-1 fleet are for hydraulic system repairs and replacements.

Problem No.: 06-1 (continued)

C. Aircraft Availability Factors -

Downtime for any one maintenance action normally ranges from 1.0 to 4.0 hours. As with maintenance workload, however, the cumulative effect of frequent failures on availability is significant, and probably represents 8-10% of all UH-1 downtime.

Remedial Action:

A number of remedial actions have been taken to improve hydraulic system reliability over the life cycle of the UH-1 fleet. Most hydraulic parts and components originally used have been replaced by other parts or components. In some cases there have been several changes made over the years. The number of changed part numbers is too lengthy to list, but a review of the appropriate technical manuals will give an indication of the extent of the changes in material that have been made.

A number of ECPs and MWOs have also been issued with the same objective. Some of these are:

MWO 55-1520-211-20/32, September 1966 and ECP UH-1-217, April 1965 - Installations of servo cylinder boots, selected UH-1A,B helicopters.

MWO 55-1520-211-34/10 - September 1964, Modifications of hydraulic cylinder assembly P/N 204-076-052-1 and -3, all UH-1 helicopters.

MWO 55-1500-206-20/1, August 1969, Improved Hydraulic Oil Filter System, UH-1A,B,D,H.

MWO 55-1520-200-30/10, June 1966, and ECP UH-1-170, September 1964, Gravity Hydraulic System for UH-1D Aircraft.

MWO 55-1520-211-30/15, September 1967, Installation of Emergency Hydraulic System to Collective Pitch Booster, UH-1C Aircraft.

While undoubtedly many of these actions have produced improvements, the problem still exists.

Problem No.: 06-1 (Continued)

Data Sources:

3,4,7,8,9,12,17,18,21,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	06-1, 06-2, 06-3
CH-47	06-1, 19-1
CH-54	06-1, 06-2, 06-3, 06-4
OH-6	-
OH-58	11-1

Helicopter TMS: UH-1B,C,D,H
Problem No.: 08-1

Problem Title: Instrument Failures and Malfunctions

Problem Description:

A. Component Identification -

	P/N
Attitude Indicator	136712-01-01- 14602-1-5-1-
Airspeed Indicator	MS28045-T1
Radio Magnetic Indicator	ID-998/ASN

B. Description of Failure -

Instruments became inoperative and gave inaccurate and erratic readings.

C. Cause of Failure -

Frequently internal failure with precise cause not known. Some failures attributed to vibration, some (attitude indicator) to omission of a seal during production, and some (airspeed indicator) to partial obstruction of static lines.

D. Period and Duration of Problem -

1966 to present.

E. Failure Rate Data -

Specific failure rate data are not available. Bell Reports to the Project Managers' M&R Committee showed, in September 1966, an MTBF of 2640 hours for the airspeed indicator, P/N MS 28045-T1, on the UH-1C. In January 1967, MTBF for the airspeed indicator on the UH-1C was reported in the same source as 600 hours, and on the UH-1D as 1070 hours. In March 1967, Bell Helicopter Company reported an MTBF of 2380 hours on the RMI.

Ft. Rucker demand data indicate, for current instruments, mean time between replacement of about 800 hours for the copilot attitude indicator, 500-600 for the pilot attitude indicator, and 900 hours for the airspeed indicator. These data

Problem No.: 08-1 (Continued)

do not include failures corrected by maintenance. It is probable that the MTBF is less than 1000 hours for these instruments.

F. Mission and Deployment -

Common to all missions and deployments.

Problem Impact:

A. Safety Factors -

USABAAR reports no mishaps resulting from failure of these instruments during the 1967-1971 period. Failure under IFR conditions, however, obviously increases flying hazards.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace Attitude Indicator	0.5 - 1.0	Organizational
Replace Airspeed Indicator	0.5 - 1.0	Organizational
Replace Radio Magnetic Indicator	3.5 - 4.5	Direct Support

C. Aircraft Availability Factors -

Downtime for replacement of attitude indicator or airspeed indicator: 1.0 - 2.0 hours

Downtime for replacement of radio magnetic indicator: .5 - 1.5 days.

Remedial Action:

Major remedial actions have consisted of changing the types of instruments used. A number of types of attitude indicators have been used over the life cycle of the UH-1. The current types are P/N 14609-1SB1 (interchangeable with P/N 613937 and P/N 14609-1 AWCL) and P/N Ind. A5UH1 (interchangeable with P/Ns DSA274, 148700-01-01, and 102550).

The current radio magnetic indicator P/Ns are MS 2802701 (pilot) and 1783755-615 (copilot).

Problem No.: 08-1 (Continued)

The airspeed indicator has not changed, and no known remedial action has been taken.

Data Sources:

3,7,8,12,33,34,36,38,39,41,42,43,44.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	08-1, 08-2, 08-3, 08-4
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: - UH-1 All Series
Problem No.: 09-1

Problem Title: Light and Light Bulb Failures

A. Component Identification -

	P/N
Navigational Light (Rotating Beacon)	G8400AF-24
Lamp for Rotating Beacon	MS25338-7079
Navigational Light (Tail Light)	MS25219-1
Lamp for Tail Light Assembly	MS25232-1683

B. Description of Failure -

Premature failure of lamps from breakage of lamp filament. Failures are identical to those observed in AH-1G lamps.

C. Cause of Failure -

Inadequacy of material to withstand vibration effects.

D. Failure Rate Data -

Data gathered in 1967 by Bell Helicopter Company on a small group of aircraft monitored at Ft. Rucker and Vietnam showed the following MTBF factors for the rotating beacon and the tail light:

	MTBF (hours)	
Rotating Beacon	Fort Rucker	Vietnam
UH-1C	435	585
UH-1D	541	477
UH-1H	63	316
Tail Light		
UH-1C	Not Avail.	Not Avail.
UH-1D	270	694
UH-1H	Not Given	859

Ft. Rucker demand data for a one-year period ending April 1971 shows a mean time between replacements for UH-1A, B, D, and H of 228 hours for the rotating beacon lamp and 53 hours for the tail light lamp, based on approximately 240,000 flying hours.

F. Mission and Deployment Factors -

Common to all missions and deployments.

Problem No.: 09-1 (Continued)

Problem Impact:

A. Safety Factor -

Light failures have produced almost no mishaps during the 1967-1971 period (one precautionary landing). However, such failures obviously increase flying hazards to some extent in night operations, particularly if there is any concentration of traffic.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace Lamp in Rotating Beacon	.2 - .3	Organizational
Replace Tail Light Lamp	.3 - .4	Organizational

Individual lamp replacement is quickly accomplished. However, the short time to failure produces a measurable maintenance workload.

C. Aircraft Availability Factors -

Downtime for a single lamp replacement - .5 to 1.0 hour. However, work is generally accomplished at scheduled PMIs.

Remedial Actions:

A number of different navigational lights have been used for UH-1 helicopters. All were replaced by P/N M58085-1, and that light, in turn, was replaced by P/N M58085-2. However, as noted above, the problem still exists.

UH-1 aircraft produced since about 1963 have a tail light assembly P/N 30-0158-7 installed in lieu of the MS25219-1 light. However, lamp failures in this light have also continued to occur.

Data Sources:

3,7,8,12,33,34,36,38,39,41,42.

Problem No.: 09-1 (Continued)

Cross References:

TMS	Problem Number
UH-1	-
AH-1	09-2
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 01-1

Problem Title: Pylon Damper Failures

Problem Description:

A. Component Identification -
Pylon Damper, P/N SGT 1270-1

B. Description of Failure -
1. Damage to snap rings, shearing of lower rivets, and elongation of rivet holes
2. Leaking at the shaft seal
3. Excessive play and sloppiness
4. "Bottoming out" and "freezing"

C. Cause of Failure -
1. Bending forces placed on snap ring during hard landings
2. Shaft seal failures
3. Internal deterioration

D. Period and Duration of Problem -
Early 1967 to present

E. Failure Rate Data (as reported by Bell Helicopter Company) -

	MTBF (hours)
Hunter Army Airfield	999.4
Vietnam	815.1
Combined	853.7

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
No mishaps attributed to pylon damper failure were recorded during the 1 January 1967 - 31 March 1971 period.

Problem No.: 01-1 (continued)

B. Maintenance Workload Factors -

Action	Manhours	Level of Maintenance
Replace	3.5 - 5.0	Direct Support

C. Aircraft Availability Factors -

Aircraft downtime - 2 hours to 1 day depending on whether aircraft is down during replacement only or during removal, repair, and replacement.

Remedial Action:

1. Production change to relocate the shim to reduce bending forces on snap ring during landing, effective with AH-1G 67-15534 and subsequent, was made in 1967.

2. Bell Service Memo No. AH-01-7-2 to provide detailed inspection procedures to detect defective dampers was issued in July or August 1968.

3. Bell Helicopter Company Service Memo AH-01-7-2 procedures were published in the EIR Digest (TB 750-992-4, 1968).

4. A repair kit (P/N SGT-1270-1-RK) was issued to DS maintenance activities and technical maintenance manuals were revised to provide repair instructions related to the kit, in late 1967.

5. The EIR Digest (TB 750-992-2, 1970) published instructions for repairing elongated rivet holes to accept oversize rivets.

Data Sources:

4,7,11,15,16,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	01-1
AH-1	01-8
CH-47	-
CH-54	04-10
OH-6	01-5, 02-2
OH-58	01-3

Helicopter TMS: AH-1G
Problem No.: 01-2

Problem Title: Air Inlet Filter Control System Failures

Problem Description:

A. Component Identification -
Air Inlet Control System - P/N EC104

B. Description of Failure -
System inoperative; fails to open filter doors

C. Cause of Failure -
Not known. In 1968, it was suspected that light corrosion in the actuator gearboxes (P/N DG-101) caused by moisture caused failures. Remedial action taken at that time (see below) to prevent entrance of moisture has apparently not solved the problem.

D. Period and Duration of Problem -
1968 to present

E. Failure Rate Data (as reported by Bell Helicopter Company) -
The MTBF shown below is high. However, at Hunter Army Airfield, it was reported in June 1971 that a high percentage of their aircraft were flown with filters closed because the control system was inoperable. MTBFs shown at end of FY 1969 were:

	MTBF (hours)
Hunter Army Airfield	6496
Vietnam	6656
Combined	6616

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
No mishaps attributable to the air inlet filter control system were recorded by USABAAR during the period 1 Jan 1967 - 31 Mar 1971.

Problem No: 01-2 (continued)

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace Control System	.5 - 1.0	Organizational

C. Aircraft Availability Factors -
Downtime: 1.0 - 2.0 hours

Remedial Action:

In August 1968, the manufacturer of the system initiated application of a bead of "stabond" to all seams on the DG-101 gearbox to assure that water could not penetrate the gearbox through the seams. As noted above, this apparently has not solved the problem.

Data Sources:

4,7,11,22,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	-
CH-47	-
CH-54	-
OH-6	01 -3
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 01-3

Problem Title: Canopy Center Window Panel Melting and Distorting From Rain Removal System Hot Air

Problem Description:

A. Component Identification -
Window assembly - P/N 209-030-509-41, effective AH-1G 66-15249 through 68-17113; P/N 209-030-509-51, effective AH-1G 69-16410 and subsequent.

B. Description of Failure -
Hot air is directed to the window assembly by the nozzle (P/N 209-070-467-1 or 209-070-467-5) of the rain removal elements of the air distribution installation. Activation of the system while the aircraft is in a hover position or on the ground results in melting, distortion and weakening of the window panels. Melting and distortion occur primarily in the lower forward portion of the panel.

C. Cause of Failure -

1. Concentration of heat in small panel area not dissipated by aircraft movement.

2. Failure of pilot or crew to inactivate system when aircraft is on ground is most frequent immediate cause.

D. Period and Duration of Problem -
Early 1967 to present

E. Failure Rate Data -
Not precisely determined, but probably MTBF is more than 1000 hours. However, the system is intentionally made inoperable on most aircraft in RVN and CONUS because of the melting problem. If the system were operable at all times, the failure rate would be much higher.

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem No.: 01-3 (continued)

Problem Impact:

A. Safety Factors -
Not a safety problem

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace	1.5 - 3.0	Organizational

C. Aircraft Availability Factors -
Downtime - 2 to 5 hours

Remedial Action:

1. Issuance of Bell Helicopter Service Memorandum No. AH-01-8-3 provided instructions to field for rigging of the rain removal nozzle.

2. Replacement of the 209-070-467-1 nozzle by a 209-070-467-5 nozzle effective with AH-1G 68-15000 and subsequent. The new -5 nozzle has a machined surface to facilitate pr[illegible] stallation.

3. Publication in the EIR Digest (TB 750-992-2, Ja[illegible] 197[illegible]) of instructions for fabricating and installing a small, as[illegible]os heat shield in the lower forward portion of the panel to protect it from the heated air.

Data Sources:

4,7,11,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	01-2
AH-1	12-1
CH-47	01-2
CH-54	-
OH-6	01-2
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 01-4

Problem Title: Ammunition Door, Smoke Grenade Door, Access Panels and Doors

Problem Description:

A. Component Identification -

	P/N
Ammunition Compartment Doors	209-030-216-7, -8, 209-030-216-11, -12
Tail Fin Drive Shaft Cover	209-030-816-3
Access Door Panels	209-030-217-7, -19

B. Description of Failure -
1. Ammunition compartment door
   a. Plastic rub strips loosening, coming off.
   b. Outer and inner skin cracking, spotweld holding skins together separating, and rivets attaching outer skin and latches to structural stiffeners failing.
   c. Damage to door interior.
2. Tail fin drive shaft covers
   a. Hinge halves wearing, failing.
   b. Cracking on the side attached to the skin by fasteners, in the area of the fasteners.
   c. Chafing on the closing support structure.
   d. Damage in area of tail rotor cable pulley brackets.
3. Access door panels
   a. Cracking of support angles in their bend radii.

