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MAJOR ORIENTATION-ERROR ACCIDENTS IN REGULAR ARMY UH-1 AIRCRAFT DURING FISCAL YEAR 1967: ACCIDENT FACTORS

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UNITED STATES ARMY AEROMEDICAL RESEARCH LABORATORY

ARMY – NAVY

Joint Report

DEPARTMENT OF THE NAVY ★ AEROSPACE MED RESEARCH LABORATORY ★

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20 October 1970

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SUMMARY PAGE

THE PROBLEM

From the military mission viewpoint, the amount of research effort to be expended on the solution of a given aviation medicine problem must be keyed to the operational cost of the problem. In the case of orientation-error accidents involving pilot disorientation and vertigo, little quantified data are available to describe either the incidence or cost of such accidents in aviation. In addition, though such accidents have been long recognized as a major aviation medicine problem, there are few data on hand to describe the direct operational setting for these accidents in terms of the pilot, aircraft, mission, and environmental factors that will be present, singly or in some combination, for each mishap. Until such data are assimilated for a considerable number of orientation-error accidents, the optimal method of correction, whether it be, for example, redesign of aircraft, cockpit layout, or instruments, or whether it is a matter of pilot selection, training, and utilization, will not be determined.

FINDINGS

To initiate the action necessary to establish the magnitude of the orientation-error problem in Army aviation, an interservice research program was organized under the joint sponsorship of the U. S. Army Aeromedical Research Laboratory, the U. S. Army Board for Aviation Accident Research, and the Naval Aerospace Medical Research Laboratory. The first step was the construction of an operational definition of an orientation-error accident. The assimilation of data pertaining to the incidence and cause of such accidents and their actual and relative costs in terms of fatalities, injuries, and aircraft damage was then set as the working objective of the program, using the master USABAAR accident files as reference. Accordingly, the decision was made to implement a five-year longitudinal study of all major and minor orientation-error accidents involving Regular Army flight operations beginning with fiscal year 1967. It was decided to summarize the findings on a fiscal-year basis in three separate lines of reports: The first line would be devoted to defining the over-all magnitude of the orientation-error problem in all aircraft types; the second line to the presentation of similar incidence and cost data for accidents involving only the UH-1 aircraft, the predominant rotary-wing aircraft in the Army inventory; and the third line to the description of the various pilot/operational factors found to be present in the major UH-1 orientation-error accidents.

This specific report is the first in the series dealing with the third line; i.e., UH-1 accident factors. A brief case history is given of each major orientation-error accident that occurred in fiscal year 1967, along with various compilations of related background data including pilot experience, psychological and physiological stress variables, mission pressures, visibility conditions, materiel difficulties, facility limitations, and supervisory factors.

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

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INTRODUCTION

This report is the first of a sequential series of reports designed to describe the accident factors found to be present in major orientation-error accidents occurring in Regular Army UH-1 aircraft over a five-year period. Concerned with fiscal year 1967 accidents, the report is directly linked to two previous ones (5, 6) prepared for the same fiscal year and dealing with the incidence and cost of Army orientation-error accidents in general. Since this report is the first of its particular series, and since proper interpretation of its data is dependent upon the definition of the orientation-error classification of accidents, selected portions of the introductory and procedural sections of the two previous reports are repeated for reader convenience.

Orientation-error accidents arising from a pilot's erroneous perception of the true spatial motion or true spatial attitude of his aircraft have been long recognized as a significant aviation safety problem. In the flight environment man finds little difficulty in correctly perceiving his spatial orientation when clearly defined geographical landmarks are available without illusory artifact. When these visual references are not present, as is often the case during bad weather or night flight missions, man's vestibular mechanisms and other related nonvisual sensory processes become the predominant source of internally derived spatial orientation information. Though these systems function well in the normal terrestrial environment, this is not the case in the flight situation. Here man can be exposed to simple and complex combinations of forces and torques that elicit sensations of movement and perceptions of orientation which may be in complete conflict with the actual motion or attitude of the aircraft. Even with clear visibility, the same form of erroneous sensations and perceptions can result if the pattern of the external environment is conducive to the elicitation of visual illusions. For example, pilot errors can arise in the perception of aircraft motion during hovering flight over fast-moving water or within wind-driven smoke or dust clouds; in the perception of aircraft attitude when sloped terrain is interpreted as being level, or a tilted cloud border or slanted tree line is perceived as representing the horizon; or in the perception of altitude during flight over water or similar planar terrain without clearly defined landmarks.

When such errors in spatial perception occur, the result may merely be a mild confusion of the pilot as to some motion, attitude, or altitude parameter. If the error is quickly recognized, the pilot can take action to establish his true perspective in space by using some other orientation reference, whether it be a specific instrument or a different set of exterior landmarks. At the other extreme, the pilot may suffer intense vertigo that seriously degrades his control ability. Equally dangerous is the situation where the pilot unknowingly experiences disorientation and controls his aircraft in accordance with his erroneous concept of its true motion. In all cases, there exists the potential for an orientation-error type accident, with the level of probability of occurrence keyed to such factors as the type of aircraft being flown, the type of mission being undertaken, and the phase of flight where the disorientation is manifested.

Unfortunately, though spatial orientation difficulties are known to contribute to Army aircraft accidents (1-4), few quantitative data are available to adequately describe the actual magnitude of the orientation-error accident problem, either in terms of the incidence and cost of such accidents in relationship to themselves or in their proportionate relationship to the over-all accident problem.

With the objective of gaining such data for orientation-error accidents occurring in Army aviation, the authors organized an interservice research program under the joint sponsorship of the U. S. Army Aeromedical Research Laboratory (USAARL), U. S. Army Board for Aviation Accident Research (USABAAR), and the Naval Aerospace Medical Research Laboratory (NAMRL). The basic plan of the program was to conduct a five-year longitudinal study of the USABAAR accident records so as to identify all major and minor orientation-error accidents that occurred in Regular Army flight operations beginning with fiscal year 1967. Once identified, the desired cost data could then be extracted from the master file associated with each orientation-error accident. In addition, the plan called for an in-depth review of selected helicopter orientation-error accidents to obtain baseline data describing the various pilot/aircraft/environment/mission factors present in such accidents.

The results of the longitudinal study will be summarized in three separate lines of reports, with one report in each line prepared for each fiscal year of the study. The first line (for example, ref. 5) will be devoted to defining the magnitude of the orientation-error accident problem in all aircraft types. The incidence and cost of all major and minor orientation-error accidents involving all aircraft types, fixed wing as well as rotary wing, that occurred in Regular Army flight operations will be reported for each fiscal year. Since the UH-1 "Huey" helicopter has been, and is, the predominant aircraft in the Army rotary-wing inventory, in fact the predominant aircraft in the combined fixed-wing and rotary-wing inventory, the second line of reports (for example, ref. 6) will be devoted to defining the magnitude of the orientation-error accident problem for only that aircraft. The layout and format of this line of reports will be almost identical to that of the first line. The third line of reports, represented by the present report, will deal with the accident factors associated with the UH-1 major orientation-error accidents. The immediate working objective here is to present a continuing summary compilation of the various accident factors listed in the master USABAAR accident jacket prepared for each incident. With this information, the initial end product will be the development of a working familiarity with the operational nature of military helicopter accidents involving pilot orientation error. Such data will strengthen the needed link between the actual applied problem of orientation error in the field and its investigation in the research laboratory. Since the great majority of the accidents involved in this study occur in Vietnam, the data will also highlight the increased performance demands of the combat environment.

The authors wish to point out several qualifications to the interpretation of the data to be presented in this and subsequent factor reports. First, the sole reference source for each accident discussed is the master accident jacket prepared by the field accident-investigation team and its various reviewing authorities. The extent of the accident details that can be extracted from this jacket is thus dependent upon the extent of the documentation entered into the written record by the investigation team. Since each accident is past history relative to this study, an in-depth exploration of certain factors thought now to be relevant to the orientation error is possible only to the extent that the investigation team pursued the point. Since each field investigation team cannot be expected to have extensive pilot disorientation/vertigo expertise, crucial answers relative to the exact form or manifestation of a visual illusion, a motion sensation, or a disorientation are usually not available in the final documentation of the accident. To this point, a hoped-for secondary end product of this study will be the formulation of operationally based questionnaire aids to assist personnel investigating accidents thought to involve orientation error.

The long-term project objective is obviously the identification of any accident factors that may have some causal relationship, singly or in combination, to orientation error. The strength of the program lies in the fact that, as opposed to most prior compilations of orientation-error accident statistics, the data derive from a single type of aircraft. Though there are many different models and configurations of the UH-1 aircraft, and though a considerable variety of missions are performed with the aircraft, the flight characteristics, cockpit plan, and instrument layout are essentially the same for all aircraft involved in the study.

The format for this and the subsequent factor reports involves the presentation of a brief narrative account of each accident; a summary compilation of various background factors such as pilot experience and workload, type of mission, phase of flight in which the accident occurred, and selected environmental conditions; and an individual case history checklist of various factors found to be present in the review of each accident. The authors wish to caution against any interpretation of the report data for a given fiscal year which would assign one single factor as the sole causal agent for either a given accident or the entire class of accidents. It is granted that in orientation-error accidents, degraded visibility is probably the single most predominant factor common to the majority of the accidents. However, additional factors or events are usually present, any of which, if eliminated singly, might possibly have prevented the accident. Hence the listing of a given factor implies only that it was present--it may or may not have played a causal role. The weight of a given factor as a common contributing element to the cause of the orientation-error class of accidents will be determined relative only to the entire body of data collected over the five-year study period.

PROCEDURE

To initiate the program it was necessary to establish a workable definition of the class of accidents to be identified as orientation-error accidents. It will be recognized by investigators actively engaged in aviation safety research that the cliché "easier said than done" is most appropriate for this task. There would be little difficulty in identifying accidents involving pilot disorientation if the latter always manifested itself in the extreme where a pilot calls out that he is experiencing severe vertigo and is having difficulty in maintaining spatial orientation. However, when the factors surrounding a given accident become borderline as to whether or not a pilot made an orientation error, it is of the essence that the accident classifier be given some appropriate criteria to help him make the classification decision. Although any definition of orientation error will be compromised at times by one or more unique features of a given accident, it was felt that a workable classifying system could be developed for the vast majority of the accident types to be encountered in our review.

DEFINITION OF ORIENTATION-ERROR ACCIDENTS

First, the term orientation is considered to involve the correct determination of the dynamic position and attitude of an aircraft in three-dimensional space. The key word here is dynamic, which implies that full knowledge of the motion as well as static attitude or position of an aircraft is required to define its instantaneous spatial orientation. For a pilot to have a full comprehension of his orientation, it is essential, for example, that he be able to describe the static pitch and roll attitude of his aircraft relative to some external reference such as the Earth-vertical defined by the gravitational vector; his yaw attitude relative to some geographical heading, the linear velocity of the aircraft, with or without attendant linear acceleration, in terms of fore-aft, left-right, and up-down motions; and the angular velocity of the aircraft, with or without attendant angular acceleration, in terms of roll, pitch, and yaw rotary motions of the aircraft. Thus, for a fully oriented fixed-wing aircraft pilot, typical information inputs would include knowledge of the forward speed of the aircraft, the vertical speed in terms of either climb or descent rates, sideward drift velocity, pitch and roll attitude, as well as bank angles, angle of attack, et cetera. In landing or rendezvous operations, recognition of the effects of these aircraft motions on absolute distance must be made to ensure that the aircraft does not undershoot or overshoot a preselected touchdown or rendezvous point.