C. Cause of Failure -
1. Ammunition door
   a. Rub strip failures
      - Improper adjustment of ammunition door cables.
      - Inadequacy of material and design to withstand hard usage.
   b. Skin cracking, spot weld separating, rivet failures:
      - Blast of XM-18 miniguns and rockets fired from XM-159 pods.
      - Use of door as a step to gain access to upper portion of forward fuselage.

Problem No.: 01-4 (continued)

c. Damage to door interior
   - Improper handling of ammunition boxes and tools

2. Tail fin drive shaft cover
   a. Hinge halves wearing, failing
      - Vibration
   b. Cracking by fasteners
      - Vibration, stress
   c Chafing on closing support structure
      - Design
   d. Damage in area of tail rotor cable pulley bracket
      - Design permitted contact with brackets

3. Access door panels
   - Rocket blasts

D. Period and Duration of Problem -

All problems originated in early 1967. Corrective action to resolve the various problems was initiated from 1967 to 1970. Specific dates of these actions are shown below under "Remedial Action".

E. Failure Rate Data (from Bell Helicopter Company studies) -

Ammunition doors	MTBF (hours)
Hunter Army Airfield	5197
Vietnam	929
Combined	1163

Tail fin drive shaft cover	
Hunter Army Airfield	684
Vietnam	294
Combined	342

Side panels	
Hunter Army Airfield	1768
Vietnam	768
Combined	1018

F. Mission and Deployment Factors -

As many of the problems are caused by ammunition handling and of gun and rocket firing, these problems are more severe in the Vietnam combat operation. The tail fin drive shaft cover problems were common to all missions and deployments.

Problem No.: 01-4 (continued)

Problem Impact:

A. Safety Factors -

One mishap (classified as incident) occurred in the period 1 January 1967 - 31 March 1971 as recorded by USABAAR. The mishap occurred as the result of fasteners shearing on the tail fin drive shaft cover.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maintenance
a. Replace ammunition door	.8 - 1.0	Organizational
b. Replace tail fin drive shaft cover hinge	1.0 - 1.5	Direct Support
c. Install anti-chafing PTFE tape	.5	Organizational
d. Install bumper on inside door	1.0 - 1.5	Direct Support
e. Beef up access door panel support angles	4.0 - 5.0	Direct Support

C. Aircraft Availability Factors -

Aircraft downtime for all work shown above, except for access door panel support angle fix, will run from 1 - 2 hours. Beef-up of the support angle (based on a two-man repair team) is estimated at four hours downtime.

Remedial Action:

1. Ammunition door

a. P/N 209-030-216-11 and -12 door assemblies replaced the 209-030-216-7 and -8 door assemblies. The -11 and -12 doors incorporated two small rub strips (rather than one larger one) bonded and attached to the door with screws rather than rivets. The new doors were effective with AH-1G 67-15450 and subsequent production and future spares.

b. The EIR Digest for the 4th Quarter FY 1969 (TB 750-992-3, 1969) published instructions for adjusting the ammunition door to prevent failures of the 209-030-216-11 and -12 door rub strips.

c. Adjustable door cable assemblies were issued to replace previous nonadjustable assemblies to facilitate door

Problem No.: 01-4 (continued)

adjustment, effective with AH-1G 67-15588 and subsequent, and were also made available through the supply systems.

d. ECP AH-1G 421R1, approved January 1969, for installation of the XM-35 weapons system provided a new ammunition door for the left side of the helicopter. MWO 55-1520-221-40/4 dated 1 December 1969 with change 1, 24 August 1970, and change 2, 17 September 1970, provided kits and instructions for field installation of the ECP.

2. Tail fin drive shaft cover

a. A Bell Helicopter Company Service Memorandum AH-01-08-14 was issued in December 1968, providing instructions for replacement of the aluminum hinge with a steel hinge. These instructions were published in the EIR Digest for the 1st Quarter, FY 1969 (TB 750-992-4, 1968).

b. ECP AH-1G 350R1 approved in May 1969 for a tractor tail rotor provides a new tail fin access door hinge. MWO 55-1520-221-40/3 provided kits and instructions for field installation of the ECP.

c. Instructions for preventing chafing of the cover by installing PTFE antichafing tape on affected surfaces were provided by the EIR Digest for the 3rd Quarter, FY 1968 (TB 750-992-2, 1968).

d. Instructions for preventing damage to the door from contact with the tail rotor cable pulley bracket by installing a steel bumper were published in the EIR Digest issue cited in (c) above.

3. Access door panels

a. Beefed-up angles were included in production on AH-1G 67-15618 and subsequent. Instruction for beefing-up the angles in the field were published in the EIR Digest for the 3rd Quarter, FY 1968 (TB 750-992-2, 1968).

Data Sources:

4,7,11,15,20,33,34,35,38,39.

Problem No.: 01-4 (Continued)

Cross References:

TMS	Problem Number
UH-1	01-5
AH-1	01-5, 01-6, 01-8
CH-47	01-1, 01-3
CH-54	-
OH-6	01-4
OH-58	01-1, 01-2, 01-3

Helicopter TMS: AH-1G
Problem No.: 01-5

Problem Title: 42° Gearbox Cover Failures

Problem Description:

A. Component Identification -
42° Gearbox Cover - P/N 209-030-814-1

B. Description of Failure -
Covers cracked in several locations and in some cases became deformed. Most cracks occurred through the fastener holes in the upper section of the cover, around the fastener stud retaining grommet, and through and in the area of the Kydex fairing (P/N 209-030-814-19).

C. Cause of Failure -
Inability of material to withstand vibration and other stresses.

D. Period and Duration of Problem -
Early 1968 until present

E. Failure Rate Data (from Bell Helicopter Company studies) -

		MTBF (hours)
Hunter Army Airfield	-	764
Vietnam	-	726
Combined	-	735

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
No mishaps attributable to 42° gearbox cover failures are recorded by USABAAR during the period 1 Jan 1967 - 31 Mar 1971.

Problem No.: 01-5 (continued)

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace gearbox cover	.5 - .7	Organizational
Repair gearbox cover	.5 -1.0	Organizational

C. Aircraft Availability Factors -
Downtime - 1.0 - 1.5 hours

Remedial Action:

In January 1969, a thicker Kydex fairing (P/N 209-030-814-29) was developed for AH-1G 68-17032 and subsequent. It was also produced for spares to replace the former -19 fairing.

In October 1969, a new cover assembly, P/N 209-030-814-5, replaced the -1 assembly. The new assembly was fabricated from a heavier aluminum alloy.

Data Sources:

4,7,11,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	01-5
AH-1	01-4, 01-8
CH-47	01-3
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 01-6

Problem Title: Canopy, Doors, Door Hardware

Problem Description:

A. Component Identification -
Canopy - P/N 209-030-004-1
a. Pilot's Door - P/N 209-030-502-9
b. Gunner's Door - P/N 209-030-501-9

B. Description of Failure -
1. Warping and bending of door - pilot
2. Latch binding, out of adjustment - pilot and gunner
3. Cracking of door frame - pilot and gunner
4. Handle breaking, loosening, coming off - pilot and gunner
5. Seals torn and loose, permitting rain water to enter cockpit - pilot and gunner
6. Loosening and breaking of handholds - pilot and gunner
7. Cracking and breaking of door hinges - pilot and gunner
8. Inoperative door strut from ball bearings' wearing and coming out - pilot and gunner.

C. Cause of Failure -
Most failures resulted from the inability of the materials used to withstand the environmental stresses (natural and operational) to which they were exposed. A problem resulting from other causes occurred only in the case of the pilot's door frame cracking, where interference between the outboard frame edge and the fuselage resulted in cracking of the frame. Specific conditions which led to material failures are:

1. Doors left open and exposed to rotor downwash from nearby hovering aircraft.
2. Inherent inadequacy (seals, metal frames)
3. Vibration
4. Harsh treatment

D. Period and Duration of Problem -
Early 1967 to present

Problem No.: 01-6 (continued)

E. Failure Rate Data (from Bell Helicopter Company studies) - The MTBF shown below is for the canopy and door assemblies and based on failure of some part or component which required maintenance work on the assembly.

	MTBF (hours)
Hunter Army Airfield	309
Vietnam	289
Combined	294

F. Mission and Deployment Factors - Common to all missions and deployments

Problem Impact:

A. Safety Factors - Doors and attaching hardware failures caused one major mishap of 24 reported for non-power plant causes between 1 Jan 1967 and 31 Mar 1971. In this case, the pilot's door came off in flight; attaching pin fatigue was suspected as the cause. Door failures do not ordinarily present safety problems.

B. Maintenance Workload Factors - Most corrections of individual door malfunctions do not present major maintenance problems. Following are some average manhours for various maintenance actions related to door repairs and replacements:

Action	Manhours	Level of Maint.
Replace door	.5	Organizational
Repair door (minor)	1.5	"
Repair door (extended)	1.0-5.0	Direct Support
Adjust door	1.0	Organizational
Replace latch	1.0	Direct Support
Repair latch	1.0-2.0	" "
Replace handle	1.0	" "

C. Aircraft Availability Factors - Downtime will normally range from 1-8 hours for any one action depending on particular maintenance action required.

Problem No.: 01-6 (Continued)

Remedial Action:

1. Instructions for proper reinstallation of pilot's and gunner's door and inspection and repair procedures for pilot and gunner door handles were published in the EIR Digest, TB 750-992-2 (3rd Quarter, FY 1970) and TB 750-992-3 (4th Quarter, FY 1970).

2. A new canopy assembly (P/N 209-030-004-23) was installed effective with AH-1G 69-16410 and subsequent production. The new assembly provides a new door assembly for both pilot and gunner, including new latch installation and exterior door handles. The screws holding the interior door handle in place in both gunner and pilot doors were replaced with self-locking screws (P/N NAS 1189-06P6L) in the new canopy assembly to prevent loosening and falling off. Instructions for installing the new self-locking screws were published in the EIR Digest TB 750-992-4, 1969 (1st Quarter, FY 1970).

3. Interference between the outboard frame edge of the pilot's door and the fuselage was eliminated by trimming the frame edge effective with AH-1G 67-15561 and subsequent production. A Bell Helicopter Company Service Memorandum (AH-D1-8-7) was released in March 1968, providing instructions for field corrections.

4. New seals to keep rain from entering the cockpit were installed on production aircraft AH-1G 67-15702 and subsequent, and drain holes through the outer skin to drain any water in the door hook area were provided on AH-1G 68-15000 and subsequent production.

5. Cracking of the gunner's door frame was corrected by installing an aluminum alloy gusset (P/N 209-030-501-67) on the inside of the metal frame at the lower forward corner, effective with AH-1G 67-15786 and subsequent production.

Data Sources:

4, 7, 11, 15, 33, 34, 38, 39, 42, 43.

Problem No.: 01-6 (Continued)

Cross References:

TMS	Problem Number
UH-1	01-3
AH-1	01-4
CH-47	01-4, 01-5
CH-54	-
OH-6	01-4
OH-58	01-1, 01-2

Helicopter TMS: AH-1G
Problem No.: 01-7

Problem Title: Honeycomb Bonded Panel Voids and Bonding Separations.

Problem Description:

The basic problem of bonded panel voids and bonding separations is described in UH-1 problem 01-4.

The problem is not as severe in the AH-1G as the UH-1, but it has appeared in certain areas. In June 1971, it was stated at Hunter Army Airfield that separations were occurring on the engine deck, in the tail boom structure below the 90° gearbox in stress areas underneath wing-stored weapons and under battery compartments.

Hunter personnel noted that engine deck problems appeared to occur after about 2200 flying hours. No additional data are available on the AH-1G beyond that provided in UH-1 problem 01-4.

Problem Impact:

A. Safety Factors -
No mishaps have resulted from this problem.

Data Sources:

1,2,3,4,7,8,9,11,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	01-4
AH-1	-
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No. G1-8

Problem Title: Fastener and Rivet Failures

Problem Description:

A. Component Identification -
Fasteners/Rivets - P/Ns too numerous to list.

B. Description of Failure -
1. Fasteners damaged, broken, lost
2. Rivets loose, pulled through, lost

Some specific areas of failure are:
a. Fasteners which secured the TAT-102A chin-mounted turret cowling to the turret frame.
b. Fasteners which secure the fairings of the armament pylon.
c. Fasteners on the tail fin access door.
d. Fasteners which attach the 42° gearbox cover to the tail boom assembly.
e. High shear rivets in tail boom, vertical fin, and lower hydraulic compartment areas.
f. Rivets which attach the clip assemblies to the transmission fifth mount, and rivets which attach fasteners to the clip assembly.
g. Rivets attaching outer skins and latches of the ammunition compartment doors to the structural stiffeners in the doors.

C. Cause of Failure -
Primarily vibration, weapons blast, and stress and fatigue. Fasteners are also frequently damaged when forced to close when they are misaligned.

D. Period and Duration of Problem -
Early 1967 to present

E. Failure Rate Data -
There is no known source of data for the MTBF on these items. They are common to several aircraft types and are

Problem No.: 01-8 (continued)

generally requisitioned in bulk quantities. Usage data related to any one aircraft type is also difficult to establish. However, the general acknowledgement of the problem indicates a high rate of failure.

F. Mission and Deployment Factors -
Common to all missions and all deployments

Problem Impact:

A. Safety Factors -
Normally failures of these items do not present serious safety-of-flight problems. Ingestion of rivets and fasteners have been reported, however, as causing engine malfunction in flight. One mishap is reported by USABAAR in the period 1 January 1967 - 31 March 1971, in which the tail fin drive shaft cover fasteners sheared and caused an incident. (See problem 01-5.)

B. Maintenance Workload Factors -
No single factor can be given. Replacement of a single fastener or rivet requires little time to accomplish. However, large-scale replacements can be time consuming. Additionally, in some cases, accessibility problems may produce high manhour requirements. Most work of this type can be done only by sheet metal skills at DS or higher levels.

C. Aircraft Availability Factors -
As with maintenance, no single factor can be given. Minor rivet and fastener replacement requirements can extend inspection downtime requirements and cause unscheduled maintenance downtime. Accessibility difficulties will also, of course, increase downtime.

Remedial Action:

As fastener and rivet failures normally result from vibration and stresses in the parts and components to which they are attached, remedial action, in most cases, is directed toward resolving the problems which create stress, cracking, bonding

Problem No.: 01-8 (continued)

separation, and other failures in these parts and components.

Some specific actions which were taken to correct, in part, fastener and rivet failures noted above are:

1. Replacement of TAT-102A system by XM-28 system.
2. Replacement of tail fin door assembly (P/N 209-030-816-3) by cover assembly (P/N 209-030-816-7).
3. Tail rotor gearbox cover (P/N 209-030-814-1) replaced by a stronger cover (P/N 209-030-814-5) and thicker Kydex fairings for covers provided on AH-1G 68-17032 and subsequent.
4. The left-hand ammunition door was replaced by ECP AH-1G-421R1, approved in January 1969, and by related MWO 55-1520-221-40/4, published 1 December 1969, with Change 1, 24 August 1970, and Change 2, 17 September 1970. The ECP and MWO made provision for the XM-35 armament system. The right-hand door assembly (P/N 209-030-216-12) was replaced by a new door (P/N 209-030-216-118).

Data Sources:

4, 7, 11, 33, 38, 39, 42.

Cross References:

TMS	Problem Number
UH-1	01-5
AH-1	01-1, 01-4, 01-5
CH-47	01-1, 01-3
CH-54	-
OH-6	01-4, 01-5
OH-58	01-3

Helicopter TMS: AH-1G
Problem No.: 02-1

Problem Title: Landing Gear Assembly Failures

Problem Description:

A. Component Identification -

	P/N
Skid Shoe Assembly	209-050-109-1
Skid Tube Assembly	209-050-002-3 (L.H.)
	209-050-002-4 (R.H.)
Cross Tube Assembly	209-050-002-5 (Fwd.)
	209-050-002-7 (Aft.)
Skid Tube Attaching Screws	MS27039-5-12
	MS27039-4-11

B. Description of Failure -
1. Rapid wearout of skid shoes.
2. Bending of cross tubes, skid tubes, skid shoes.
3. Cracking of skid tubes where aft cross tube attaches.
4. Collapsing of the aft section of the skid tubes on bottom side, near and aft of the ground handling wheel fitting in area of the aft cross tube saddle joint.
5. Skid tube attachment bolts loosening.

C. Cause of Failure -
1. Rapid wearout of skid shoes caused primarily by running landings on concrete during pilot training.
2. Skid shoe, skid tube, cross tube bending, cracking, collapsing caused by hard landings, high gross weight, and landing on uneven terrain.
3. Loosening of skid tube attachment screws resulted from the screws being too short to engage the locking feature of the nuts into which they are screwed.

D. Period and Duration of Problem -
1. Skid shoe wearout - early 1967 to early 1970.
2. Skid shoe, skid tube, cross tube - early 1967 to 1969.
3. Skid tube attaching screws - late 1967 to late 1968.

Problem No.: 02-1 (continued)

E. Failure Rate Data (as reported by Bell Helicopter Company) -

Landing Gear System	MTBF (hours)
Hunter Army Air	650
Vietnam	449
Combined	486

The AVSCOM Quarterly Record of Equipment Improvement Recommendations for the AH-1G fleet shows a two-year total of 14 EIRs for the landing gear system, with 10 of the 14 related to the skid tube and cross tube assemblies. Items represented by the 14 EIRs had an average time since new of 500 hours at the time of failure.

F. Mission and Deployment Factors -

1. Skid shoe wear resulted from frequent landings, hard landings, and autorotation incident to pilot training at Hunter Army Airfield.
2. Failures from landings on uneven terrain and high weight occurred mostly in Vietnam.
3. Loosening of skid tube attachment screws was common to all missions and deployments.

Problem Impact:

A. Safety Factors -

Five mishaps related to landing gear failures occurred during the period 1 January 1967 - 31 March 1971. All were classified as incidents. Three were caused by cross tube failures, one by a skid tube failure, and one by a skid.

B. Maintenance Workload Factors -

Action	M/H	Level of Maint.
1. Remove and replace skid shoe	1.0	Organizational
2. Remove and replace skid tube	1.5	Organizational
3. Remove and replace cross tube	2.0	Organizational
4. Remove and replace skid tube attaching screw	.25	Organizational

Problem No.: 02-1 (continued)

C. Aircraft Availability Factors -

	Average Downtime
1. Remove and replace skid shoe (1 man)	2.0 hours
2. Remove and replace skid tube (2 men)	2.0 hours
3. Remove and replace cross tube (2 men)	2.0 hours
4. Remove and replace skid tube attaching screw (1 man)	.5 hours

Remedial Action:

1. Skid shoe wearout. A heavy-duty skid shoe was developed and fabricated for use in pilot training. The heavy-duty shoe (P/N 209-050-004-3) was ordered in September 1969.

2. A number of actions were taken to correct skid tube and cross tube failures :

   a. Doublers were added to skid tubes where the cross tube attaches. The forward doubler was effective on AH-1G 67-15450; the aft, on 66-15293. ECP AH-1G 356 for skid tube reinforcement retrofit was also approved in January 1968.

   b. In September 1968, Engineering Orders 209 DA-424 and 209 DA-420 created new skid tubes with greater wall thickness, effective for all future procurement and spares.

   c. The forward and aft cross tube assemblies (P/N 209-002-5 and -7 respectively) were replaced by P/N 209-005-002-45 and -41.

   d. Left-hand and right-hand skid tube assemblies (P/N 209-050-002-3 and -4 respectively) were replaced by a -23 and -24, a -31 and -32, a -35 and -36, and finally, by a -51 and -52 assembly

3. The loose skid tube attaching screws were corrected by incorporation (effective AH-1G 66-15300 and subsequent) of longer screws, P/N MS 27039-4-13.

Data Sources:

4,7,11,16,33,34,35,38,39,42.

Problem No.: 02-1 (Continued)

Cross References:

TMS	Problem Number
UH-1	02-1
AH-1	02-2
CH-47	-
CH-54	-
OH-6	02-1
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 02-2

Problem Title: Cross Tube Fairing Installation Failures

Problem Description:

A. Component Identification -
Cross Tube Fairing Installation
P/N 209-050-003-1, AH-1G 66-15249 - 66-15357
P/N 209-050-003-5, AH-1G 67-15450 - 67-15869
P/N 209-050-003-63, AH-1G 68-15000 and subsequent

B. Description of Failure -
Fairing assemblies cracked, missing after flight.

C. Cause of Failure -
The use of the fairing as a step by mechanics and pilots is the primary cause of failure. Some failures have been attributed to armament debris striking the aft ring. The plastic material used for the fairings fails under these conditions.

D. Period and Duration of Problem -
Early 1967 to present. Fairing failures were still noted as a problem in June 1971 at Hunter Army Airfield.

E. Failure Rate Data (from Bell Helicopter Company Reports) -

	MTBF (hours)*
Hunter Army Airfield	867
Vietnam	1051
Combined	976

F. Mission and Deployment Factors -
Common to all missions and deployments

* No aircraft with the -63 fairing installation (AH-1G 68-15000 and subsequent) were monitored; thus the MTBF represents earlier fairing installations before the remedial action discussed below was applied.

Problem No.: 02-2 (continued)

Problem Impact:

A. Safety Factors -

No mishaps were recorded by USABAAR related to cross tube fairing failure during the period 1 January 1967 - 31 March 1971.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace fairing assembly	15.0 - 20.0	Organizational

The manhours required vary considerably. The reliability test of the AH-1G performed by the Aviation Test Board produced values ranging from 14.0 to 81.0 manhours. However, 15.0 to 20.0 manhours is considered adequate under most circumstances.

C. Aircraft Availability Factors -

Downtime (assuming 2-man crew) - 1.5 to 2.0 days.

Remedial Action:

Effective with AH-1G 68-15000 and subsequent, a new fairing installation (P/N 209-005-003-63) was installed which provided a right - and left-hand step (P/Ns 209-050-118-5 and -6 respectively) on the aft cross tube. No retrofit was provided, and problems with earlier models were not remedied by this action.

Data Sources:

4,7,11,22,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	02-1
CH-47	01-3
CH-54	-
OH-6	02-3
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 04-1

Problem Title: Tail Rotor Assembly Failures and Malfunctions

Problem Description:

A. Component Identification -

	P/N
Tail Rotor Hub	209-010-701-3
Thrust Bearings	204-010-704-9
Pitch Change Link Bearings	204-011-764-1
	204-011-763-3
Tail Rotor Control Quill Assembly	204-010-740-5
Tail Rotor Chain	204-001-739-3
Tail Rotor Slider	204-010-720-5
Tail Rotor Crosshead Assembly	204-011-711-1

B. Description of Failure -

Most failures resulted from excessive wear of parts and components, particularly bearings. Wear also produced cracking of threads in hub yoke spindles, breaking of pins holding tail rotor chain links together, binding in tail rotor control quill from worn sprocket teeth, and looseness of tail rotor slider on 90^{o} gearbox output shaft.

C. Cause of Failure -

1. Improper rigging
2. Material and design unable to withstand environmental stresses, particularly sand and dust.

D. Period and Duration of Problem -

Early 1967 until present

E. Failure Rate Data (as reported by Bell Helicopter Company) -

	MTBF (hours)	
	Hunter Army Airfield	Vietnam
Tail Rotor Hub	1083	258
Tail Rotor, Pitch Change Link	962	1192
Tail Rotor Control Quill Assembly	1624	1426

Problem No.:04-1(Continued)

	MTBF (hours) Hunter Army Airfield	Vietnam
Tail Rotor Chain Assembly	2165	1479
Tail Rotor Slider	4331	2853
Tail Rotor Crosshead	3248	3631

MTRs, based on data in the AVSCOM MIRF Report, are as follows:

	P/N	MTR (hours)	Removals
Tail rotor hub	209-010-701-3	Approx. 150 - 160	210
Tail rotor hub*	204-011-801-3	205	125

F. Mission and Deployment Factors -

Most problems have been more severe in Vietnam than at Hunter Army Airfield. It is probable that the sand and dust environment in Vietnam and combat flying stresses are reasons for the differences in MTBF shown above.

Problem Impact:

A. Safety Factors -

The tail rotor system has produced more major mishaps than any other helicopter area except the engine. Of 11 total losses sustained between 1 January 1967 and 31 March 1971, charged to other than power plant failures, 6 were known or suspected to be caused by failures in the tail rotor system. Of 21 major mishaps charged to other than power plant failures, 11 were known or suspected to be caused by failures in the tail rotor system. One total loss and one major mishap of those noted above from tail rotor failure resulted from maintenance errors. Three of the major mishaps were also related to the tail rotor gearbox, and the exact cause of the mishap could not be determined.

There were also 9 forced landings (out of a total of 27) and 8 precautionary landings resulting from failures of bearings, grip assembly, chain and sprocket, slider and hub. Six of the forced landings and two of the precautionary landings resulted from maintenance errors.

*See discussion of this component under Remedial Action No. 1.

Problem No.: 04-1 (Continued)

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace tail rotor hub	2.0-3.0	Organizational (hub & blade assy) Direct Support (hub assembly)
Replace pitch change links	2.0-3.0	Organizational
Replace slider	1.0-1.5	Organizational
Replace tail rotor chain assembly	2.0-2.5	Organizational
Replace tail rotor control quill assembly	3.0-4.0	Organizational
Replace tail rotor crosshead assembly	.5-1.0	Organizational

C. Aircraft Availability Factors -

Downtime ranges from 2 hours to 1 day, depending on the task to be performed and the number of men in the work crew.

Remedial Actions:

A number of remedial actions have been taken:

1. A major action was the replacement of the P/N 209-010-701-3 hub with a P/N 204-011-801-3 hub. This was accomplished by ECP AH-1G 388R1, approved in December 1968. This new hub included a new yoke assembly, P/N 204-011-722-5.
2. The pitch change link assembly was replaced by a new assembly (P/N KSP 9003-5) which resulted in changing rod end bearings 204-011-764-1 and 204-011-763-3 to bearing KSP 7077-3. The new bearings are Kacarb rather than PTFE.
3. ECP AH-1G 350R1 was approved in May 1969 to provide a tractor tail rotor system. MWO 55-1520-221-40/3 provides for retrofit installation of the ECP. This ECP will provide new tail rotor controls, including silent chain assemblies.