The rotary-wing aircraft pilot requires similar information. However, during low-level hovering conditions, additional information is required in the form of linear velocity in the backward as well as forward direction. Unfortunately, the majority of the currently operational helicopters do not have instruments that provide this backward velocity or, for that matter, sideward drift velocity information. The usual lack of short-range radar altimeters in helicopters is another problem that confronts the rotary-wing aircraft pilot during low-level operations performed with poor ground visibility.

By this definition of the word orientation, it follows that a pilot will be considered to have made an orientation error whenever his perception of the motion and attitude of his aircraft differs from the true motion and attitude; i.e., the true orientation of the aircraft. The exact magnitude of an orientation error will obviously vary over a wide range. When a pilot suffers severe vertigo and completely loses all perception of either aircraft motion or aircraft attitude, the probability of a large-scale orientation error is high, as is the probability of an accident if the disorientation is prolonged or is experienced at a critical control phase within the flight. In another case, the pilot may sense or feel that the aircraft is climbing or turning when in actuality it may be flying straight and level. If during this disorientation experience the pilot accepts that his sensations define the orientation of the aircraft, then an orientation error is present. However, if he realizes that his sensations are in conflict with another input, say the aircraft instruments, and intellectually arrives at the correct judgment of the true motion and attitude, then though the pilot is experiencing disorientation, an orientation error does not result.

Initially, then, an orientation-error accident can be defined as one that occurs as a result of an incorrect control or power action taken by a pilot due to his incorrect perception of the true motion and attitude of his aircraft. Using this definition, an accident classifier can place primary emphasis on determining whether or not the accident involved an erroneous judgment of orientation on the part of the pilot. It follows that questions pertaining to the causes of the orientation error, or its manifestation to the pilot, need not be immediately answered during the initial classification.

There must, however, be several qualifications to this definition. For instance, the accident situation must be one in which the demands on pilot skill are reasonable. To illustrate, consider a helicopter pilot who has a main rotor strike as a result of landing from a hover in a nonlevel attitude, say with an excessive roll angle. This is an orientation-error accident involving incorrect perception of aircraft attitude. The causes of the orientation error could be much varied, ranging from inattention to instruments, a tilted horizon level, visual illusions produced by a nearby moving aircraft, or distraction. A simple but essential assumption is that the pilot did not deliberately fly his aircraft into the ground. However, if in a similar landing from a hover situation, a nearby helicopter flies over the given aircraft and produces severe rotor downwash or turbulence, and the end result is a similar rotor strike, the accident would not be classified as an orientation-error accident. But again, if this tail rotor strike occurred during a routine uninterrupted landing, it would fall into our classification since the pilot's perception of closing rate or pitch angle was incorrect.

A further qualification involves accidents associated with navigation errors. Though knowledge of heading is pertinent to orientation, accidents involving navigation mistakes, and only navigation mistakes, are not classified as orientation-error accidents. That is, if a pilot strikes a hillside as a result of flying a course of 100 degrees instead of 200 degrees, the error is one of navigation, not orientation. In this respect, the word misorientation has received some usage to account for navigation errors. However, if in addition to being on the wrong course or heading, a pilot is having difficulty controlling his aircraft and an accident results because of this difficulty, an orientation-error accident classification would generally result.

Accidents resulting from collision with unseen objects, e.g., a wire strike, are also not included if the collision occurs during normal controlled flight. However, if a hovering pilot allows his aircraft to drift backward, without detection, and finally to impact against an unseen object, an orientation-error classification would result. That is, collisions of this sort are included only when they derive from an orientation error.

As qualified by all of the above, an orientation-error accident is thus said to occur whenever an accident results from a pilot's incorrect perception of his true motion and attitude in space. The orientation error may range from a complete loss of all knowledge of orientation to simple confusion as to only one of the many motion and attitude parameters required to be recognized by the pilot. Or, as mentioned previously, the pilot may never realize that the motion or attitude of his aircraft is gradually changing so as to be soon unfavorable to safe flight.

ACCIDENT-FILE SEARCH PROCEDURES

With this definition of orientation-error accidents serving as a classification reference, a comprehensive search was made of the USABAAR accident files to determine all major and minor accidents (as defined in refs. 7,8) that occurred in Regular Army flight operations during fiscal year 1967. This search involved having a classifier, with previous experience in detecting disorientation/vertigo accidents, read each and every accident brief in the master files. These briefs covered all types of accidents in all types of aircraft, fixed wing and rotary wing, and included accidents occurring in Vietnam as well as those occurring in all other locations.

For redundancy, the entire accident file was also searched by means of the coded summaries that USABAAR prepares for each accident. These summaries, in punched card form, list the essential background data of a given accident as well as the primary causal factors. The objective was to obtain the accident identification number of all accidents involving vertigo, disorientation, poor visibility, bad weather, obstructed vision, night flight difficulties, visual illusions, and the like.

Upon completion of these two searches, the authors reviewed the accident briefs independently for the purpose of establishing whether or not an orientation-error accident classification would result. In addition, the comprehensive master file on each suspect accident was obtained and reviewed. Whenever there was serious question as to the contribution of orientation error to the accident, or where equally weighted alternative causal factors existed, then the accident was not included in the classification. The net effect of this policy is to give a conservative estimate of the magnitude of the orientation-error accident problem.

An analysis was then made of the cost of each of these accidents in terms of personnel and dollars. In addition, the statistical section of USABAAR was requested to compile equivalent incidence and cost data pertaining to 1) accidents of all forms, and 2) accidents classified as involving pilot-error factors. These data then serve as baseline reference for evaluation of the relative magnitude of the Army orientation-error accident problem on a fiscal year basis.

The master accident jacket for each major UH-1 aircraft accident classified as involving orientation error was then taken from the USABAAR files for further study. To facilitate the compilation of factor data, the authors compiled a series of questionnaires and checklists to be used by the accident classifier responsible for extracting the information desired. The effectiveness of the various checklists was tested on a wide variety of orientation-error accidents extending from fiscal year 1968 back through 1966. In general, the questionnaires first developed were quite lengthy, and many detailed questions pertaining to the exact form and manifestations of the disorientation event were included. However, as use of these questionnaires proved, few answers were available in the vast majority of the accidents. As a result, a generalized questionnaire, shown in the Appendix, was prepared to aid the classifier in the extraction of the factor data. The broader aspects of the accident are outlined in the check-list elements, with separate narrative sections describing more specific details. In addition, the classifier and the authors of this report prepared independent check-list summaries of selected accident details represented by the data compiled in figures shown later in this report. It is expected that, as the study progresses, these summary checklists will be expanded as additional factors are identified.

RESULTS AND DISCUSSION

The search of the fiscal year 1967 accident files resulted in an orientation-error classification for 44 UH-1 Regular Army major aircraft accidents. Of this total, 15 accidents involved one or more fatalities. These 44 accidents accounted for 38 fatalities, 77 nonfatal injuries, and 27 aircraft strikes. The relative magnitude of these major orientation-error accidents can be established by using the data presented in the related UH-1 incidence and cost report (6) as reference. In terms of UH-1 major accidents of all forms, these major orientation-error accidents represent 10.7 percent of the total number of accidents, 17.6 percent of the total number of fatal accidents, and 14.6 percent of the total number of fatalities. In terms of only those UH-1 major accidents classified as involving one or more pilot-error causal factors, orientation-error accidents represented 15.7 percent of the total number of accidents, 28.8 percent of the total number of fatal accidents, and 27.7 percent of the total number of fatalities.

Before presenting the individual case-history data for these 44 accidents, a brief summary will be made of selected background information pertinent to the accidents as a whole. As indicated by the cost data in Figure 1A, the hazard of orientation-error accidents was considerable for that fiscal year. Some 34.1 percent of the accidents were fatal, while 61.4 resulted in a total loss of the aircraft. The time-of-day data show that the majority of the accidents (59.1 percent) occurred at night. In terms of the phase of flight in which the accident occurred, Figure 1A indicates that the greatest number of accidents took place while landing, the least during takeoff. It should be noted that the "other" phase classification used in this report denotes localized operations, such as reparking an aircraft, lifting a sling load, or moving an aircraft to a nearby refueling site. Though such operations may involve a takeoff, a short hovering flight, and a landing within the confines of a field, the takeoff classification is reserved solely for conventional outbounds or departures, the landing classification for inbounds, and the inflight classification for the intermediate phase.

The mission data presented in Figure 1B show that the majority (61.4 percent) of the accidents occurred on flights that had some form of combat-related mission assignment. This would be expected since 37 (84.1 percent) of the 44 accidents occurred in Vietnam. The reader is reminded that although a combat mission may have been assigned to the crew, the resulting mishap was an accident and not a loss attributable to direct enemy action.

In Figure 2A a distribution is given of the number of accidents during each month of the fiscal year. Since the majority of the accidents occurred in Vietnam, the time-of-year incidence of accidents due to weather and dust peaked in that country's monsoon and dry seasons, respectively. Interpretation of these data beyond this point is restricted by

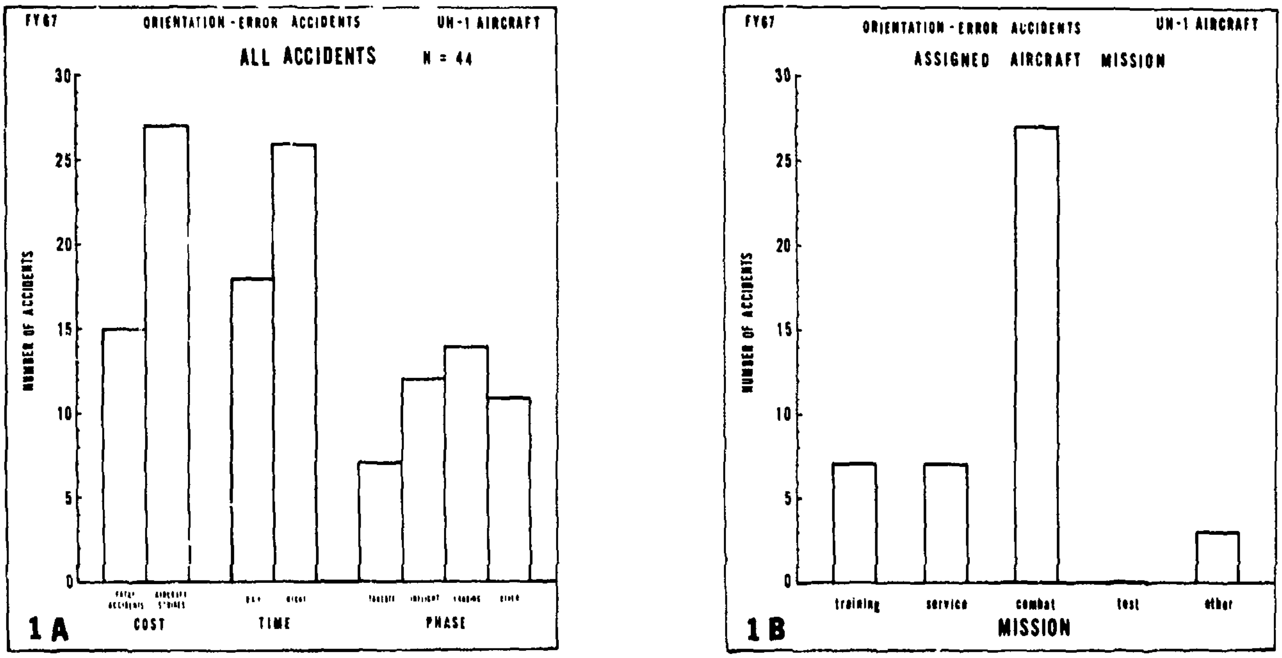

Figure 1

Major orientation-error accidents occurring in Regular Army UH-1 aircraft during fiscal year 1967. Number of fatal accidents, number of aircraft strikes, time of day of the accidents, and the flight phase in which the accident occurred (A); and types of missions assigned to the accident aircraft (B).