Problem No.: 04-1 (Continued)

4. Bell Helicopter Service Memorandum UH-05-9-1 was released in February 1969 providing information on thrust bearing lubrication requirements.

Data Sources:

4,7,11,20,22,25,33,34,35,38,39.

Cross References:

TMS	Problem Number
UH-1	04-1
AH-1	04-2, 04-4, 11-1
CH-47	04-6
CH-54	04-10, 04-11
OH-6	04-2, 04-5
OH-58	04-3

Helicopter TMS: AH-1G
Problem No.: 04-2

Problem Title: Tail Rotor Gearbox Assembly Failures and Malfunctions

Problem Description:

A. Component Identification -
   Tail Rotor Gearbox Assembly - P/N 204-040-012-13

B. Description of Failure -
   1. Damage to gears - primarily scuffing
   2. Mounting studs broken and mount holes elongated
   3. Leakage at input and output quill seals

C. Cause of Failure -
   1. Gear failure - excessive torque delivered through anti-torque system in maximum gross weight and certain sideward and rearward flights exceeded gearbox capacity.

   2. Excess sealant in jackscrew holes on input quill sleeve flange caused improper mating between the sleeve flange and its mating surface on the tail boom fin, thus permitting motion of the mounting faces and subsequent stud failure and mount hole elongation.

   3. Leakage caused by inadequate seal material and design.

D. Period and Duration of Problem -
   Early 1967 to present

E. Failure Rate Data (from Bell Helicopter Company studies) -

	MTBF (hours)
Hunter Army Airfield	500
Vietnam	493
Combined	495

AVSCOM report "Major Item Removal Frequency, AH-1G Fleet" for the period 1 January 1964 throug[illegible] June 1971 shows a mean time to removal for failures [illegible]ximately 420-430 hours for new gearboxes based on [illegible]als. Leaking

Problem No.: 04-2 (continued)

accounted for 104 or 27.5% of the total. For 115 gearboxes with one prior overhaul, the mean time to removal was about 300 to 310 hours, with leaking again the major single cause (17.4%).

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
In the category of non-power plant major mishaps, tail rotor gearbox failures are known to have produced 1 of 11 total losses and 1 of 21 major mishaps. Additionally, three major mishaps as noted in problem 04-1 could also possibly have been caused by gearbox failures. In two cases, the tail rotor and gearbox separated from the aircraft in flight, and identification of the cause as gearbox or tail rotor failure could not be made. One other major mishap also could not be clearly traced to either the gearbox or the tail rotor.

Two incidents (of a total of 20), one forced landing and seven precautionary landings resulted from tail rotor gearbox failures and malfunctions.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace tail rotor gearbox	5 - 7	Organizational

C. Aircraft Availability Factors -
Downtime for replacement - 1/2 to 1-1/2 days depending on size of work crew.

Remedial Action:

1. ECP AH-1G 350R1 for a tractor tail rotor system was approved in May 1969, and MWO 55-1520-221-40/3 was published for ECP retrofit.
2. Limitations on certain sideward and rearward movements were incorporated in appropriate technical manuals to prevent overtorque of gearbox.

Problem No.: 04-2 (continued)

3. Bell Helicopter Company Service Memorandum SEM UH-04-6-2 was released to provide field information on gearbox installation. This information was published in the EIR Digests for the 2nd and 3rd Quarters FY 1969 (TB 750-992-1 and -2, 1969). Instructions for eliminating the excess sealant problem, warning against reusing lock nuts, and instructions for proper installation were included in the Digests.

Data Sources:

4,7,11,15,22,25,33,34,35,38,39,42.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	04-1
CH-47	-
CH-54	04-8
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 04-3

Problem Title: Main Rotor Blade Failures

Problem Description:

A. Component Identification -
Main Rotor Blade Assembly - P/N 540-011-001-5

B. Description of Failure -
Failures incurred by blades can be categorized as inherent and external. Inherent failures included such items as excessive wear, corrosion, cracking, bonding separation, delamination, and excessive vibration. External failures include overstress, punctures, dents, breaking, and blistering.

C. Cause of Failure -
Inherent failures resulted from material and design inadequacies. External failures were caused primarily by combat damage, crash damage, blade strikes and overspeed.

D. Period and Duration of Problem -
Early 1967 to present

E. Failure Rate Data -
USAAVLABS Technical Report 71-9, "UH-1 and AH-1 Main Rotor Blade Failure and Scrap Rate Data Analysis", January 1971, provides mean time to removal data for the blade as follows:

		MTR (hours)
CONUS -	Inherent Causes	455
	External Causes	290
	Combined	364
VIETNAM -	Inherent Causes	371
	External Causes	272
	Combined	297

The AVSCOM "Major Item Removal Frequency Report, AH-1G Fleet", 1 January 1964 through 30 June 1970, shows a mean time to removal based on 1022 removals from all areas of:

Problem No.: 04-3 (Continued)

	Hours
Inherent Causes	290
External Causes	247

It may be noted that while the respective MTR sources are in general agreement, although clearly the USAAVLABS MTRs significantly exceed those of the Major Item Removal Frequency Report, the evidence is that external causes of failure exceed the inherent causes in all breakdowns.

F. Mission and Deployment Factors -

Failures are common to all missions and deployments, but they are more severe in Vietnam, where battle damage and the combat and natural environment induce higher failure rates.

Problem Impact:

A. Safety Factors -

While it is apparent that complete failure of a rotor blade presents a safety problem, USABAAR data covering mishaps during the period 1 January 1967 through 31 March 1971 (excluding combat losses) shows only two precautionary landings attributed to main rotor blade failures. Main rotor blade failures have not presented safety problems.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace blade	6 - 7	Organizational
Repair blade	6 - 7	Organizational

It should also be noted that while a large percentage of blades removed for failure are scrapped on removal by the removing organization (50-60% according to USAAVLABS Technical Report 71-9 cited above), the balance are repaired on site or returned to a CONUS inspection/repair facility. Of those returned to CONUS, 65-80% are scrapped by the inspection/repair facility. Thus, only about 20-30% of blades removed are reused. Those actions represent a sizable workload at all levels of maintenance, with little productive output resulting.

Problem No.: 04-3 (Continued)

C. Aircraft Availability Factors -
Downtime for blade replacement ranges from 1/2 to 1-1/2 days depending on size of work crew.

Remedial Action:

ECP AH-1G 450 was approved in February 1969 to provide an improved main rotor blade, P/N 540-011-250-1, to replace P/N 540-011-001-5. The mean time to removal for this blade, as shown in the AVSCOM Major Item Removal Frequency Report cited above, based on 114 removals, shows no improvement over the previous blade. However, the limited period covered by the data on the new blade may reflect only early removals, and a true MTR cannot be established from these data.

Data Sources:

1,17,19,38,39,42.

Cross References:

TMS	Problem Number
UH-1	04-2
AH-1	-
CH-47	04-1
CH-54	04-1
OH-6	04-4
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 04-4

Problem Title: Main Rotor Hub Bearing Failures

Problem Description:

A. Component Identification -

	P/N
Grip Bearing (outboard)	540-011-110-13
Grip Bearing (inboard)	540-011-110-9
Trunnion Bearing	540-011-110-5

B. Description of Failure -

Inboard and outboard grip bearings.

1. Excessive wear of bearing surface and unbonding of PTFE bearing material.
2. Trunnion bearing lining (PTFE) worn through, causing spalling and pitting of trunnion sleeve.

C. Cause of Failure -

1. Outboard bearing - Failure of dust seal (P/N 540-011-168-3) permits bearing to be contaminated with dust and dirt.
2. Inboard bearing - Failure of seal (P/N 540-011-159-1) allows bearing dust and dirt contamination.
3. Trunnion bearing - Inability of PTFE bearing lining to withstand stresses applied.

D. Period and Duration of Problem -

Late 1967 to present

E. Failure Rate Data (as reported by Bell Helicopter Company) -

Main Rotor Hub:	MTBF (hours)
Hunter Army Airfield	351
Vietnam	403
Combined	389

The mean time to removal of main rotor hubs for bearing failure, as shown in the AVSCOM report "Major Item Removal Frequency, AH-1G Fleet" for the period 1 January 1964 through 1 July 1970, is 312 hours for new hubs and 246 hours for hubs with one prior overhaul. Bearing failure accounted for the largest number of removals resulting from failure (22.2% new, 21.8% one prior overhaul).

Problem No.: 04-4 (continued)

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
Although failure of the main rotor hub in flight presents a serious safety problem, no mishaps are recorded by USABAAR related to the main rotor hub during more than four years of AH-1G operations (1 January 1967 - 31 March 1971). Thus, in spite of the frequency of failure, inspection and maintenance procedures have been adequate from a safety standpoint.

B. Maintenance Workload Factors -

Action	M/H	Level of Maint.
Replace grip bearing	20 - 25	Direct Support
Replace trunnion bearing	10 - 15	Direct Support

C. Aircraft Availability Factors -
Downtime for grip bearing (assuming 2-man crew), 2-3 days
Downtime for trunnion bearing (assuming 2-man crew), 1-2 days

Remedial Action:

None known.

Data Sources:

4,7,11,17,22,23,32,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	04-3, 04-4
AH-1	04-1
CH-47	04-6
CH-54	04-7, 04-11, 18-1
OH-6	04-5
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 04-5

Problem Title: Transmission Input Quill Seal Failures

Problem Description:

A. Component Identification -

	P/N
Quill Assembly	204-040-363-3
Seal	455942-H

B. Description and Cause of Failure -
The AH-1G transmission input quill assembly is identical to that in the UH-1B, C, D and H, and has experienced the same types of failures from the same causes (see Problem UH-1 04-4).

C. Period and Duration of Problem -
Mid-1967 to present

D. Failure Rate Data (from Bell Helicopter Company Reports) -

	MTBF (hours)
Quill Assembly:	
Hunter Army Airfield	200
Vietnam	377
Combined	310

AVSCOM Report "Major Item Removal Frequency, AH-1G Fleet" for the period 1 January 1964 through 1 July 1970 shows that of 72 removals, 52 were for leaking, and for these 52, the mean time to removal was 300 hours.

E. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
During the period 1 January 1967 - 31 March 1971, only two mishaps were attributed to the quill. One was a forced landing; the second was a precautionary landing resulting from leakage which caused the bypass valve to open. However, as noted in UH-1 Problem 04-4, seal leakage can contribute to other assembly or component malfunctions which create safety problems.

Problem No.: 04-5 (Continued)

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace seal	12 - 14	Direct Support
Replace transmission input quill	8 - 10	Direct Support

C. Aircraft Availability Factors -

Aircraft downtime (assuming 2-man crew): approximately 1 to 1.5 days.

Remedial Action:

Remedial actions for the AH-1G were same as those applied to the UH-1, described in UH-1 Problem 04-4.

Data Sources:

3,4,7,8,11,17,22,33,34,38,39,43.

Cross References:

TMS	Problem Number
UH-1	04-5
AH-1	-
CH-47	04-5
CH-54	04-3, 04-8, 04-11, 06-2, 18-1
OH-6	04-3
OH-58	04-2

Helicopter TMS: AH-1G
Problem No.: 06-1

Problem Title: Lockout Valve, Relief Valve, and Accumulator Solenoid Valve Failures

Problem Description:

A. Component Identification -

	P/N
Lockout Valve	204-076-012-3
Relief Valve	204-076-343-3
Accumulator Solenoid Valve	204-076-439-1

B. Description of Failure -

1. Lockout valve: valve open, failed to close at specified pressure, failed to open at specified pressure, leaked internally.
2. Relief valve: cracks in housing permitted internal and external leaks, became inoperative.
3. Solenoid valve: malfunctioned, became inoperative.

C. Cause of Failure -

1. Lockout valve - design inadequacy.
2. Relief valve - design inadequacy and maintenance error (installation of valve).
3. Solenoid valve - design inadequacy.

D. Period and Duration of Problem -
Early 1968 until present

E. Failure Rate Data (from Bell Helicopter Company Reports) -

	MTBF (hours)
Hunter Army Airfield	
Lockout Valve	1624
Accumulator Solenoid Valve	4331
Vietnam	
Lockout Valve	19969
Accumulator Solenoid Valve	13313

Problem No.: 06-1 (continued)

F. Mission and Deployment Factors -
Primarily a problem at Hunter Army Airfield (see MTBF above); reasons for disproportion between Hunger and Vietnam are not known.

Problem Impact:

A. Safety Factors -
The valves are a part of the emergency hydraulic backup system. Failure under normal operating conditions would not be felt, but in an emergency situation could result in loss of the aircraft. However, only 2 mishaps are charged to these valves (both to the lockout valve), and both were precautionary landings during the period 1 January 1967 - 31 March 1971.

Problems with the hydraulic system generally are discussed in problem 06-3. Many failures in the hydraulic system recorded in available data are not sufficiently specific to identify the particular component affected. Several merely state "hydraulic failure", "No. 2 hydraulic system failed", etc. Thus, there may have been more mishaps during the period than the two noted above.