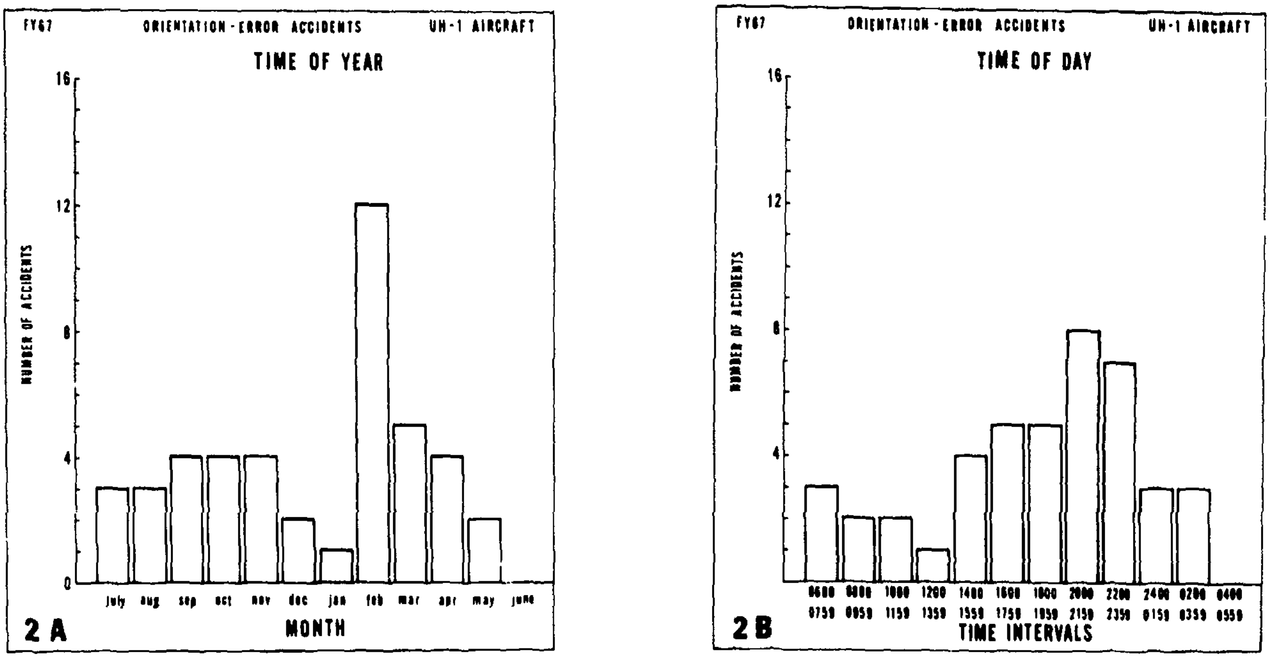

Figure 2

Number of orientation-error accidents as a function of the time of year (A) and the local time of day (B).

the month-to-month variations in the level of combat operations being conducted at a given time. Similarly, the daily variation in frequency of operations would affect interpretation of the hourly distribution data plotted in Figure 2B which shows accident incidence in 2-hour increments over a 24-hour period.

Additional data related to the time-of-day incidence of the accidents are presented in Figure 3. Statistics pertinent to the 18 accidents that occurred under daylight visibility conditions are plotted in Figure 3A. Similar data for the 26 night accidents are shown in Figure 3B. It is obvious that the cost of night accidents in terms of fatal accidents and aircraft strikes was considerably greater than the corresponding costs of daylight accidents. That is, 46.1 percent of the night accidents were fatal compared to only 16.7 percent of the daylight accidents; 76.9 percent of the night accidents resulted in aircraft strikes as compared to only 38.9 percent of the daylight accidents. In terms of the phase of flight for the night accidents, the inflight and landing phases had equal incidence, followed by the "other" and takeoff phases in that order. For the daylight accidents, the greatest incidence occurred in the "other" phase followed by the landing, takeoff, and inflight phases.

Data pertaining to accidents involving degraded visibility due to weather and rotor-raised ground dust are presented in Figure 4. As denoted in Figure 4A, poor weather of one form or another was present in 16 (36.4 percent) of the 44 major orientation-error accidents. The hazard of these weather accidents was most significant since 68.7 percent of the accidents were fatal and 93.7 percent resulted in aircraft strikes. The majority (75 percent) of these accidents occurred at night. In terms of the phase of flight when the accident occurred, the inflight phase had the highest incidence (56.25 percent). When these weather accidents involved flight at night, the incidence of fatal accidents rose to 75 percent. Of the four daylight accidents, two were fatal.

As indicated in Figure 4B, degraded visibility due to rotor-raised ground dust or ashes was present in an additional 16 accidents. Though no fatalities resulted from these dust accidents, a considerable number (31.2 percent) involved the total loss or strike of the aircraft. Relative to the phase of flight, landing accidents had the greatest incidence (50.0 percent); as will be gained from reading the individual case history briefs which follow, these occurred at established heliports as well as at temporary field sites. It appears from a cursory scan of the orientation-error accidents occurring in subsequent fiscal years of this study that application of peneprime or similar surface coverings to minimize dust has decreased the incidence of this form of accident.

In Figures 5 through 9, summary listings are made of various aviator-related background information. For each figure, a separate compilation is made for each of the two pilots normally aboard the UH-1 aircraft. The terms "first pilot" and "second pilot" have been arbitrarily selected to identify the commanding aviator (not necessarily the senior-ranked aviator) and his copilot, respectively. Outside of Vietnam, the first and second pilot notation corresponds to the conventional pilot (P) and copilot (CP) identification. In Vietnam, however, the two aviators are usually identified as the air commander (AC) and pilot (P); the air commander rating applies only after an aviator gains a certain

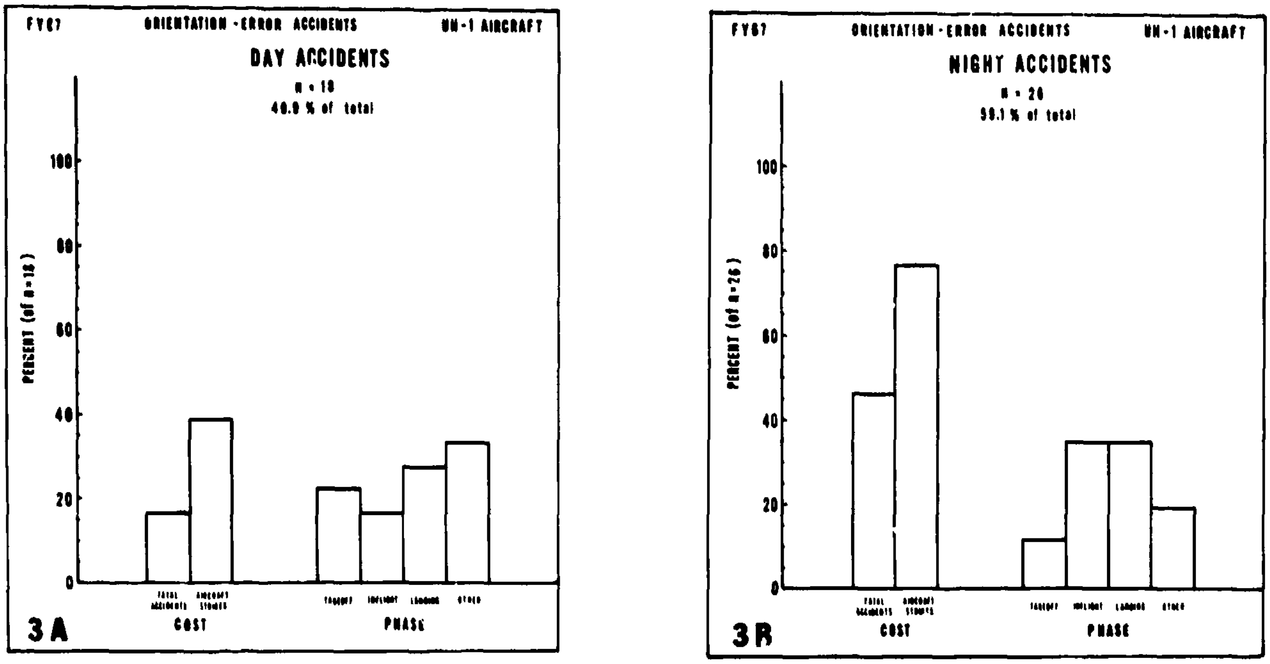

Figure 3

Comparison of percent incidence of fatal accidents, aircraft strikes, and flight phases for the 18 orientation-error accidents that occurred under daylight visibility conditions (A) and the 26 accidents that occurred under night visibility conditions (B). Note the considerably greater hazard of the night flights.

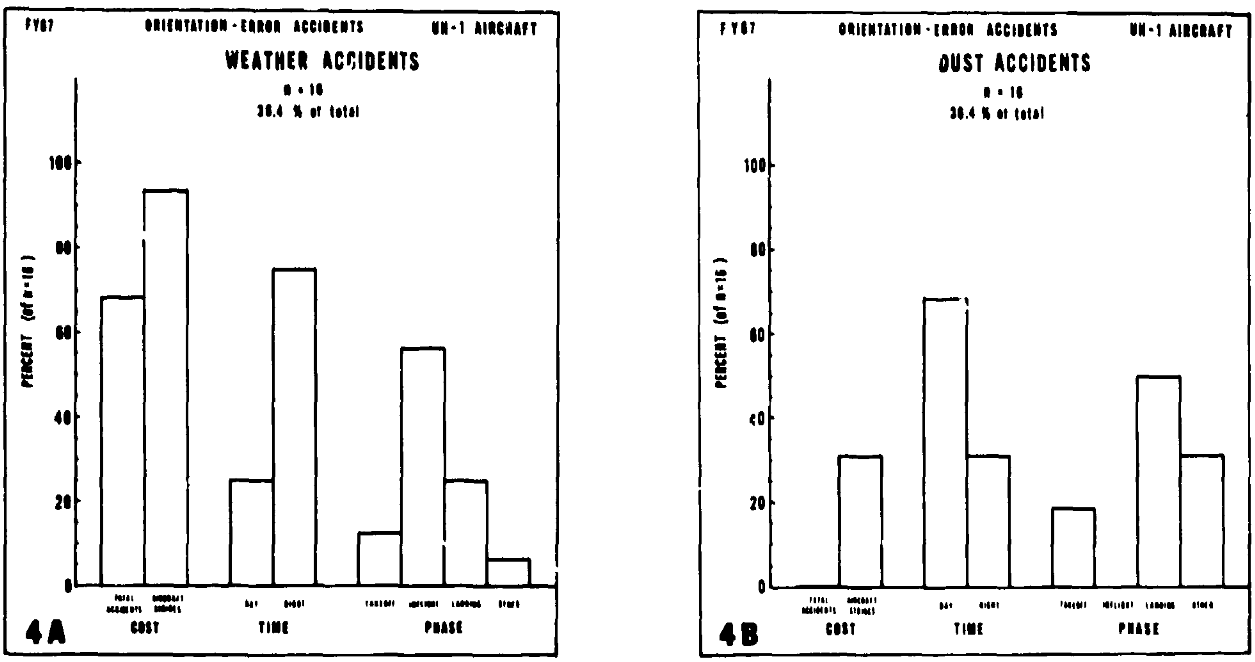

Figure 4

Comparison of percent incidence of fatal accidents, aircraft strikes, day/night accidents, and phases of flight for the 16 orientation-error accidents that involved poor weather (A), and the 16 accidents that involved rotor-raised ground dust or ashes (B). Note the high incidence of fatal accidents and aircraft strikes involved in the weather accidents.

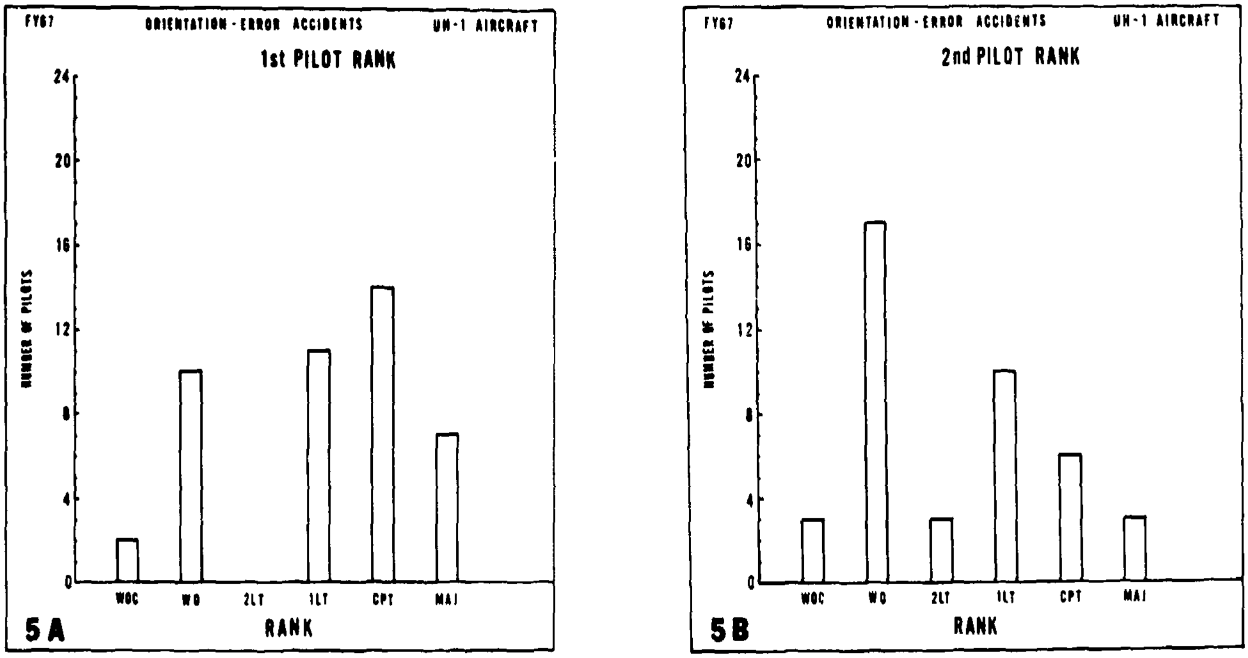

Figure 5

Distribution by rank of the 44 first pilots (A) and the 42 second pilots (B) involved in the orientation-error accidents. As explained in the text, the first pilot notation is used to describe the commanding aviator aboard the aircraft. In general, for Vietnam accidents, the first pilot is the "air commander" and the second pilot is the "pilot." For accidents occurring elsewhere, the first and second pilot notation usually corresponds to the conventional "pilot" and "copilot" designations, respectively.

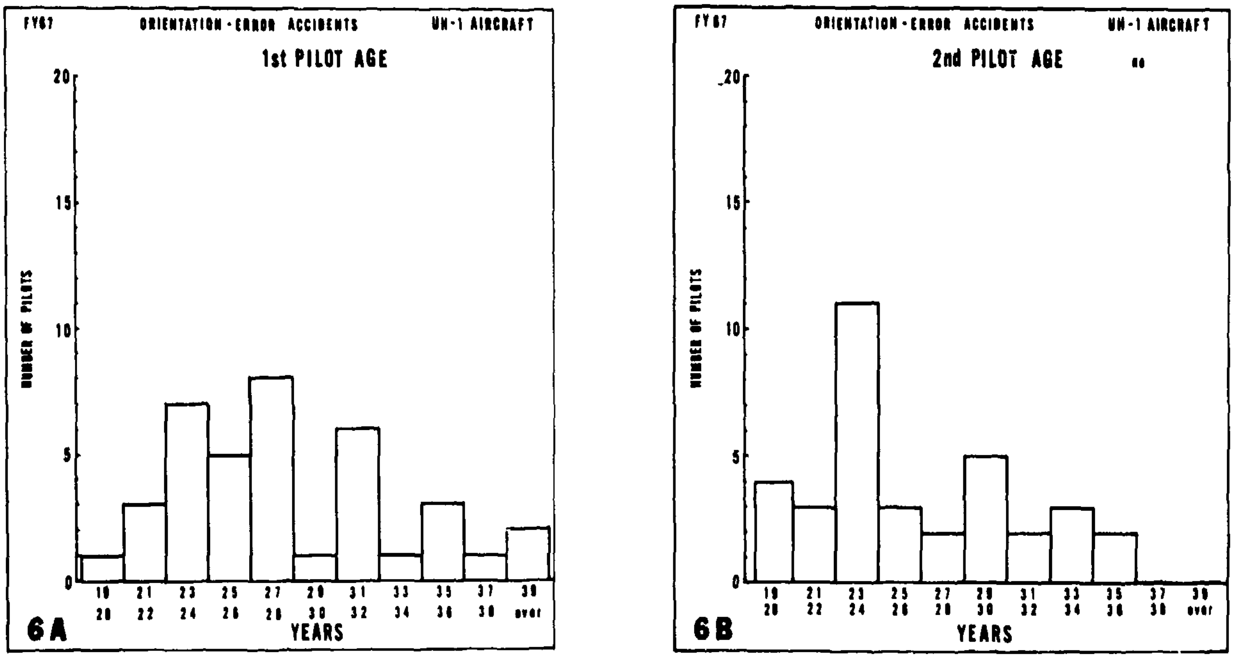

Figure 6

Age distribution of the first pilots (A) and second pilots (B). The median ages were approximately 27.8 years and 24.9 years, respectively.

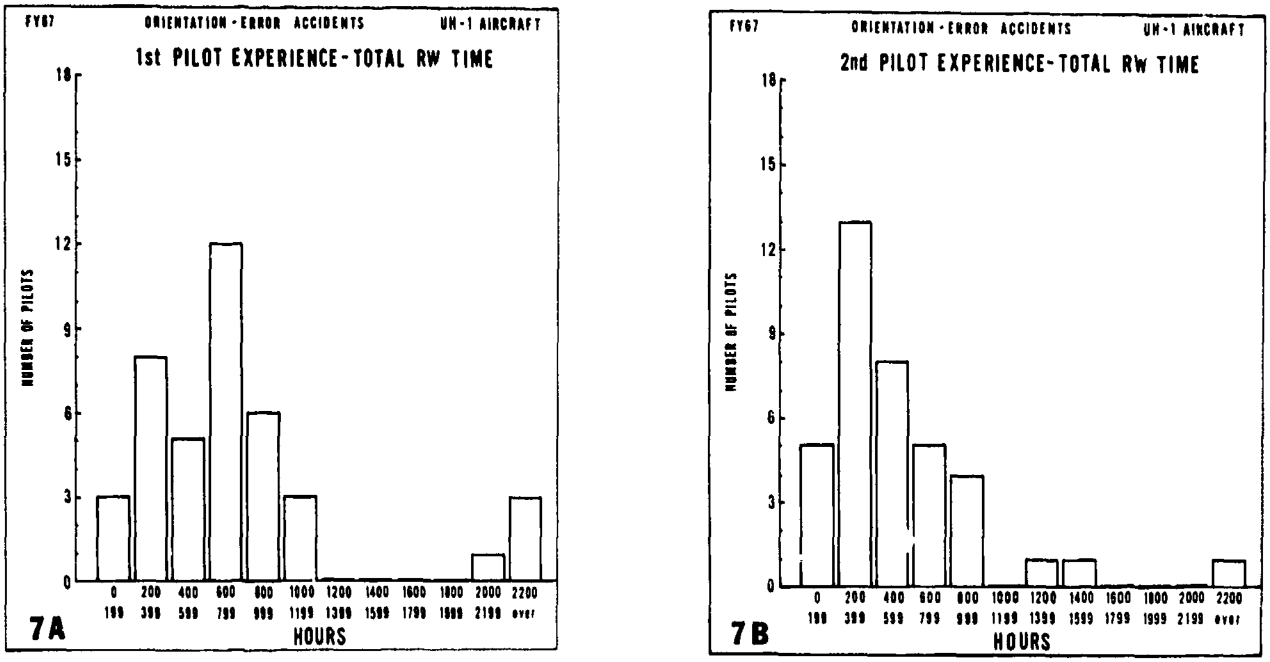

Figure 7

Distribution of total flight hours experience in military rotary-wing aircraft of the first pilots (A) and second pilots (B). The medians were approximately 675 hours and 425 hours, respectively. These data do not include any additional fixed-wing experience. (See Figure 10 for related FW and RW experience data.)

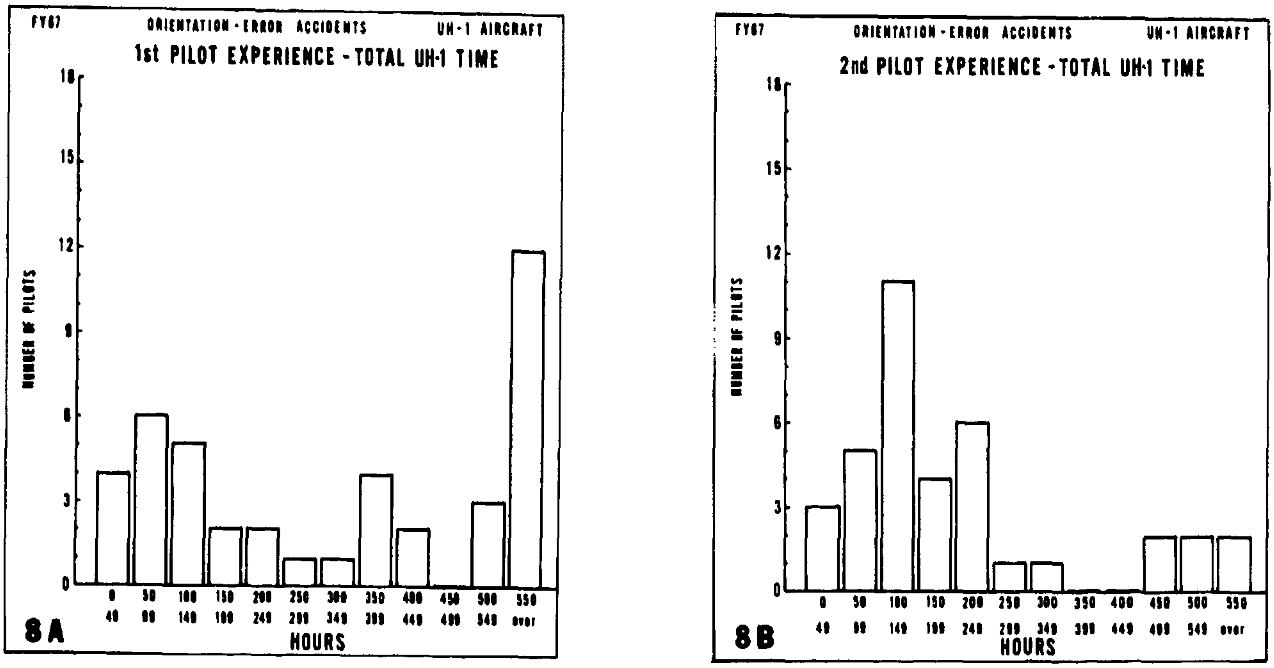

Figure 8

Distribution of total flight hours in the UH-1 aircraft of the first pilots (A) and second pilots (B). The median times were approximately 350 hours and 147.7 hours, respectively. (See Figure 10 for related UH-1 experience data.)