B. Maintenance Workload Factors -

Action	M/H	Level of Maint.
Replace Lockout Valve	1.5 - 2.5	Organizational
Replace Solenoid Valve	1.0 - 1.5	Organizational

C. Aircraft Availability Factors -
Aircraft downtime ranges from 2 to 4 hours for valve replacement.

Remedial Action:

1. ECP UH-1C/E-AH-1G-378 was approved on 30 August 1968. The ECP provides an improved lockout valve system. The lockout valve, P/N 204-076-012-3, was replaced by P/N 209-076-136-1. The relief valve was eliminated from the system.

2. MWO 55-1520-221-30/24 dated 26 January 1970 provided field instructions for ECP retrofit installations.

Problem No.: 06-1 (continued)

3. The EIR Digest for the 3rd Quarter, FY 1968 (TB 750-992-2, 1968) provided instructions for proper installation of the relief valve until application of the MWO 30/24 eliminated it from the system.

4. No known remedial action has been taken regarding the solenoid valve. However, it has presented a less serious problem.

Data Sources:

4,7,11,15,20,22,33,34,35,38,39.

Cross References:

TMS	Problem Number
UH-1	06-1
AH-1	06-2, 06-3
CH-47	06-1
CH-54	06-3, 06-4
OH-6	-
OH-58	-

Helicopter TMS: TH-1G
Problem No.: 06-2

Problem Title: Hydraulic Servo Cylinder Malfunctions

Problem Description:

A. Component Identification -
Servo Cylinder, Hydraulic - P/N 41103740 (TH-1G only)

B. Description of Failure -
Leakage and internal failures. Leakage primarily at shaft seals.

C. Cause of Failure -
Material (seals) inadequacy and design inadequacy

D. Period and Duration of Problem -
Late 1968 to present. The MWO providing the instructor boost system (MWO 55-1520-221-30/6) which resulted in installation of the servo was published in December 1968. Changes 1 and 2 were published in March and September 1970 respectively.

E. Failure Rate Data -
Unknown - Data providing MTBF are not available. Personnel at Hunter Army Airfield listed it as current problem in June 1971.

F. Mission and Deployment Factors -
CONUS training mission only

Problem Impact:

A. Safety Factors -
No mishaps have been attributed to this component over the period 1 January 1967 - 31 March 1971.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace	2.0 - 3.0	Direct Support

Problem No.: 06-2 (Continued)

C. Aircraft Availability Factor -
   Aircraft downtime for replacement - 4-5 hours

Remedial Action:
   None Known

Data Sources:

4,7,11,20,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	06-1
AH-1	06-1, 06-3
CH-47	06-1
CH-54	06-3, 06-4
OH-6	-
OH-58	11-1

Aircraft TMS: AH-1G
Problem No.: 06-3

Problem Title: Hydraulic Servo, Valve, Pump, Line Failures

Problem Description:

A. Component Identification -
The number of hydraulic components that fail is too great to identify each by part number. Included are most servos and cylinders, valves, pumps, lines and hoses, and fittings, to varying degrees.

B. Description of Failure -
Lines chafed, cracked, and ruptured; connections and fittings cracked, broke, and loosened; servos, cylinders, and valves leaked and suffered internal failures; pumps became inoperative; seals and O-rings leaked.

C. Cause of Failure -
Material and design unable to withstand operating and natural environmental stresses.

D. Period and Duration of Problem -
1967 until present

E. Failure Rate Data -
Unknown, except for one or two components. However, hydraulic component failures and malfunctions are frequent.

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
Hydraulic failures have not presented major safety problems in terms of total losses and major mishaps over the 1967-1971 time period. However, they have caused more precautionary landings than any other type of failure. Of 247 precautionary landings during the 1 January 1967 - 31 March 1971 period for the non-power plant causes, 99 or 40% were

Problem No.: 06-3 (Continued)

related to hydraulic component failures and malfunctions. Of the 99, 23 were attributed to maintenance error. Hydraulic lines and hoses accounted for 65 precautionary landings; servo and cylinders, for 22. Additionally, one major mishap resulted from failure of a cyclic servo; one incident and four forced landings resulted from hydraulic component failures.

B. Maintenance Workload Factors -

Manhours required for any one item replacement are not great. Most valves, servos and cylinders can be replaced in 4 manhours or less. Connections can be tightened in .5 manhour or less, and hoses can be replaced in 1.0 manhours or less. However, in total, hydraulic component adjustments, repairs, and replacements impose a sizable maintenance workload.

C. Aircraft Availability Factors -

Downtime normally ranges from 1 to 6 hours for any one maintenance action.

Remedial Action:

Eight different hydraulic system installations have been installed over the production period of the AH-1G fleet. One installation covers 1966 production, four cover various portions of 1967 production, one covers 1968, one covers 1969, and one covers AH-1Gs after compliance with MWO 55-1520-221-30/21 (ECU installation). Each has produced some component changes designed to improve reliability and performance. Success in correcting the problems appears limited. Remedial actions related to the lockout and accumulator solenoid valves are discussed in Problem 06-2; those related to the TH-1G hydraulic servo cylinder are discussed in Problem 06-1.

Data Sources:

4,7,11,22,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	06-1
AH-1	06-1, 06-2
CH-47	06-1
CH-54	06-1, 06-2, 06-3, 06-4
OH-6	-
OH-58	11-1

Helicopter TMS: AH-1G
Problem No.: 08-1

Problem Title: Attitude Indicator Failures

Problem Description:

A. Component Identification -
Attitude Indicator -
Pilot's - P/N 209-070-109-1, 209-070-109-3, MS17313-1
Gunner's - P/N 209-070-116-1, 209-070-116-3, MS17313-1
The gunner's indicator is a repeater unit of the pilot's.

B. Description of Failure -
1. P/N 209-070-109-1 and -3, and 209-070-116-1 and -3.
   a. Slow to erect
   b. False reading relative to bank and dive position
   c. Air bubbles in gunner's inclinometer

2. P/N MS17313-1
   a. Inoperative
   b. Rate switching gyro failures

C. Cause of Failure -
Unknown. Apparently inherent reliability, although the higher rate of failure in Vietnam (see below) may result from natural and/or operating environmental factors.

D. Period and Duration of Problem -
1. P/N 209-070-109-1 and -3, and 116-1 and -3 -- early 1967 to early 1968

2. P/N MS17313-1 -- early 1968 to present

E. Failure Rate Data (from Bell Helicopter Company studies) -
1. August 1967 - March 1968
P/N 209-070-109-1 and -3 and P/N 209-070-116-1 and -3.

	MTBF (hours)
Hunter Army Airfield	750
Vietnam	199
Combined	310

Problem No.: 08-1

F. Mission and Deployment Factors -
Primarily a problem in Vietnam; a lesser problem at Hunter Army Airfield.

Problem Impact:

A. Safety Factors -
No mishaps attributable to attitude indicator failures were recorded by USABAAR during the period 1 January 1967 - 31 March 1971.

B. Maintenance Workload Factors -

Action	M/H	Level of Maint.
Replace and test	.5	Organizational

C. Aircraft Availability Factors -
Aircraft downtime averages 1 - 2 hours.

Remedial Action:

A number of actions were taken, most of which were unsuccessful.

1. The pilot's indicator (P/N 209-070-109-1) was repositioned in the instrument panel. Additionally, reference lines were changed to $\pm$ 40° and 10° pitch lines marked on both pilot and gunner indicators to aid in adjusting level operation. These changes resulted in part number changes from 209-070-109-1 and 209-070-116-1 to 209-070-109-3 and 209-070-116-3, and were made on all ships produced from start of production, in October 1967.

2. As an interim fix, indicator MS17313-1 (MB-1) was substituted for the -109-1 and -116-3 indicators. ECP AH-1G-393, which provided for installation of the MB-1 indicator on production aircraft and for provision of retrofit kits, was approved in March 1968. A new inclinometer (P/N 2-0994-92) was included in the ECP.

3. MWO 35-1520-221-30/14, dated 5 March 1969, provided kits and instructions for installation of the MB-1 indicator on fleet aircraft.

Problem No.: 08-1

4. ECP AH-1G 366 was approved, effective with AH-1G 68-15000 and subsequent. Production of retrofit kits was also authorized. The new system utilized a remote attitude gyro with a repeater indicator at the pilot's and gunner's instrument panel, and contained a new rate-switching gyro.

5. MWO 55-1520-221-30/19, dated 16 December 1969, and change 1, dated 3 August 1970, provided kits and instructions for retrofit of the improved attitude indicator system on fleet aircraft. The new attitude indicator installed by ECP 366 carries P/N 148110-01-01. The new inclinometer carries P/N 146718-01. The new rate-switching gyro is type MC-1.

Data Sources:

11, 20, 22, 28, 33, 34, 35, 38, 39, 42.

Cross References:

TMS	Problem Number
UH-1	08-1
AH-1	08-2, 08-3, 08-4
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 08-2

Problem Title: Fuel Quantity Indicator Malfunction

Problem Description:

A. Component Identification -
Fuel Quantity Indicator - P/N 209-060-602-5

B. Description of Failure -
Indicator shows no reading or erroneous reading.

C. Cause of Failure -
Unknown. At Hunter Army Airfield, it was suspected that the problem was in the electrical circuit connecting the fuel probe to the indicator.

D. Period and Duration of Problem -
Early 1969 to present. Hunter Army Airfield had six aircraft down for this reason in June 1971, and AVSCOM personnel noted that it was a current and recurring problem.

E. Failure Rate Data (from Bell Helicopter Company reports) -

	MTBF (hours)
Hunter Army Airfield	1856
Vietnam	1664
Combined	1707

F. Mission and Deployment Factors -
Common to all missions and all deployments

Problem Impact:

A. Safety Factors -
No mishaps attributed to fuel quantity indicators are recorded by USABAAR during the period 1 January 1967 - 31 March 1971. However, malfunctions of this indicator present a potential safety hazard.

Problem No.: 08-2 (Continued)

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace	1.0 - 1.5	Direct Support

C. Aircraft Availability Factors -
Downtime for replacement - 2.0 - 3.0 hours

Remedial Action:
None known

Data Sources:

4,7,11,33,34,38,39,43.

Cross References:

TMS	Problem Number
UH-1	08-1
AH-1	08-1, 08-3, 08-4
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 08-3

Problem Title: Airspeed Indicator Failures

Problem Description:

A. Component Identification -
Airspeed Indicator - P/N B15821-10-008

B. Description of Failure -

1. Internal failures made instrument inoperative.
2. Impact and static lines obstructed by water caused inaccurate readings.
3. Impact air line and other lines in the system pulled loose, making instrument inoperative.
4. Pitot tube difficult to seal, resulting in leaks.

C. Cause of Failure -

1. Vibration and shock, particularly from weapons firing.
2. Improper assembly of couplings

D. Period and Duration of Problem -
Early 1970 to present

E. Failure Rate Data (as reported by Bell Helicopter Company) -

	MTBF (hours)
Hunter Army Airfield	3248
Vietnam	1536
Combined	1764

F. Mission and Deployment Factors -
Common to all missions and deployments, although more severe in Vietnam.

Problem Impact:

A. Safety Factors -
No mishaps attributable to airspeed indicator malfunctions are recorded by USABAAR during the period 1 January 1967 - 31 March 1971. Malfunctions of the indicator, however, present a potential safety hazard.

Problem No.: 08-3 (Continued)

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace airspeed indicator	.5 - 1.0	Organizational
Apply MWO 55-1520-221-30/30	3.0	Direct Support

C. Aircraft Availability Factors -

Downtime to replace indicator - 1.0 - 1.5 hours
Downtime to apply MWO 30/30 - 4.0 - 8.0 hours

Remedial Actions:

1. MWO 55-1520-221-30/30 provided a new airspeed indicator, P/N 209-070-178-1, to replace previous indicators.

2. A product improvement task (AH-8-06) study was made to determine reasons for fluctuations of airspeed indicating system during wing stores firing. Results showed that shock mounts at regular attaching points produced a 3:1 damping effect. Shock mounts were included in the provisions for the XM-35 weapons system installation (ECP AH-1G 421, January 1969, and MWO 55-1520-221-40/4, 18 December 1969, with Change 1, 24 August 1970, and Change 2, 17 September 1970).

3. The EIR Digest for the 3rd Quarter, FY 1968 (TB 750-992-4 1968) provided instructions for installation of a grommet between the hose installation Plexiglas and the pitot tube in lieu of putty filler to prevent leaking.

4. The EIR Digest for the 1st Quarter, FY 1970 (TB 750-992-4 1969) provided detailed instructions for the proper assembly and sealing of nylon couplings within the pitot static system piping.

Data Sources:

4,7,11,15,33,34,35,38,39,42,43.

Problem No.: 08-3 (Continued)

Cross References:

TMS	Problem Number
UH-1	08-1
AH-1	08-1, 08-2, 08-4
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 08-4

Problem Title: Radio Magnetic Indicator Failures

Problem Description:

A. Component Identification -

	P/N
Radio Magnetic Indicator - Pilot	ID 998/ASN
Radio Magnetic Indicator - Gunner	ID 250/ARN

B. Description of Failure -

1. Both pilot and gunner indicators had internal failures resulting in indicators becoming inoperative, precessing, recording 90° and 180° off of heading, and having loose internal parts.
2. CN 998/ASN 43 - Gyrocompass suffered internal failures, causing RMI to give erratic indications, precess, and spin, or became inoperative and had poor annunciator sensitivity.
3. Pins in plug fragile and easily broken when inserting plug.
4. Illuminating bulb in pilot indicator failing.