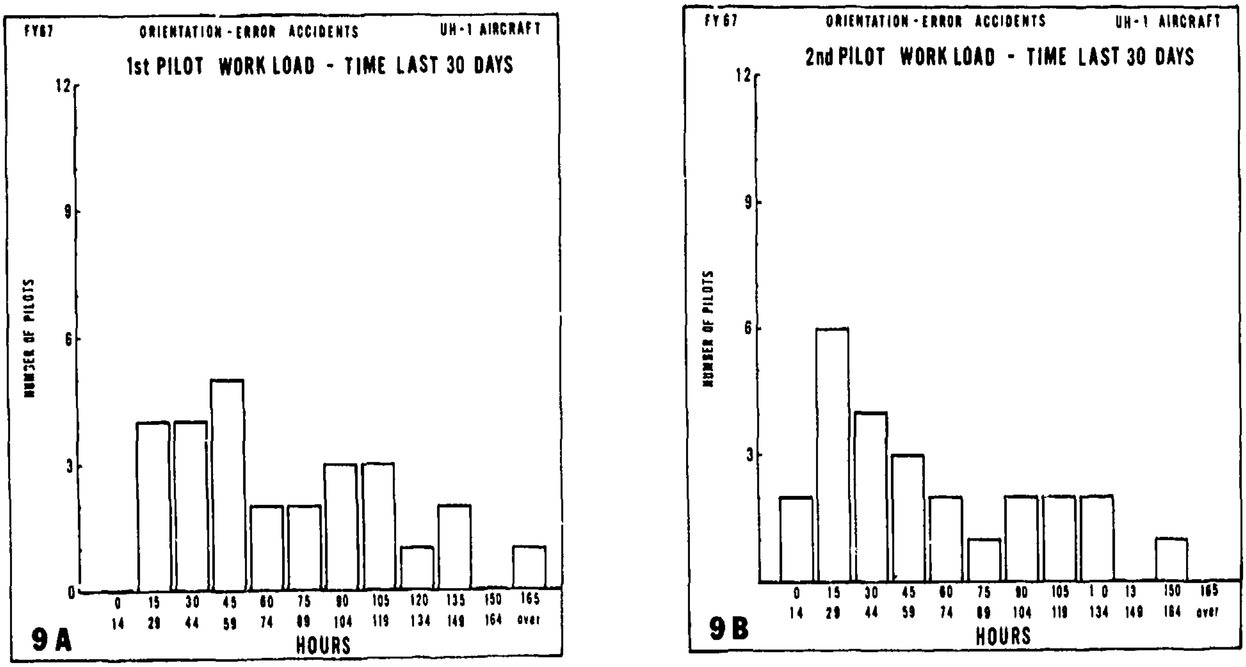

Figure 9

Distribution of pilot workload in terms of the total number of hours flown the 30 days preceding the accident by the first pilot (A) and the second pilot (B). The median workloads were 63.7 hours and 57.5 hours, respectively. (See Figure 11 for related fatigue listings.)

prescribed minimum of in-country experience within the air unit to which he is assigned. An air commander is thus identified as the first pilot and the pilot as the second pilot in this report. In the case of student aviators, the individual assigned to fly the aircraft at the time of the accident is identified as the first pilot. The total number of pilots will vary from figure to figure because of incomplete field reports.

Data pertaining to the rank of the first and second pilots involved in the 44 orientation-error accidents are shown in Figures 5A and 5B, respectively. In the case of the 44 first pilots, there were almost as many individuals (21) with the rank of captain and above as there were of lower rank. As would be expected for the 42 second pilots (two accidents involved flights without a second pilot aboard) the median rank was lower, with 22 individuals having a rank of second lieutenant or above. The age distribution data, based on those whose ages were recorded, presented in Figure 6A for the 38 first pilots indicate a median of 27.8 years; Figure 6B data indicate a median of 24.9 years for 35 second pilots.

Aviator experience in terms of total flight hours both in all types of rotary-wing aircraft and in the UH-1 aircraft is described by Figures 7 and 8, respectively. The median for the total recorded RW experience data, presented in Figure 7, was 675 hours for 41 first pilots and approximately 425 hours for 38 second pilots. The median times for total UH-1 experience were approximately 350 hours and 147.7 hours for the 42 first and 37 second pilots, respectively.

Work-load data concerned with the total number of hours flown by the aviators the 30 days preceding the accident are shown in Figure 9; specific hours data were available for only 27 of the first pilots and 25 of the second pilots. The median times were approximately 63.7 hours for the first pilots and 57.5 hours for the second pilots. Army regulations place 140 hours per 30-day interval as the official upper limit relative to pilot fatigue. After 90 hours, however, observation of the pilot by the air unit commander and flight surgeon is required.

Before listing the various factors found in an individual accident, a case history of each accident is presented, with the objective of acquainting the reader with the general nature of the orientation-error problem in actual flight operations. The first paragraph of each account lists in the designated order: accident location; the type mission assigned to the crew; the phase of flight in which the accident occurred; the time of day of the accident in terms of either night or daylight visibility conditions; the number of persons aboard the aircraft; the number of fatalities, major injuries, and minor injuries; and the presence of aircraft strike damage. The second section presents a brief narrative of the accident proper.

CASE BRIEF 67-1

Vietnam: combat mission--urgent medical evacuation; flight phase--inflight; night flight; five persons aboard--five fatalities; aircraft strike damage.

Two noninstrument-rated pilots given a night emergency med-evac mission under bad weather conditions. An IFR-rated pilot was available but med-evac did not assign him to this mission. After takeoff AC reported heavy fog with low ceiling. Circled takeoff field and requested artillery flare illumination. Flares fired but crew could not see them. AC advised ground unit that soup was thick and he was having weather difficulties. Med-evac requested GCA beacon for crew but AC stated he was not instrument rated and didn't think he could reach med-evac site. Soon after, aircraft impacted ground in steep right bank at an estimated forward speed of 40 to 60 knots.

CASE BRIEF 67-2

Vietnam: service mission--administrative passenger flight; flight phase--inflight; day flight; nine persons aboard--seven major injuries and one minor injury; aircraft strike damage.

Crew inadvertently flew into deteriorating weather. Though mission not urgent, crew continued flight into weather. Entered fog bank and began a climbing left turn. Broke out of fog and saw mountainside dead ahead which AC assumed was level terrain. AC then flared aircraft so skids were level with terrain. Aircraft struck 50-degree slope in an estimated 50-degree nose-high attitude. AC thought he might have had bad vertigo. P observed that he thought AC control of aircraft during turn was erratic, with aircraft never level for long and in varying degrees of bank and pitch attitude. P experienced steep spiralling dive sensation during IFR turn.

CASE BRIEF 67-3

Vietnam: service mission--search and rescue; flight phase--inflight; night flight; four persons aboard--four fatalities; aircraft strike damage.

Pilots assigned a night search and rescue mission for an aircraft downed in an unsecure area. Encountered intermittent fog banks during search--also received conflicting orders from ground commander which added to problem. Ground witness saw aircraft make turn and then dive into ground. Last radio message received from aircraft established crew recognition of vertigo. "I've got vertigo -- down -- let go of the stick! We've both got vertigo real bad -- we're going down! I have vertigo! Look out! We're going in, you're going down -- pull it up, pull it up!"

CASE BRIEF 67-4

Vietnam: service mission--administrative conference; flight phase--inflight; night flight; four persons aboard--four fatalities; aircraft strike damage.

Two aircraft returning to base encountered patchy areas of ground fog with minimum ceiling and visibility. Both aircraft descended under a cloud bank, saw weather was too bad to continue, and decided to return to takeoff site. Lead aircraft started 180-degree standard rate turn to the left, with searchlight turned on in heavy fog; soon after, AC verified that he had passed through 90 degrees. Fifteen seconds later second aircraft asked if lead aircraft had completed turn, but received no message. Lead aircraft impacted ground with relatively high rate of descent and forward speed. AC not checked out in special UH-1B as directed. Instructor pilot for AC thought he was overconfident relative to his own flying ability with little regard for training - "a bunch of administrative nonsense." FM radio inoperative; however, all communications on UHF.

CASE BRIEF 67-5

Vietnam: combat mission--priority medical evacuation; flight phase--landing; night flight; four persons aboard--two fatalities (AC and P) and two minor injuries; aircraft strike damage.

Crew volunteered for night med-evac of patient with only priority rating; i.e., evac not critical, 24-hour limit. Extremely dark night with broken clouds, scattered ground fog, and no visible horizon. Arrived over field site, lighted by a blinking hand-held flashlight, and began circular left-turn descent from 3000 feet. After four turns, leveled off at 700 feet and began normal straight-in approach. Ground personnel radioed that two other aircraft in immediate area. Surviving crew members said approach seemed routine until aircraft suddenly hit trees about 3000 feet short of landing site at an estimated angle of 12 degrees and a forward speed of 75 knots. Accident board determined flashlight could not be seen from point of impact.

CASE BRIEF 67-6

Vietnam: combat mission; flight phase--takeoff; night flight; five persons aboard--four minor injuries; aircraft strike damage.

Crew ordered to evacuate aircraft under low-ceiling, light-rain weather conditions as a result of enemy attack on field site. Necessary to make hurried takeoff without adequate preflight check. AC started takeoff without using windshield wipers, attempting to gain forward speed before making a climbing turn. Turned on landing lights for a moment, then turned them off to prevent attracting enemy gunfire. When AC thought forward speed was adequate, he began climbing turn. He later stated that he felt that they were making a normal climb out. P then noticed airspeed indicator read zero, even though outside references showed that they were moving at 30 to 40 knots. (Probable that rain had filled pitot tube.) P also observed that the vertical climb indicator began to indicate a descent. Shortly thereafter, the aircraft impacted ground during turn.

CASE BRIEF 67-7

United States: training mission; flight phase--other; night flight; two persons aboard--no injuries.

SP, readying for takeoff in good weather conditions, lifted aircraft to hover and made 90-degree turn to left with ground handler in nonoptimum position. SP concerned about nearby moving/stationary aircraft, and SCP concentrating on instruments, tuning radios, and activating hard-to-operate landing light switch. Aircraft drifted to right, with neither SP nor SCP detecting motion until too late. Impacted another helicopter on ground with SP and SCP both on controls. Flight surgeon mentioned possibility of relative motion visual illusion involving blinking lights on nearby aircraft in peripheral visual field of SP.

CASE BRIEF 67-8

Vietnam: combat mission--troop transport; flight phase--landing; night flight; eight persons aboard--three major injuries.

Aircraft last in trail formation of 12 aircraft making landing approach to one-ship landing site on mountain ridge which was poorly illuminated. Heavy rain, cloud bank, gusty winds, and ground fog present. Formation had successfully completed two previous landings at site before weather set in. FM radio removed for maintenance so ground communication not possible. Aircraft went IFR near setdown and started moving backwards without crew detecting motion until ground references became visible an instant before crash. Impacted tail rotor and rolled over. Two preceding aircraft had near accidents. Crew hadn't eaten properly in 9 hours and had been inside aircraft during same period. AC had flown 37 hours in 4 days while P had flown 27 hours in 3 days. P said he couldn't focus his eyes properly on instruments or other aircraft in formation. Flight leader didn't warn formation of bad weather in immediate area of landing zone.

CASE BRIEF 67-9

Vietnam: combat mission--resupply; flight phase--takeoff; night flight; four persons aboard--two fatalities, one major injury, and one minor injury; aircraft strike damage.