C. Cause of Failure -

Primarily vibration and shock from helicopter operation and particularly weapons firing. Breaking of the fragile pins on the plug results from design.

D. Period and Duration of Problem -

From early 1967 to present, although actions have been taken to correct problems (see remedial actions below). Problems still exist with RMI, particularly on ships on which corrective actions have not been applied.

E. Failure Rate Data (from Bell Helicopter Company reports) -

	MTBF hours
Hunter Army Airfield	565
Vietnam	1175
Combined	930

Problem No. 08-4 (continued)

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
No mishaps were attributed to RMI failures by USABAAR during the period 1 January 1967 - 31 March 1971.

B. Maintenance Workload Factors -

Action	M/H	Level of Maint.
Replace RMI	.5 - 1.0	Organizational

C. Aircraft Availability Factors -
Downtime of 1.0 to 1.5 hours

Remedial Action:

1. A product improvement program study (Task AH-8-26) determined that the use of shock mounts at each regular attaching point reduced "G" levels by one-half or more in the firing mode and has a 3 to 1 damping effect on the gunner and pilot instrument panels.

2. Based on the product improvement task, instrument panel shock mounts were included in the provision for installation of the XM-35 weapons system under ECP AH-1G 421 approved January 1969 and in MWO 55-1520-221-40/4, 18 December 1969 (with changes 1, 24 August 1970, and 2, 17 September 1970) which provided kits and instructions for ECP installation.

3. The EIR Digest for the 1st Quarter, FY 1969 (TB 750-992-4, 1968) provided instructions for rework of the CN 998/ASN 43 gyrocompass to improve annunciator sensitivity.

Data Sources:

4,7,9,11,15,20,33,34,35,38,39,42.

Problem No.: 08-4 (Continued)

Cross References:

TMS	Problem Number
UH-1	08-1
AH-1	08-1, 08-2, 08-3
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 09-1

Problem Title: Main and Spare Rotary Inverter Failures

Problem Description:

A. Component Identification -

	P/N
Main Rotary Inverter	P/U -542A
Spare Static Inverter	209-075-213-1

B. Description of Failure -

1. Main Rotary Inverter
   a. Output voltage fluctuation - caused malfunctions in instruments and armament, and high-frequency vibrations in aircraft. SCAS malfunctions and disengagement resulted from low voltage output.

2. Spare Static Inverter
   a. Internal shorts occurred when switching from main to standby AC power or checking standby AC circuit.
   b. Little or no output and variations in output when switched into AC power system caused instrument, armament and SCAS malfunctions.

C. Cause of Failure -

The main rotary inverter P/U-542A and the spare static inverter had a rated output of 100 VA. Power requirements nearly equaled the rated output. The installation of the improved attitude indicator ECP AH-1G 366 (see Problem 08-1) further increased power requirements.

D. Period and Duration of Problem -

From 1967 until installation of the larger inverters resulting from ECP AH-1G 380 and the corresponding MWOs.

E. Mission and Deployment Factors -

Common to all missions and deployments

Problem No.: 09-1 (Continued)

F. Failure Rate Data (main and spare inverters combined)*

	MTBF (hours)
Hunter Army Airfield	279
Vietnam	859
Combined	569

Problem Impact:

A. Safety Factors -

One mishap attributed to inverters was recorded by USABAAR during the period 1 January 1967 - 31 March 1971. It is recorded as a precautionary landing; however, it is also stated that the aircraft caught fire.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace inverter	1.3 - 1.7	Organizational
Install MWO 55-1520-221-30/12	60.0	Direct Support

C. Aircraft Availability Factors -

Downtime for inverter replacement - 2 hours

Downtime for MWO installation - 3-10 days, depending on size of work crew and work schedule

Remedial Action:

1. ECP AH-1G-380, providing a higher capacity main rotary inverter output rating, was approved in April 1968. The new inverter (P/U 543-A) had a rated output of 250 VA. The ECP was effective on production aircraft AH-1G 68-15000 and subsequent, and provided for retrofit kits for field application.

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* The MTBF shown (from Bell Helicopter Company reports) relates to a single inverter. However, as there are two inverters on the AH-1G (main and spare), the actual time between aircraft downtime from inverter failures would be half that shown.

Problem No.: 09-1 (Continued)

2. ECP AH-1G-366 (see Problem 08-1) provided a 150 VA spare inverter as part of the improved attitude indicator system. This ECP was also effective on production aircraft AH-1G 68-15000 and subsequent, and provided for retrofit kits for field application.

3. MWO 55-1520-221-30/12 and 30/19 provided kits and instructions for application of the new inverters resulting from ECPs AH-1G-380 and -366 respectively. MWO 55-1520-221-30/12 had a publication date of 29 April 1969, and -30/19, a publication date of 16 December 1969, with Change 1, dated 3 August 1970.

Data Sources:

11, 20, 33, 34, 35, 38, 39, 42.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	-
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 09-2

Problem Title: Light and Light Bulb Failures

Problem Description:

A. Component Identification -

	P/N
Instrument and Console Lights	MS25010B11A327
Cockpit Lights	209-075-250-1
Searchlight	G-6250-4
Navigational Lights, Tail	204-075-527-3
a. Lamps	
b. Wiring	
c. Shockmount	
d. Bulb Socket	
Navigational Lights - Wing Mounted	AN3033-12 and -13
Navigational Lights, Top Mounted	
Rotating Beacon	40-0103-1
	WRM-24

B. Description of Failure -

The most common problem in AH-1G lighting assemblies is failure of the lamp. This problem has occurred in all of the assemblies listed above. Specific problems are:

1. Instrument and console lights.
   a. Variable dimming resistor (P/N 110-046-3) operation intermittent or not at all.
   b. Transistor (P/N T1-1131) in gunner and pilot's dimmer-control circuit failed.
   c. Broken rheostat switch wires at switch terminals.
   d. Lamp failures.

2. Cockpit lights
   a. Electrical cable separations
   b. Bond failures between attaching studs and armor panels - P/N 209AA5459-1
   c. Lamp failures.

3. Searchlights
   a. Failure to rotate properly
   b. Lamp failures

Problem No.: 09-2 (continued)

4. Navigational lights - tail light (fin mounted)
   a. Broken wires
   b. Broken shock mount
   c. Broken lamp socket
   d. Lamp failures

5. Navigational lights - wing
   a. Broken ground wire
   b. Broken lenses
   c. Flasher unit failures (P/N MS 24577-2)
   d. Lamp failures

6. Navigational light - top-mounted rotating beacon
   a. Failure to rotate
   b. Separation from mount because of loosened mounting screws
   c. Lamp failures

C. Cause of Failure -

Almost without exception, the failures listed above resulted from vibrations from normal helicopter operations, and from shock and vibration resulting from helicopter-mounted weapons firing. Vibration and shock broke filaments in lamps, loosened mounting screws, broke wires, and caused internal failures in electrical components.

D. Period and Duration of Problem -

Most problems were noted in early 1967 during initial operations. Many still exist, particularly lamp failures.

E. Failure Rate Data (from Bell Helicopter Company reports) -

1. Instrument and console lights

	MTBF (hours)
Hunter Army Airfield	228
Vietnam	303
Combined	280

Problem No.: 09-2 (continued)

2. Cockpit lights*

	MTBF (hours)
Hunter Army Airfield	549
Vietnam	763
Combined	696

3. Searchlights

	MTBF (hours)
Hunter Army Airfield	481
Vietnam	1331
Combined	929

4. Navigational lights - tail light (fin mounted)

	MTBF (hours)
Hunter Army Airfield	121
Vietnam	245
Combined	179

5. Navigational lights - wing*

	MTBF (hours)
Hunter Army Airfield	1732
Vietnam	898
Combined	1018

6. Navigational light - top-mounted rotating beacon

	MTBF (hours)
Hunter Army Airfield	245
Vietnam	186
Combined	198

F. Mission and Deployment Factors -
Common to all missions and deployments

* There are three cockpit lights and two navigational lights. Thus, while the MTBF for a light is as shown, the time between light failures for the airplane is one-third that shown for the cockpit light and one-half that shown for the wing navigational lights.

Problem No.: 09-2 (continued)

Problem Impact:

A. Safety Factors -

No mishaps attributable to light failures were recorded by USABAAR during the period 1 January 1967 - 31 March 1971.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maintenance
1. Console lights - replace	.7	Direct Support
a. Variable resistor replacement	.6	Direct Support
b. Transistor replacement	.5	Direct Support
2. Cockpit lights - replace	.7	Direct Support
a. Installation of MWO 55-1520-22-30/28	13.0	Direct Support
3. Searchlight	.8	Organizational
4. Navigational light - wing	.6	Organizational
a. Installation of MWO 55-1520-221-20/5	8.0	Organizational
5. Navigational light - tail	.6	Organizational
a. Installation of MWO 55-1520-221-30/10	16.0	Direct Support
6. Navigational light - top-mounted rotating beacon	.8	Organizational

C. Aircraft Availability Factors -

Aside from MWO installations, most light and part replacements produce about an hour of downtime, and are frequently done during daily inspections and aircraft servicing. MWO downtime ranges from one day to three days, depending on work schedules and number of men in crew.

Remedial Action:

1. Console and instrument lights
   a. ECP AH-1G-506 to install new instrument light dimming rheostats was approved by the Army in April 1971 for retrofit of the fleet.

Problem No.: 09-2 (continued)

2. Cockpit lights
   a. ECP AH-1G-404 to install an improved cockpit lighting system was approved in February 1969, to be applied to production aircraft.

   b. MWO 55-1520-221-30/28, dated 5 February 1970, provides the improved cockpit lighting system for fleet retrofit.

   c. A change to an improved bonding material for bonding mount studs to armor plate was made in September 1971 and was applied to FY 1966 ships in production and to all subsequent production.

   d. Lamp P/N 15-0007-43 replaced by P/N MS17245-5.

3. Searchlights
   a. The searchlight, P/N G6250-4, was replaced by P/N M81174-2-1A.

4. Navigational light - tail light (fin mounted)
   a. ECP AH-1G 363 for an improved tail light configuration, including relocation of the light from the fin to the end of the tail boom, was approved in January 1968. The ECP called for incorporation of the improved system effective with AH-1G 67-15702 and subsequent, and for production of retrofit kits.

   b. MWO 55-1520-221-30/10 provided the improved system for retrofit of fleet aircraft prior to 67-15702.

   c. A new tail light assembly P/N 204-075-527-3 replaced tail light assembly P/N 30-158-7.

5. Navigational lights - wing
   a. ECP AH-1G 386 to provide improved accessibility of the external ICS connector for the headset was approved by the Army in March 1968. This ECP permitted a change from a wire-type ground for the navigation lights to a stronger metal strip ground. The ECP was effective with AH-1G 67-15786 and subsequent, and production of retrofit kits was authorized.

Problem No.: 09-2 (continued)

b. MWO 55-1520-221-20/15 was published in December 1969, providing retrofit kits and instructions to the field for installation of the new ICS connector, including the metal strip ground.

c. AN 3033-12 and 3033-3 light assemblies were replaced by AN 3033-9 assembly.

6. Navigational light - top-mounted rotating beacon
   a. A great many different navigation lights have been tried and replaced. The current light is P/N M58085-2, which replaces earlier lights (P/N's 40-0103-1, G8400A8-24, G8400A24-24, WRMC 24, M58085-1, WRM 24, and G8400A24).

Data Sources:

4,7,11,15,20,33,34,35,38,39,42.

Cross References:

TMS	Problem Number
UH-1	09-1
AH-1	30-1
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 11-1

Problem Title: Tail Rotor Cable Failure and Rigging Problems

Problem Description:

A. Component Identification -

	P/N
Tail Rotor Cables - Aft	205-001-720-1
Tail Rotor Cables - Quadrant to Speed Rig	209-001-728-1

B. Description of Failure -
1. Cables hard to rig properly
2. Cables frayed and worn
3. Cable fairleads (grommets) worn, allowing cables to rub against bulkheads

C. Cause of Failure -
1. Inadequate rigging instructions in technical manuals.
2. Sand and dirt between pulleys and cable acted as abrasive and accelerated cable wear.
3. Incorrect cable tension contributed to fairlead failures.
4. Fairlead failures contributed to excessive cable wear.

D. Period and Duration of Problem -
Late 1967 to present

E. Failure Rata Data (as reported by Bell Helicopter Company) -
Tail rotor cables:

	MTBF (hours)
Hunter Army Airfield	620
Vietnam	220
Combined	262

F. Mission and Deployment Factors -
Problem more severe in Vietnam than CONUS, probably attributable to effect of severe sand and dirt conditions in Vietnam on cable wear.

Problem No.: 11-1 (continued)

Problem Impact:

A. Safety Factors -

Any malfunctions in the flight control and antitorque systems present safety problems. Tail rotor cable failure in flight would, of course, present an extremely dangerous condition. However, a review of worldwide mishap data from 1 January 1967 through 31 March 1971 shows only two mishaps definitely attributed to tail rotor cables. One was a forced landing and the other a precautionary landing, both made because the tail rotor was out of rig. The precautionary landing resulted from a maintenance error.

The cables are a critical inspection item in the daily inspection checklist. Wear and fraying are not difficult to observe by inspection personnel, and out-of-rig conditions are quickly identified by the pilot. These factors may account for the low mishap rate.