Crew eager to perform resupply mission to camp thought to need emergency help. AC observed that weather looked good and didn't bother to obtain available forecast. Used three flashlights during preflight. Began takeoff with searchlight on. When searchlight glare from fog occurred, AC had P turn off light. Began gradual right climbing turn. Ground witness saw aircraft "snaking" from side to side during a gradual descent into ground. AC stated he felt he was in a climb even though aircraft was descending.

CASE BRIEF 67-10

Vietnam: mission not reported; flight phase--inflight; night flight; two persons aboard--two fatalities; aircraft strike damage.

Crew returning to base when ground control advised of a heavy front in their flight path. AC acknowledged but continued on course and penetrated front, encountering heavy rain and severe turbulence. Ground control advised new heading to pass through weakest storm concentration. AC acknowledged, saying that he would take this heading in 30 seconds. AC then called in that he was on this heading. One minute later, radio transmission heard, indicating confusion relative to spatial orientation and difficulties in controlling aircraft. Last transmissions were: "What are you doing, what are you doing? Give me some altitude, give me some altitude. Which way are we turning, I've got it! Let go of it! We've got to gain altitude." Aircraft crashed nose low--probably while in right turn with a high rate of descent.

CASE BRIEF 67-11

Vietnam: combat mission--support; flight phase--landing; night flight; six persons aboard--one fatality and four minor injuries; aircraft strike damage.

Crew flying support over downed aircraft, waiting for evacuation aircraft to arrive. Departed station when message received that aircraft enroute. Prior to reaching base station, received word that evacuation aircraft could not reach downed aircraft because of poor weather. With relatively low-fuel state, aircraft returned to site to evacuate part of downed crew. After pickup, returned to base, encountering heavy rain and gusty winds near landing field. Low visibility conditions were complicated by inoperative windshield wipers. Overshot poorly illuminated field; made a right turn with landing lights and searchlight turned on when "rain closed in like a sheet." Passed low over a river in a right turn with crew not realizing that they were in a slight descent. Crew chief saw water and AC tried to pull pitch, but aircraft hit water and rolled over. AC had flown 105 combat assault hours in the past 30 days, 34 hours at night, and had been up since 0430 the day of accident.

CASE BRIEF 67-12

Vietnam: combat mission--support; flight phase--inflight; day flight; ten persons aboard--two fatalities, six major injuries, and two minor injuries; aircraft strike damage.

AC leading flight of three aircraft returning to a command station in order to relieve members of unit who had remained overnight on a ready reaction mission. Took off in heavy rain, which turned into a steady drizzle, with RW instrument-rated P at controls. When clouds encountered, FW instrument-rated AC took over controls and changed course toward a mountain pass, not asking for any instrument assistance from P. Flew at low level, encountered ground-fog bank, made a right turn, and impacted ground during turn. Force trim not operative, but P reported they did not use this feature on accident flight.

CASE BRIEF 67-13

United States: training mission; flight phase--other; night flight; two persons aboard--one minor injury.

Student pilots downed one aircraft during preflight inspection. Assigned second aircraft which was preflighted and found O.K. except for a "hard to move" navigation light switch. Foreign SP with limited English language capability lifted aircraft to hover with navigation lights on steady dim. Ground handlers not present. Tower instructed crew to turn navigation lights to steady bright. SCP attempted to do this but lights went out. SP, in total darkness, then turned on searchlight. Immediately a radio command was received to turn off searchlight. SP obeyed, temporarily losing all night vision. Shortly thereafter, aircraft hit ground and rolled over. SCP detected aircraft drift before impact but didn't know which way they were moving.

CASE BRIEF 67-14

Antarctica: service mission--search and rescue; flight phase--landing; day flight; five persons aboard--four minor injuries; aircraft strike damage.

Crew departed base to rescue scientists stranded on a mountain peak as a result of bad weather. Crew concerned since scientists' radio indicated carrier being transmitted without any voice signals. Located scientists but unable to land because of bad weather and decided to return to base and wait for weather to clear since scientists O.K. Two 90-degree turns made as aircraft approached base and continued in on a normal straight-in descent. Encountered blowing snow and slightly turbulent air on approach. Impacted ground at 60 knots in a nose-low attitude during whiteout. Neither pilot realized he was so close to ground.

CASE BRIEF 67-15

Vietnam: service mission--personnel transportation; flight phase--landing; night flight; four persons aboard--two fatalities (AC and P) and two minor injuries.

After flying 6 hours and making 19 landings, crew assigned to routine night-flight mission, with both pilots slightly perturbed over having to go back out on a mission which was obviously not an emergency. AC was known to be apprehensive in past about night flights. Also concerned about having to fly with only 5 days left in Vietnam--had asked to be relieved from flying 2 weeks earlier. On morning of accident, AC again requested flight leader to excuse him from flying this day. During following flights on this day, flight leader reported that AC would ask unanswerable type questions on radio, indicating apprehensive state. One hour before accident flight, P (not the AC) remarked that he had a dream the night before that he was going to be killed. As aircraft approached field, pilots instructed field to turn off tower lights because they "blinded them." Tower obliged, with only remaining light coming from flashlight held by ground handler. Aircraft continued approach without turning on landing lights or searchlight. Aircraft hit ground 75 to 100 yards short of touchdown point, appearing to "fly into the ground" in a normal descent attitude. Terrain elevation at impact site was 30 feet higher than the area at nearby control tower. Seconds before crash, crew chief heard P ask AC if he wanted the landing lights or searchlight turned on. AC replied, "Yeah, I guess so."

CASE BRIEF 67-16

Vietnam: combat mission--support; flight phase--landing; night flight; four persons aboard--two minor injuries; aircraft strike damage.

Crew accepted aircraft that preflight check indicated had intermittent reception difficulties with the FM receiver and no attitude indicator on the AC instrument console (removed for maintenance). Shortly after takeoff, P reported that his attitude indicator was drifting and wouldn't maintain a level attitude. Crew continued on flight and performed assigned gunship mission with two other aircraft. Upon completion of mission, made a normal descending approach with searchlight turned on to a landing field which was illuminated only by the lights of two refueling aircraft. Tower advised that aircraft could not land in the refueling area, making it necessary for AC to look for nearby landing site without ground-handler assistance. As AC made a terminating flare to a hover, aircraft engulfed in a billowing cloud of dust, resulting in a loss of all visual contact with ground. AC turned searchlight off because of its reflection from dust cloud and attempted to climb out without instruments. When visual contact with ground regained, AC realized that he was hovering backwards. Another attempt was made to set down with the visibility again going IFR. As the aircraft settled into the dust it was observed to be nosing over, finally impacting in a nose-low attitude.

CASE BRIEF 67-17

Vietnam: combat mission--aircraft recovery; flight phase--other; day flight; four persons aboard--no injuries.

Field commander ordered crew to make a sling-load pickup of downed O-1 aircraft which had crashed in a river (task impossible because weight of water-filled aircraft far exceeded the UH-1 lift capability). Nearby air strike in progress. AC lowered crew member into fast running river to connect sling and act as ground guide. After connecting sling, ground guide slipped and was swept away in river current. Rotor wash covered windshield and P turned on windshield wipers. AC bent over to observe sling load through lower part of chin bubble which was also obscured by spray. Aircraft started to roll right with AC not detecting motion. P came on controls at last moment but rotor hit water and aircraft impacted into river. AC later observed that "the running water might have induced a subconscious forward drift of my hover. . . ."

CASE BRIEF 67-18

Vietnam: combat mission--support; flight phase--inflight; night flight; three persons aboard--two fatalities and one major injury; aircraft strike damage.

Noninstrument-rated P assigned night radio relay station mission in an aircraft without ADF equipment. Instrument-rated CP had been found to be unsatisfactory on an instrument check ride 8 days prior to the accident. Upon completion of mission, crew started to return to base when ground fog rolled in. Attempted to make visual contact with ground, delaying request for GCA assistance until low fuel light (20 minutes of fuel left) came on. P advised GCA he could not locate landing zone and that he did not know his position. GCA gave heading instructions which P followed. P mentioned at one time that he had misread the altimeter. When about 1-1/2 miles from touchdown, aircraft began a rightward drift off the GCA course. There were many different ground light sources in this area that could have confused the crew relative to the location of the field. GCA asked P if field was in sight, but received no reply. Meanwhile, ground observers saw aircraft make a descending left turn, strike a tent, and begin a climbing left turn. After striking the tent, the aircraft landing lights were turned on momentarily and a climb initiated. After completing a 90-degree turn, the aircraft continued on in a near level attitude in a direction where there were no ground lights. Twenty seconds after the GCA request for reply, a radio transmission was received in an excited voice, "I am out of control." Aircraft struck ground, left skid first, in a nose-low attitude, with an airspeed of approximately 60 knots.

CASE BRIEF 67-19

Vietnam: mission--refuel and park aircraft; flight phase--other; night flight; four persons aboard--two minor injuries; aircraft strike damage.

After refueling, AC lifted aircraft to hover and moved toward a nearby tiedown, using the aircraft searchlight to maintain ground reference in the poorly illuminated area. Dust on the surface of the taxi strip was lifted into the rotor wash, resulting in IFR conditions. With searchlight still on and reflecting from the dust cloud, AC attempted an instrument takeoff. Impacted ground in a right bank, with a nose-low attitude, bounced, and went into a right turn with rotor hitting ground at 45-degree angle.

CASE BRIEF 67-20

Vietnam: training mission--shipboard takeoff; flight phase--takeoff; night flight; two persons aboard--one fatality and one minor injury; aircraft strike damage.

AC arranged orientation ride for P to demonstrate problems inherent to night operations from the flight deck of a ship. AC and P discussed problem of vertigo during preflight inspection of aircraft. Maintenance records indicated landing anticollision light and one navigation light were inoperative and the altitude indicator for the P was inoperative. Immediately before takeoff, an unshielded flashlight was used in cockpit to fasten seat belts. AC lifted aircraft to hover over deck of ship and began straight takeoff over ocean. Poor visibility conditions on an extremely dark night with low overcast and no visible horizon. Crew chief observed aircraft to takeoff in the usual manner, then to "fly down a wire" into the ocean. Aircraft impacted water in a slightly nose-low level attitude approximately 900 feet from ship. Surviving P felt they were making a normal climbing takeoff.

CASE BRIEF 67-21

United States: service mission--ferry aircraft; flight phase--inflight; night flight; one person aboard--one minor injury; aircraft strike damage.

P flying solo for first time in UH-1 as part of a flight of eight aircraft on a cross-country ferry mission. Flight leader only aviator with a rotary wing standard instrument ticket. Flight group was on VFR flight plan and behind schedule because of 3-hour delay in takeoff. Nightfall closed in as flight approached destination with heavy clouds in region. Since P not familiar with area and only person aboard, he had to read maps with neck-suspended flashlight. Problem complicated in that P had switched to wrong UHF radio frequency, thus losing radio contact with remainder of flight. P encountered heavy clouds and turbulence and had difficulty maintaining visual contact with formation. Saw steady bright light and headed toward it since he thought it was another aircraft. Hit heavy rain, and P had "the tremendous sensation I was being pushed up. I thought I could see clouds; I could see a cloud I thought I was going to be pushed up into." Saw bright light again and flew toward it, finally realizing that it was on the ground. Attempted to flare but impacted trees. Two other pilots in same flight reported similar difficulties and near accidents.

CASE BRIEF 67-22

Vietnam: combat mission--Firefly attack team; flight phase--inflight; night flight; five persons aboard--two major injuries and three minor injuries; aircraft strike damage.