B. Maintenance Workload Factors -

Action	M/H	Level of Maint.
1. Replace tail rotor cables - aft 1 cable or 2 cables concurrently	3.0 - 3.5*	Organizational
2. Replace Quadrant to speed rig cables 1 or 2 cables concurrently	2.5 - 3.0*	Organizational
3. Replace cable fairlead	0.4 - 0.6*	Organizational

C. Aircraft Availability Factors -

Downtime for cable replacement - 1/2 to 1 day.
Downtime for fairlead replacement - 1 to 2 hours.

* Includes re-rigging and test flight.

Problem No.: 11-1 (continued)

Remedial Action:

1. Bell Helicopter Company Service Memorandum AH-05-7-1 was issued in May 1968 providing additional tail rotor rigging procedure requirements. TM 55-1520-221-20 incorporated these procedures.

2. ECP AH-1G 350 R1 was approved in May 1969. The ECP provides a new tractor tail rotor system and includes new tail rotor cables. The new cables (P/N 209-001-779-1) are nylon coated. The ECP is effective with AH-1G 70-15936 and subsequent.

3. MWO 55-1520-221-40/3 published in 1970 covers retrofit installation of ECP 350R1.

Data Sources:

4,7,11,20,33,34,35,38,39,42.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	04-1
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 11-2

Problem Title: SCAS Malfunctions

Problem Description:

A. Component Identification -

	P/N
Pylon Transducers	570-074-080-1
Sensor/Amplifier Unit	570-074-010-1
Valve Driver Module	
Pylon Compensation Unit	570-074-131-1
Printed Circuit Boards	

B. Description of Failure -

Most failures occurred in the roll channel. Major problems have been:

1. Erroneous roll inputs to flight control
2. Intermittent operation of roll channel
3. Hardovers in roll channel
4. Interference between VHF system and SCAS
5. Excessive "pylon rock"

C. Cause of Failure -

1. Defective and improperly installed pylon transducers
2. Failure of welded joint in the valve driver module of the sensor/amplifier unit
3. Inadequate shielding of SCAS from VHF system EMI
4. Malfunctions of the pylon compensation unit
5. Malfunctions and failures of printed circuit boards

D. Period and Duration of Problem -

Early 1967 to present

E. Failure Rate Data (as reported by Bell Helicopter Company) -

	MTBF (hours)
Hunter Army Airfield	194
Vietnam	300
Combined	265

F. Mission and Deployment Factors -

Common to all missions and deployments

Problem Impact:

A. Safety Factors -

SCAS failures or malfunctions resulted in 1 of 11 total losses and 2 of 23 major mishaps resulting from non-power plant causes between 1 January 1967 and 31 March 1971. One major mishap resulted from failure of a yaw channel actuator. Causes of the other two mishaps are unknown. Additionally, one forced landing (actuator failure) and seven precautionary landings resulted from SCAS failures. Of the precautionary landings, two were caused by an actuator, one by a transducer, and one by a driver module failure; causes for the remainder were unknown.

B. Maintenance Workload Factors -

Most maintenance on the SCAS consists of replacement of transducers, roll channel components, actuators, etc. The great majority of replacements fall within a .3 to 3.0 manhour range, with 50% or more requiring less than 1 manhour. Few actions require more than 5.0 manhours.

Most replacements are authorized at organizational maintenance level. Testing, troubleshooting, and repairs are at DS and higher levels.

C. Aircraft Availability Factors -

Downtime - 1.0 - 8.0 hours, depending on extent of maintenance required

Remedial Action:

1. ECP AH-1G 398 was approved in July 1968. The ECP provided an improved pylon compensation network effective with AH-1G 68-17032 and subsequent.

2. MWO 55-1520-221-20/9 was published in April 1970 and provided instructions and parts for installation of ECP 398 in the field.

3. Effective with AH-1G 68-15000, an improved transducer (P/N 570-074-080-3) replaced the former -1 transducer. The -3 transducer is now prime for all SCAS systems.

4. The weld failure in the valve driver module was soldered in addition to the weld to insure a good electrical connection, effective in November 1968.

Problem No.: 11-2 (continued)

5. Effective with AH-1G 67-15786 and subsequent, filter capacitor and wire shielding were installed to eliminate EMI in the SCAS. ECP AH-1G 415 to provide retrofit kits was approved in August 1968.

Data Sources:

4,7,14,20,22,33,34,35,38,39.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	-
CH-47	04-4, 19-1
CH-54	19-1
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 12-1

Problem Title: Air Distribution, Heating and Ventilation Installation Malfunctions

Problem Description:

A. Component Identification -

Air Distribution Installation, Heating and Ventilation

P/N	A/C
209-070-400-1	66-15249 - 66-15357
209-070-400-3	67-15450 - 67-15617
209-070-400-5	67-15618 - 67-15785
209-070-400-7	67-15786 - 67-15869
209-070-400-11	68-15000 - 68-15144
209-070-400-9	68-15145 - 68-17113
209-070-400-13	69-16410 and subsequent

B. Description of Failure -

1. Plastic parts cracking, separating, breaking
   a. Elbow ducts - P/Ns 209-070-468-1 & 209-070-468-5
   b. Duct - P/N 209-070-485-1
   c. Impeller (P/N 209-070-482) blades.
2. Ventilation valve, P/N 209-070-476-1, cracking around flange area.
3. Temperature control valve (P/N 397884-1) malfunctioning, providing only hot or cold air; not mixing.

C. Cause of Failure -

1. Plastic parts - inability of material to withstand operating environmental stresses.
2. Ventilating valve. Valve was used as a handhold by pilots entering pilot compartment.
3. Temperature control valve - unknown. During the product improvement test of the environmental control system conducted by the Army Aviation Test Board in 1969, a similar failure occurred, i.e., system would produce only hot air. Teardown analysis at that time indicated failure was result of leak in the high-pressure supply line to the torque motor on the

Problem No.: 12-1 (Continued)

temperature control valve. The leak was caused by chafing of the line against an armored hydraulic line. Whether this condition is causing current failures is not known.

The USAVSCOM report "Quarterly Records of Equipment Improvement Recommendations, AH-1G Fleet" for October through December 1970 shows a total of 12 EIRs over a two-year period, covering cracking of the ram air inlet duct (3 each), cracking of the reheat condenser duct (2 each), cracking of the housing assembly (5 each), failure of the air pressure valve (1 each), and failure of the cooling turbine (1 each). Most of these failures and malfunctions could have contributed to the problem.

D. Period and Duration of Problem -
   1. Plastic parts - early 1967 to present
   2. Ventilation valve - late 1967-1968
   3. Temperature control valve - early 1970 to present

E. Failure Rate Data -
Unknown - no data available. The AVSCOM EIR report cited above showed an average of 552 hours since new at the time failure occurred, resulting in the EIRs for the environmental control unit. However, this includes only failed units and is a small sample. Other components (ducts, etc.) showed about 400 hours, again based on a small sample. However, the problems were sufficiently severe to produce a number of remedial actions and, as shown in the installation identification above, seven different configurations of the total installation.

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
Eight mishaps (all precautionary landings) were attributed to components of this installation. Four resulted from impeller failures (in two cases, the impeller disintegrated), two from fan failures, one from filter failure, and one from an unknown cause. Three of the four impellers which failed were P/N A 25481; the part number of the fourth is unknown.

Problem No.: 12-1 (Continued)

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace duct assemblies (P/Ns 209-070-545-1, 209-070-538-1)	.5 - 1.0	Direct Support
Replace impeller	1.0 - 1.5	Direct Support
Replace temperature control valve	1.0 - 2.0	Direct Support

C. Aircraft Availability Factors -

	Aircraft Downtime (hours)
Duct replacement	1.0 - 2.0
Impeller replacement	2.0 - 3.0
Temperature control valve replacement	2.0 - 3.5

Remedial Actions:

1. Elbow duct P/N 209-070-468-1 replaced by P/N 209-070-468-5, which was, in turn, replaced by P/N 209-070-545-1. The -545-1 duct contained a replaceable filter to filter out sand and dust formerly brought into the cockpit by the ventilation blower.

   Instructions for installing the new duct were published in the EIR Digest for the 2nd Quarter, FY 1969 (TB 750-992-1, 1969).

2. Duct P/N 209-070-485-1 was replaced by P/N 209-070-538-1. The new duct was incorporated into production effective with AH-1G 67-15534 and subsequent. Bell Helicopter Company Service Memorandum AH-12-7-1 was released in July 1968, providing field installation procedures for prior aircraft.

3. Impeller P/N 209-070-482 was replaced by P/N A25481 and later by P/N 197803-1.

Problem No. 12-1 (Continued)

4. Ventilation valve:
   a. P/N 209-070-476-1. The EIR Digest for the 2nd Quarter, FY 1969 (TB 750-992-1, 1969) recommended stenciling "No Handhold" on the valve assembly to prevent damage from use as a handhold.
   b. Effective with AH-1G 67-15450 and subsequent, the valve was relocated and replaced by valve assembly P/N 209-070-492-1.

5. No known remedial action has been taken regarding temperature control valve malfunctions.

Data Sources:

4,7, 11,15,26,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	01-3
CH-47	01-3
CH-54	-
OH-6	01-3
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 19-1

Problem Title: FM Radio Set AN/ARC-54 Malfunctions

Problem Description:

A. Component Identification -
Radio Set AN/ARC 54:
Receiver-Transmitter RT-348/ARC-54
FM Antenna - P/N 522-4773-001
Power Amplifier

B. Description of Failure -
1. Radio inoperative - receiver/transmitter failures
2. Signal weak
3. Broken and disconnected RF cables
4. Broken power amplifiers
5. Antenna short circuits

C. Cause of Failure -
1. Excessive heat in radio compartment - also caused failures of UHF radio AN/ARC-51 BX and the VHF radio AN/ARC-134 transceiver.
2. Oil from engine oil tank scupper assembly collecting on antenna.
3. Vibration suspected.

D. Period and Duration of Problem -
Early 1967 until present. Problems with the ARC-54 radio were discussed in June 1971 at Hunter Army Airfield, and it was stated there that it was considered to be the least reliable radio in the AH-1G.

E. Failure Rate Data (as reported by Bell Helicopter Company) -

	MTBF (hours)
Hunter Army Airfield	210
Vietnam	97
Combined	112

While there have been relatively few failures requiring replacement of the entire radio, receiver/transmitter MTBF is the lowest of any radio. The combined MTBF of the UHF

Problem No.: 19-1

AN/ARC-51 BX receiver/transmitter (RT-742/ARC-51 BX) is also only 169 hours.

F. Mission and Deployment Factors -
Common to all missions and deployments, but more severe in Vietnam

Problem Impact:

A. Safety Factors -
No mishaps related to radio or radio component failures were recorded by USABAAR during the period 1 January 1967 - 31 March 1971.

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace Receiver-Transmitter RT-348	.4 - .6	Organizational
Check, test, adjust receiver-transmitter RT-348	.5 - 1.0	Organizational
Replace antenna	1.0 - 3.0	Organizational
Clean, adjust, repair antenna	.5 - 1.0	Organizational

C. Aircraft Availability Factors -
Downtime for any one maintenance action ranges from 1.0 to 4.0 hours, with most downtime at 2 hours or less.

Remedial Actions:

1. The radio compartment in the tail boom was ventilated to reduce heat in this area. Ventilation was accomplished by replacing the solid radio access door with louvered construction, effective with AH-1G 66-15293 through 15302 and 66-15305 and subsequent and future spares.

2. The tail boom access door was changed to include two screens, also effective with AH-1G 66-15293 through 15302 and 66-15305 and subsequent and future spares.

Problem No.: 19-1 (Continued)

3. Bell Helicopter Company Service Memorandum AH-01-8-1 providing instructions for installation of the louvered doors and screens was issued in January 1968. These instructions were published in the EIR Digest for the 3rd Quarter FY 1968 (TB 750-992-2, 1968).

4. ECP AH-1G 390 was approved in May 1968. Included in the ECP were provisions for relocating the FM antenna to the cabin roof to eliminate engine oil contamination. Retrofit provisions were included in MWO 55-1520-221-20/11 published in August 1969.

Data Sources:

4,7,14,20,22,33,34,35,38,39,42.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	-
CH-47	19-2
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 19-2

Problem Title: Impedance Matching Network Malfunctions

Problem Description:

A. Component Identification -
Impedance Matching Network - P/N 209-075-235-1

B. Description of Failure -
Wire and capacitors broken, pin to plug connections inadequate, printed circuit boards failing.

C. Cause of Failure -
Design inadequate to meet operating environmental stresses. Failures of wiring, printed circuit board, and capacitors have been attributed to vibration.

D. Period and Duration of Problem -
1967 to present. Although remedial actions have been taken (see below), the impedance matching network still presents problems.

E. Failure Rate Data (as reported by Bell Helicopter Company) -

	MTBF (hours)
Hunter Army Airfield	1299
Vietnam	1210
Combined	1230

F. Mission and Deployment Factors -
Common to all missions and deployments

Problem Impact:

A. Safety Factors -
No mishaps attributable to the impedance matching network were recorded by USABAAR during the period 1 January 1967 - 31 March 1971.

Problem No.: 19-2 (Continued)

B. Maintenance Workload Factors -

Action	Manhours	Level of Maint.
Replace assembly	.5 - 1.0	Organizational
Repair assembly	.5 - 2.5	Direct Support
Install MWO 55-1520-221-20/12	2.0	Organizational

C. Aircraft Availability Factors -
Downtime - 1.0 - 4.0 hours, depending on extent of work required.

Remedial Actions:

1. ECP AH-1G 426 was approved in September 1968. The ECP provided an adaptor to support the electrical wires entering the connector at the impedance matching pad, effective with AH-1G 67-15702 and subsequent production.