Firefly type mission, consisting of lightship with special high-intensity searchlight and gunship without any lights; gunship usually flies beneath lightship during attack. Team had just finished attack on an enemy position when lightship spotted sampan. Lightship pilot notified gunship and directed Firefly light on new objective. Gunship completed a low recon on the sampan and began a turn to the right. At this time the AC of the lightship experienced vertigo and turned off the Firefly light, resulting in the gunship being left in total darkness. Gunship AC "pulled in power and pulled the cyclic back which I felt started a climbing right turn which my instruments indicated." Approximately 20 seconds later, aircraft crashed having flown into the ground even though AC thought he was in climb.

CASE BRIEF 67-23

Vietnam: combat mission--medical evacuation; flight phase--takeoff; day flight; fourteen persons aboard--no injuries; aircraft strike damage.

Tower instructed AC to depart to the east, resulting in a downwind takeoff. No wind direction indicator visible to AC. As aircraft hovered off the helipad, it went IFR in dust. AC attempted instrument takeoff, began to lose power gradually, and decided to land to ensure not striking a barbed-wire enclosure known to be somewhere ahead in his flight path. In attempting to make a level touchdown under the IFR dust conditions, aircraft struck ground in a left bank with nose low, resulting in a complete overturning of the aircraft.

CASE BRIEF 67-24

Vietnam: combat mission--support team; flight phase--takeoff; day flight; four persons aboard--two fatalities and two minor injuries (AC and P); aircraft strike damage.

Aircraft assigned to give fire support to combat assault operation. Dissension between AC and P, with latter being of senior rank. AC recommended that P fly in second aircraft of flight, but P stated he did not agree with proposal and would fly with AC in lead aircraft. In good weather, P made takeoff over water, expressing concern about clearing barbed wire near water's edge. AC busy tuning radios during takeoff. The P stated, "while glancing at the rpm, my only recollection of the water was the white glare off of the water from the sun. Before my glance at the rpm returned to outside the cockpit, we hit the water." Aircraft observed to descend in a nose-low attitude, striking water left skid first, then nose over, and sink about 600 feet from shore.

CASE BRIEF 67-25

Vietnam: mission--repark aircraft; flight phase--other; day flight; one person aboard-- no injuries.

AC ordered to move aircraft from one parking spot to another to clear area for an ongoing airmobile operation. Lifted aircraft to a high hover to avoid as much dust as possible and started flying circular pattern to new parking spot in construction area. Had difficulty maintaining visual contact with ground as a result of dust. Descended too rapidly in dust and crashed with excessive forward speed.

CASE BRIEF 67-26

Vietnam: combat mission--assault; flight phase--landing; day flight; ten persons aboard--no injuries.

Aircraft, one of eight ships participating in a combat assault mission, made steep approach to landing zone which had been recently burned, leaving dust and ashes on surface. Aircraft went IFR in dust and touched down prematurely with excessive forward speed, resulting in a collapse of the skid gear.

CASE BRIEF 67-27

Vietnam: combat mission--assault; flight phase--landing; day flight; four persons aboard--no injuries.

AC and P had only 3.3 flight hours each during the 24-hour period preceding the accident. However, during the preceding 30 days, AC had flown 173 hours and P had flown 160 hours. Aircraft flying number two slot during approach to landing field. Under instructions of flight leader, who was aware of dust at landing site, aircraft in formation tripled their normal spacing. AC brought the aircraft to hover and went IFR in his own dust plus that caused by the first aircraft to land. Third aircraft decided to make a go around, further adding to dust. AC of second aircraft reported, "When I couldn't see the ground, I pulled pitch so that I could make a go around. I'm not sure how close I was to the ground or what sort of attitude I was in." Aircraft began to lose rpm and, while still IFR in dust, crashed.

CASE BRIEF 67-28

Vietnam: combat mission--assault; flight phase--landing; night flight; eight persons aboard--three minor injuries; aircraft strike damage.

Aircraft part of eight-ship airlift force, flying troops to base camp undergoing enemy attack. As flight approached landing strip, a tank searchlight was turned on and pointed toward oncoming aircraft to illuminate area. As the accident aircraft approached the ground, dust was encountered and AC decided to terminate at a hover. Aircraft drifted sidewards in dust without crew noticing movement. Left skid hit ground and aircraft rolled over. AC and P had been on duty for 18 hours.

CASE BRIEF 67-29

Vietnam: combat mission--support; flight phase--other; day flight; five persons aboard--one minor injury; aircraft strike damage.

In haste to comply with controller instructions to clear the active runway, AC listed ship to a 3- to 5-feet hover, moving off runway toward parking area. Went IFR in dust, losing all visual contact with ground. Attempted to regain visual reference by looking through chin bubble, but without success. Knowing personnel and other aircraft in immediate area, AC tried to set down level in dust. Hit right skid heel first in an extreme tail-low attitude.

CASE BRIEF 67-30

Vietnam: training mission--tactical; flight phase-takeoff; day flight; eleven persons aboard--no injuries.

IP, assigned to transport personnel and to give P a checkout ride in this model UH-1, observed to make a seemingly hasty takeoff. Takeoff was downwind since IP misjudged wind direction by 180 degrees. Aircraft began to gradually lose power after clearing wires at end of field, and IP decided to land, encountering severe dust at 30- to 40-feet altitude. Visibility went completely IFR and tail observed to begin moving left. Impacted truck with right skid while tail drifting left.

CASE BRIEF 67-31

United States: training mission; flight phase--other; day flight; three persons aboard--three minor injuries.

P, leading flight of four other aircraft, lifted aircraft to hover, moved to the lead position of the formation, and set down to watch flight form. When formation ready, P lifted aircraft to hover, turned left and simultaneously rolled right with rotor blades striking ground. Witnesses said roll was synchronous with the left turn and not sudden or violent. During the liftoff, CP was checking maps at request of P who was concerned with both leading flight and reaching destination. Gradual slope of terrain at site was down and to the right of aircraft which would give false impression of actual horizon. P killed in aircraft accident that occurred six months later.

CASE BRIEF 67-32

United States: training mission; flight phase--landing; night flight; two persons aboard--two minor injuries; aircraft strike damage.

Student pilots on a night training mission to practice landing in a tactical zone under minimal lighting conditions. Pilots disregarded verbal orders and attempted an approach to the flare-pot-illuminated field without establishing radio contact with ground personnel. Made approach to field under bright moonlight conditions. Pilots misjudged aircraft altitude and flew far below proper glide angle. Aircraft impacted wire 36 feet above ground approximately 2700 feet short of field. Flight surgeon noted that during examination of wreckage, FM radio was found to be set to 49.5 instead of correct 49.6 frequency.

CASE BRIEF 67-33

Vietnam: service mission--command and control flight; flight phase--takeoff; day flight; seven persons aboard--three minor injuries.

Pilots had landed at dusty unimproved field site with BGEN aboard. When ready for takeoff, AC lifted aircraft to hover, experienced gradual loss of rpm, and lost visual reference with ground due to dust. AC successfully landed aircraft. He then decided to make another attempt at takeoff without lightening his load. Same conditions resulted again, and as AC attempted IFR, set down in dust, aircraft drifted with rotor blades striking a nearby parked truck.

CASE BRIEF 67-34

Vietnam: combat mission--Firefly team; flight phase--inflight; night flight; six persons aboard--five fatalities and one minor injury; aircraft strike damage.

After completing first phase of mission, three-ship Firefly team landed at airstrip for briefing on second phase of mission. First gunship made takeoff over water followed by lightship. Night was clear, but dark without moonlight. Shortly after takeoff, lightship crashed into river some 1500 meters from takeoff site. Surviving AC had searchlight, landing lights, and running lights turned on during takeoff. AC stated that when he was at an altitude where thought he didn't need the lights, he switched them off. Seconds later he hit the water. Ground witnesses observed "as soon as he turned off his landing lights, the aircraft began to slowly descend." AC had flown 137 hours last 30 days; P 134 hours during same period. P had already flown 8-1/2 hours during the day when assigned this 4-hour night mission.

CASE BRIEF 67-35

Vietnam: combat mission--resupply; flight phase--other; day flight; seven persons aboard--four minor injuries.

P lifted aircraft to hover enroute to refueling area before takeoff. Encountered heavy dust at edge of runway, and P decided to setdown instead of climb out because of possible overhead traffic. Chaplain aboard aircraft said ". . . had just started to hover a short distance off the ground when it was enveloped in a heavy cloud of red clay dust. It was impossible to see anything and it was just like being in a large red cloud." During IFR letdown, aircraft drifted backward without detection, finally hitting ground right skid first.

CASE BRIEF 67-36

Vietnam: combat mission--resupply; flight phase--landing; day flight; four persons aboard--two minor injuries.

Aircraft approached landing site intending to setdown behind another UH-1. As they were on final approach, this UH-1 took off, raising a large dust cloud. P asked AC if he should continue or make a go around. AC advised him to continue with aircraft, finally entering dust area. Crew chief saw parked van below and told pilot not to go down. P applied power, resulting in large dust cloud surrounding aircraft. AC came on controls with aircraft turning 60 degrees undetected. AC saw tree top above dust cloud and tried to set aircraft down under IFR conditions, with left drift resulting in main rotor strike on parked aircraft. AC had flown 134 hours last 30 days and 8-1/2 hours the last 24 hours.

CASE BRIEF 67-37

United States: training mission; flight phase--other; night flight; two persons aboard--no injuries; aircraft strike damage.

SP on first solo night tactics mission performed preflight and radioed for permission to takeoff. Lifted aircraft to a low hover, with physical layout of parking area requiring first a leftward movement and then a 90-degree turn. SP left navigation lights on steady dim. During the turn, the aircraft drifted right, hitting ground with rear of right skid, resulting in aircraft rolling to right and main rotor striking ground.

CASE BRIEF 67-38

Vietnam: combat mission--Firefly; flight phase--inflight; night flight; four persons aboard--two minor injuries; aircraft strike damage.

Aircraft flying "low" gunship on a dark night Firefly mission. As team flew along a small canal, lightship lost sight of canal and made a 180-degree turn to regain visual contact. Low ship, with conventional searchlight turned on, continued down canal and then began a turn to the right. As soon as turn started, AC turned off the searchlight. When 180-degree turn nearly completed, AC turned searchlight on momentarily and scanned area to see that no obstacles present. Scan indicated marsh terrain below when aircraft at an approximate altitude of 50 feet. Pilots said they could see nothing with their lights off. To join up with lightship, AC turned off searchlight and rolled into a right turn with approximately 45 degrees of bank. AC stated he simultaneously initiated a slight climb as was his normal custom. Especially when turning to the right. Aircraft struck ground near the end of the turn.

CASE BRIEF 67-39

Vietnam: combat mission--assault; flight phase--landing; day flight; five persons aboard--no injuries in the number two aircraft and one minor injury in the lead aircraft.

Four-gunship team made approach to landing site in trail formation. Flight leader warned group of dust in area and instructed them to spread out. On short final, steam roller pulled across approach path, causing them to make an approach steeper than normal. Lead aircraft terminated approach and moved to side of runway, becoming engulfed in dust but making successful landing. The number two aircraft terminated at a hover and also went IFR in dust from both aircraft. As the number two aircraft moved toward touchdown, visibility went completely IFR, and aircraft drifted into the parked lead aircraft with the rotor blades overlapping by 14 inches.

CASE BRIEF 67-40

Vietnam: combat mission--support; flight phase--inflight; day flight; two persons aboard--two fatalities; aircraft strike damage.