2. MWO 55-1520-221-20/12 provided parts and instructions for applying the adaptor to previously issued aircraft in the field. The MWO was published on 8 April 1969.

3. Effective with AH-1G 68-17032, on production aircraft the capacitor (C3) was bonded to the board with Epon 956 clear epoxy cement prior to soldering.

Data Sources:

4,7,14,20,22,33,34,35,38,39.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	-
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 30-1

Problem Title: XM-28 Turret Malfunctions

Problem Description:

A. Component Identification:

	P/N
Circuit Breaker	MS22073-5 Turret Power
	MS25244-15 Weapon Fire
XM-28 Control Unit	717420-301
K-45 Clearing Relay	92481 or 2107-1
Gunner's Sight Station Lamp	MS15584-5
7.62MM (XM-134) Drive Cable	717730-1
XM-28 7.62MM Minigun	XM-134
XM-28 Crossover Assembly	717500-1

B. Description of Failure -

1. Circuit breakers stick, break
2. Internal failures of control unit
3. K-45 clearing relay inoperative or intermittently operative
4. Sight lamp burning out
5. Drive cable sheared at crossover assembly end
6. Minigun stoppages from feeder delinker malfunctions
7. Shearing of pins causing crossover assembly malfunctions

C. Cause of Failure -

1. Circuit breakers - sand contamination
2. Bad relays in control unit and other unknown causes of internal failure. Vibration suspected as a basic cause.
3. K-45 cl---ing relay design inadequate. Vibration suspecte- -- immediate cause of failure.
4. Sight lamp - vibration suspected (see roblem 09-2)
5. Drive cable shearing attributed to jams, personnel not engaging the cable properly, design inadequacy.
6. Minigun failures caused by feeder delinker malfunctions defective and out-of-tolerance ammunition, improper loading procedures.

Problem No.: 30-1 (Continued)

7. Crossover assembly failures attributed to shearing of pins in the assembly.

D. Period and Duration of Problem

From introduction of the XM-28 system (AH-1G 67-15534 and subsequent) to present.

E. Failure Rate Data -

No data providing the MTBF for the XM-28 system are available. However, for all armament systems, Bell Helicopter Company reports the following:

	MTBF (hours)
Hunter Army Airfield	71
Vietnam	27
Combined	32

More failures were recorded for the armament system than any other system in the aircraft (1659 failures in 52,930 flying hours.)

Problem Impact:

A. Safety Factors -

Six mishaps during the period 1 January 1967 - 31 March 1971 were attributed to the XM-28 turret system. Four resulted from hydraulic hose failures, discussed in Problem 06-3. The fifth resulted from installation of the wrong circuit board and the sixth, from a loose turret fairing. The last two were maintenance errors. All resulted in precautionary landings.

USABAAR data does not include mishaps related to combat. Obviously, malfunctions of the turret would present both mission accomplishment and safety problems in a combat environment.

B. Maintenance Workload Factors -

No data are available on maintenance workload. However, at Hunter Army Airfield, it was stated that troubleshooting and repairs require from 32 to 48 manhours per downtime event.

Following are replacement times published by the Aviation Test Board for various components of the XM-28 system:

Problem No.: 30-1 (Continued)

Action	Manhours	Level of Maint.
Replace XM-134 machine gun	.3	Organizational
Replace XM-129 grenade launcher	.4	Organizational
Gunner's sighting station	.5	Organizational
Pilot's sight	.3	Organizational

C. Aircraft Availability Factors -

It was estimated at Hunter Army Airfield that downtime per maintenance event runs from 2 to 3 days.

Remedial Actions:

The XM-28 system was itself, in a sense, considered a remedial action. Nearly all of the failures and malfunctions noted above occurred in the preceding TAT-102A Turret System. It was expected that the XM-28 system would resolve or reduce these problems. The following are the only known remedial actions taken on the XM-28 system:

1. A divider across the coil winding of the K-45 relay was added to prevent relay failures.
2. MWO 55-1520-221-30/20 was published 20 November 1969 to provide overload protection for the system.

Data Sources:

4,7,11,20,22,27,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	09-2
CH-47	-
CH-54	-
OH-6	-
OH-58	-

Helicopter TMS: AH-1G
Problem No.: 30-2

Problem Title: External Stores Ejector Rack Malfunctions

Problem Description:

A. Component Identification -

	P/N
External Stores Ejector:	
Rack Assembly - Outboard	15-002-002
Left Hand	15-001-001-3
Right Hand	15-001-001-4

B. Description of Failure -

Rack hooks open and release pods prematurely.

C. Cause of Failure -

Pod attaching lug threads stripped in some cases. Pilot error suspected in some cases. Others unknown.

D. Period and Duration of Problem -

1968 to present

E. Failure Rate Data -

No data are available; however, the MTBF is probably high. Bell Helicopter Company report cited two instances and Hunter Army Airfield cited two. From the descriptions of the incidents, it appears each source was citing the same events.

F. Mission and Deployment Factors -

Common to all missions and deployments

Problem Impact:

A. Safety Factors -

Although two occurrences of failure are noted above, only one is recorded in USABAAR data for the period 1 January 1967 - 31 March 1971. It is believed that one failure occurred on the ground during run-up and was probably not reported. The mishap reported was classified as an incident.

Problem No.: 30-2 (continued)

B. **Maintenance Workload Factors -**

Action	Manhours	Level of Maint.
Replace ejector rack assembly	.5 - 1.0	Organizational

C. **Aircraft Availability Factors -**
Downtime for replacement - 1.0 - 2.0 hours

Remedial Actions:

1. Effective with AH-1G 67-15702 and subsequent, a decal was placed on the wing pylon fairing which stated:

> "If store has center lug well, use AH8-11A bolt in ejector piston. If store has no center lug well, use AN8-6A bolt in ejector piston."

2. The P/N 15-002-002, 15-001-001-3 and 15-001-001-4 racks were replaced by P/N 209-070-080-1, -2, and -3 racks respectively. Personnel at Hunter Army Airfield felt that the new racks were more reliable.

Data Sources:

4,7,11,33,34,38,39.

Cross References:

TMS	Problem Number
UH-1	-
AH-1	-
CH-47	-
CH-54	-
OH-6	-
OH-58	-

DATA SOURCES - UH-1 AND AH-1G ANALYSES

1. APJ trip report, U.S. Army Air Mobility Research and Development Laboratory, Eustis Directorate, Ft. Eustis, Va., 27 and 28 May 1971.
2. APJ trip report, USCONARC, Fort Monroe, Va., 28 May 1971.
3. APJ trip report, U.S. Army Aviation Center, Ft. Rucker, Ala., 1,2, and 4 June 1971.
4. APJ trip report, Hunter Army Airfield, Ga., 3 June 1971.
5. APJ trip reports, USABAAR, Ft. Rucker, Ala., 1 June 1971 and 12 July 1971.
6. APJ trip reports, U.S. Army Aviation Test Board, Ft. Rucker, Ala., 4 June 1971 and 12 July 1971.
7. APJ trip report, USAVSCOM, St. Louis, Mo., 7-11 June 1971.
8. APJ trip report, UTTAS Project Manager's Office St. Louis, Mo., 8 June 1971.
9. APJ trip report, USARADMAC, Corpus Christi, Texas, 21-24 June 1971.
10. APJ trip report, Bell Helicopter Company, Fort Worth, Texas, 25 June 1971.
11. Technical Manuals, TM 55-1520-221 Series for the AH-1G, TH-1G Helicopters:
    - a. -10
    - b. -20
    - c. -20P
    - d. -35P
12. Technical Manuals, TM 55-1520-210 Series for the UH-1 Helicopters:
    - a. -10
    - b. -20
    - c. -20P
    - d. -34P
    - e. -35

13. TM 55-1520-220-20, UH-1C.

14. TM 11-1520-221-35, Electronic Equipment Configuration, Army Model AH-1G Helicopter.

15. TB 750-992 Series, Equipment Improvement Report and Maintenance Digest (Rotary Wing Aircraft), from the Third Quarter FY 1968 through the Second Quarter FY 1971. The specific volume cited will be noted when the reference is used in the report.

16. USAAVSCOM Report, Quarterly Record of Equipment Improvement Recommenaations, AH-1G Fleet and UH-1, all series, October 1,1970 through December 31, 1970. The report includes a 2-year cumulative record of EIRs related to the subject aircraft.

17. USAAVSCOM Report, Major Item Removal Frequency, AH-1G Fleet and UH-1D, UH-1H, January 1, 1964 through June 1, 1970.

18. USAAVSCOM Report, Reportable Items and Action Data Sort, UH-1D,H, January 1, 1964 through June 30, 1970.

19. USAAVLABS Technical Report 71-9, UH-1 and AH-1 Helicopter Main Rotor Blade Failure and Scrape Rate Data Analysis, January 1971.

20. New Cumberland Army Depot, Aircraft Maintenance Information Bulletin Series, Janaury 1966 through April 1971.

21. DA Pamphlet No. 310-7, U.S. Army Index of Modification Work Orders, February 1971.

22. U.S. Army Aviation Test Board report, Reliability Test of AH-1G Helicopter (Huey Cobra), July 1968.

23. U.S. Army Aviation Test Board report, Final Report of Test, Product Improvement Test (Desert Environment, CY 1966) of UH-1B 540 Helicopter, October 1966.

24. U.S. Army Aviation Test Board report, Final Report of Product Improvement Test of the UH-1/AH-1G Tail Rotor Hubs 204-011-810-3 and -5, May 1969.

25. U.S. Army Aviation Test Board report, Final Report of Product Improvement Test of the AH-1G Tractor Tail Rotor System, January 1970.

26. U.S. Army Aviation Test Board report, Final Report of Product Improvement Test of the Environmental Control System Installed on the AH-1G Helicopter, November 1969.

27. U.S. Army Aviation Test Board report, Approved Final Report of Service Test of the XM-28 Armament Subsystem Installed on the AH-1G Helicopter, Revised November 1968.

28. U.S. Army Aviation Test Board report, Final Report of Product Improvement Test of ACA Attitude Indicator, March 1970.

29. U.S. Army Aviation Test Board letter report, Product Improvement Test of UH-1B Tail Boom Fitting, June 1966.

30. U.S. Army Aviation Test Board letter report, Product Improvement Test of UH-1 Symmetrical Drive Shaft, August 1968.

31. U.S. Army Aviation Test Board report, Partial Report of Product Improvement Test UH-1 Glass Laminated Windshields, February 1971.

32. U.S. Army Aviation Test Board report, Final Report of Test, Logistics Evaluation (Phase F) of UH-1B Helicopter Equipped with Model 540 Rotor System, September 1966.

33. Bell Helicopter Company report to the Project Manager's M&R Committee, 205-099-157, with Revisions.

34. Bell Helicopter Company Quarterly Progress Report Series, UH-1/AH-1 Maintainability and Reliability Program:
    a. Report 205-099-172, March 1968
    b. Report 299-099-500, July 1968
    c. Report 299-099-505, November 1968

35. List of Engineering Change Proposals submitted for the AH-1G and UH-1 Helicopters, by Bell Helicopter Company, the U.S. Army Plant Activity, Bell Helicopter Company, Fort Worth, Texas.

36. UH-1A,B,D,H Helicopter Parts Usage, year ending 30 April 1971, U.S. Army Aviation Center, Fort Rucker, Alabama.

37. USABAAR report, UH-1 Accident Summary, FY 1967.

38. USABAAR Mishap Data, Material Failures and Malfunct..., AH-1 and UH-1, 1 January 1967 through 31 March 1971:
    a. Vietnam
    b. USARPAC less Vietnam
    c. CONUS training base
    d. CONUS other than training base
    e. USARAL
    f. Worldwide summary covering all areas and all years

39. USABAAR Weekly Summary Army Aircraft Accidents, Incidents, Forced Landings and Precautionary Landings, January 1966 through August 1971.

40. USARADMAC Value Engineering Project No. 70-34 report, UH-1 Radius Rings, 1970.

41. APJ report 501-1, Flat Rate Manual, UH-1D Organizational Maintenance, April 1967.

42. APJ report 501-2, Flat Rate Manual, UH-1A/B/C Organizational Maintenance, June 1967.

43. APJ report 501-4, Flat Rate Manual, UH-1A/B/C Direct Support Maintenance, October 1967.

44. APJ report 501-6, Flat Rate Manual, UH-1D/H Direct Support Maintenance, November 1967.

45. U.S. Army Aviation Test Board, Final Report, Product Improvement Test of UH-1 Tail Rotor Drive Shaft Hanger Bearings, December 1967.

46. U.S. Army Aviation Test Board, Final Report of Product Improvement Test of UH-1 Main Rotor Blades with Erosion-Resistant Leading-Edge Coating, December 1969.

47. ARADMAC Value Engineering Project No. 70-34, UH-1 Radius Ring, Attachment 1, 1970.

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13. ABSTRACT

This volume presents discussions of a series of reliability and maintainability problems related to Army Utility, Attack, and Training Helicopters (UH-1, AH-1, TH-1). A detailed discussion of the standard format used for problem presentation and of the various analysis elements within the standard format is provided in Volume I.

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Remedial actions						
AH-1						
UH-1						
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CH-54						
OH-6						
OH-58						

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