Six aircraft returning to home base encountered deteriorating weather with flight leader given 500-feet overcast at field. Flight leader issued radio instructions to remainder of flight to remain at altitude until he checked the ceiling out. Either this command was not heard or misunderstood since the first two aircraft followed the lead aircraft into the clouds at 1500 feet. At about the time the lead aircraft broke out at 70- to 80-feet altitude, operations told flight not to penetrate the clouds. Flight leader passed these instructions on to other five aircraft. The number two aircraft, piloted by aviators who had not logged any instrument time since training, then changed from a 1500 feet/minute descent to a climbing right turn into the clouds, finally losing control of aircraft. Aircraft struck ground at an angle of approximately 45 degrees at an extremely high rate of descent in a slight right-turn attitude, with neither skid touching ground at impact.

CASE BRIEF 67-41

Vietnam: combat mission--assault; flight phase--other; day flight; four persons aboard--no injuries.

Aircraft assigned mission that required additional fuel. As AC hovered aircraft toward refueling site, located in an extremely dusty area, visibility went IFR due to swirling dust. When AC couldn't establish visual contact with ground by looking down through chin bubble, he began a steep climb out. AC later stated that while still in the dust, ". . . it felt as if I was moving backwards and I knew that I was moving forward and I had not applied any rearward pressure on the cyclic." At this time rotor rpm began to decrease, and AC told P, "I've got vertigo." P took over and attempted to set aircraft down through dust cloud, experiencing a diving right sensation. Aircraft hit level, bouncing 10 to 15 feet.

CASE BRIEF 67-42

Vietnam: combat mission--resupply; flight phase--landing; night flight; two persons aboard--no injuries.

Crew had been on duty 14-1/2 hours, eating irregular meals and logging 10 hours' flight time, when assigned night mission to resupply troops in urgent need of ammunition. As aircraft approached landing zone on a dark night without a visible horizon, ground unit informed AC that area was no longer receiving gunfire. AC elected, however, to make a "lights out" approach to field site illuminated by two flashlight batons held by an untrained ground guide who had selected a dusty area for touchdown. During approach, with all lights off except those in the cockpit interior, AC momentarily turned on landing light. Because of reflection off haze, AC immediately turned these lights off. At a high hover of 15 to 20 feet, and under the direction of ground guide, AC started to set down when aircraft became engulfed in cloud of dust. Having difficulty viewing ground lights, aircraft began drifting left, striking nearby tree.

CASE BRIEF 67-43

Vietnam: combat mission--Firefly; flight phase--other; night flight; ten persons aboard--two fatalities (AC and passenger) and four minor injuries; aircraft strike damage.

Firefly lightship had reached combat area and was following river at 1500 feet when aircraft engine malfunction occurred, resulting in severe vibration and a loss of power. AC took over controls and prepared for an autorotation landing, instructing P to turn on landing lights and searchlight. Also instructed Firefly light operator to turn on his lights. Both AC and P lost visual contact with ground when the lights were turned on, due to their reflection from ground fog and haze. Cockpit reflections from Firefly lights also caused visual difficulties. P stated he was "blinded" as soon as lights came on. As autorotation descent continued, P thought AC experienced vertigo and came on controls, with aircraft finally striking tree on bank of river. Standby (P) attitude indicator was inoperative on flight.

CASE BRIEF 67-44

Vietnam: combat mission--resupply; flight phase--landing; night flight; four persons aboard--no injuries.

Crew flying an emergency resupply mission on a dark night, with heavy overcast obscuring moon and making horizon difficult to identify. As aircraft made approach to confined-area landing zone illuminated by aircraft searchlight and ground vehicle headlights, AC experienced vertigo and turned controls over to P who completed landing without incident. Crew returned for additional supplies and made a second approach to same site with P at controls. Nearing touchdown point, aircraft went IFR in dust raised by first takeoff. Dust diffused the light from the landing lights, and crew immediately turned lights off, with P continuing approach instead of attempting a go around which would have required a steep climb to get over nearby barriers and trees. While still IFR in dust, aircraft drifted and struck a large mound of dirt short of touchdown point, causing aircraft to swerve right 90 degrees. With AC and P both on controls, aircraft finally set down, with rear cross-tube collapsing due to initial contact with dirt mound.

Even a hasty examination of the narrative data will drive home the often-stated point of accident researchers that, in general, no single factor is solely responsible for causing a given accident. Though one factor or event may initiate or trigger the orientation error, other factors or events are usually present which act in combination to finally effect an accident rather than a simple incident or near-miss situation.

A further point to be gained from these narrative data is related to the considerable number of Vietnam accidents that occurred at low altitude under poor visibility conditions. At first glance, it would seem that these accidents point to the need for additional instrument experience under actual or simulated IFR conditions. Such a conclusion, however, must be tempered by the fact that many of the Vietnam combat operations demand complete pilot dependence on VFR flying conditions at low altitude. That is, the very survival of an aircraft crew depends on clearing such obstacles as trees, stumps, concertina wire, and supply stockpiles that may be adjacent to, or in line with, their flight path. It should be realized also that since the average duration of a flight in Vietnam is only about 18 minutes, little flight time is available for the maintenance of instrument proficiency.

A selected listing of the various factors derived from the review of the master accident files for these 44 accidents is presented in Figures 10 through 14 on an individual case history basis. Once again the reader must remember that the listing of any factor or event for a given accident is controlled solely by the amount of data actually contained in the related master accident jacket. The format used in the preparation of Figures 10 through 14 is keyed to the identification of factors and events on an individual accident basis for fiscal year 1967. In each of these figures a separate vertical column is assigned to each accident where the number at the top of each column corresponds to the accident number used to sequentially identify the individual case history briefs presented earlier. An alpha-numeric index code is used to identify selected accident factors where an x-entry denotes the presence of the related factor. In addition to these individual listings, the total number of accidents in which a given factor was present is tabulated in a separate column.

Figure 10 summarizes various accident/aviator background information associated with these 44 accidents. The location of each accident is denoted in rows A1 through A3. For that fiscal year, 84.1 percent of the accidents occurred in Vietnam. As denoted by the A4-A8 entries, the majority of the accidents (68.2 percent) occurred in the D model of the UH-1. Rows A9-A13 indicate the mission assignment, rows A14-A17 the phase of flight in which the accident occurred, and rows A18 and A19 the time of day in terms of daylight or night visibility as coded by USABAAR. Under the miscellaneous heading, A20 denotes those accidents in which one or more fatalities were involved. Row A21 indicates those fatal accidents in which all personnel aboard the aircraft were killed; this listing is included to indicate those accidents where post-flight information on the nature or manifestations of the orientation-error difficulty was not available from the crew. Entries in Row A22 indicate accidents of sufficient severity to result in a total loss or strike of the aircraft. In contradistinction, entries in A23 denote accidents resulting in minimal damage; i.e., the accidents producing a total dollar damage of less than $25,000, which amounts to approximately 10 percent or less of the replacement cost of the aircraft.

The B and C headings in Figure 10 give data related to the background and experience of the first and second pilots, respectively. The interpretation of the experience data contained in Rows B3-B9 and C3-C9 should be related to the data previously presented in Figures 7 and 8, which pertain to only total RW time and total UH-1 time. Entries B1 and C1 indicate that 15 of the first pilots and 12 of the second pilots had some amount of military FW experience in addition to the RW time listed in Figure 7. Rows B5 and C5 denote those aviators with both FW and RW military aircraft time who had a total FW and RW experience of greater than 1000 hours. These data indicate that 13 first

FIGURE 10

MAJOR ORIENTATION-ERROR ACCIDENTS
- REGULAR ARMY UH-1 AIRCRAFT -

FY67 — BACKGROUND DATA

ACCIDENT CASE NUMBER (1–60) — O = DATA NOT AVAILABLE

CODE		TOTAL
A	ACCIDENT BACKGROUND	
	LOCATION	
1	Viet Nam	37
2	United States	6
3	Other	1
	AIRCRAFT MODEL	
4	UH-1B	8
5	UH-1C	6
6	UH-1D	30
7	UH-1H	0
8	UH-1 other	0
	ASSIGNED MISSION	
9	Training	7
10	Service	7
11	Test	0
12	Combat	27
13	Other/unknown	3
	ACCIDENT FLIGHT PHASE	
14	Takeoff	7
15	Inflight	12
16	Landing	14
17	Other	11
	TIME OF DAY	
18	Daylight Accident	18
19	Night Accident	26
	MISCELLANEOUS	
20	Fatal Accident	15
21	Fatal Injury: all aboard	5
22	Aircraft Damage: strike - total loss	27
23	Aircraft Damage: less than $25,000	7
B	1st PILOT BACKGROUND	
1	Past Military FW Experience	15
2	FW Instrument Ticket	10
3	RW Instrument Ticket	18
4	Not Instrument Rated	15
5	Total FW-RW Experience: greater than 1000 hours	13
6	Total RW Experience: greater than 1000 hours	7
7	Total RW Experience: less than 400 hours	11
8	Total UH-1 Experience: greater than 500 hours	15
9	Total UH-1 Experience: less than 100 hours	11
10	Received Fatal Injury	11
11	Involved in Previous/Later Accidents	10
C	2nd PILOT BACKGROUND	
1	Past Military FW Experience	12
2	FW Instrument Ticket	7
3	RW Instrument Ticket	17
4	Not Instrument Rated	13
5	Total FW-RW Experience: greater than 1000 hours	7
6	Total RW Experience: greater than 1000 hours	3
7	Total RW Experience: less than 400 hours	18
8	Total UH-1 Experience: greater than 500 hours	4
9	Total UH-1 Experience: less than 100 hours	10
10	Received Fatal Injury	10
11	Involved in Previous/Later Accidents	9
12	2nd Pilot Not Aboard	2

Figure 10

Individual case history listing of basic accident details and selected aviator background information.

pilots and 7 second pilots had this relatively considerable experience. In fact, an inspection of the B5 and C5 entries combined reveals that 16 of the 44 accidents had one or more aviators aboard the aircraft who had a total FW and RW experience exceeding 1000 hours. In terms of only RW flight time, entries B6 and C6 denote those aviators with 1000 hours or more of RW experience. In the opposite direction, entries B7 and C7 identify aviators with less than 400 hours RW time, denoting minimal experience. These data indicate that 7 first pilots and 3 second pilots had greater than 1000 hours RW experience while 11 first pilots and 18 of the second pilots had less than 400 hours of RW time. However, considering the individual RW experience of each aviator, only 6 accidents involved flights where both pilots had less than 400 hours' total time, and 4 of these occurred during training.

Relative to total time in the UH-1 type aircraft, entries B8 and C8 denote aviators with greater than 500 hours, while B9 and C9 denote those with less than 100 hours. Of the first pilots, 15 were known to have 500 hours or more, and 11 less than 100 hours. Of the second pilots, 4 were known to have 500 hours or more, and 10 to have less than 100 hours. In only 8 accidents did neither aviator have greater than 100 hours' flight time in the UH-1 aircraft. As before, 4 of these accident involved the pilot trainee situation.

Entries B2-B4 and C2-C4 pertain to the instrument-rating qualifications of the aviators. These data indicate that of the 41 first pilots for whom instrument rating data were available, 15 were not rated, while the remainder possessed either a FW or RW or both a FW and RW instrument ticket. Similarly, from the data available on 38 of the 42 second pilots, only 13 were not instrument rated. Combining the B2, B3 and C2, C3 data shows 33 of the flights were known to have had at least one aviator aboard who was instrument rated.

To gain insight into the availability of post-flight data from the aviators involved in the accidents, entries B10 and C10 indicate those pilots fatally injured. Data pertaining to other accidents the pilots may have been involved in are listed in entries B11 and C11. For that fiscal year, 10 first pilots and 9 second pilots were involved in one or more additional accidents that occurred either before or after the accident under discussion. Sixteen accidents (36.4 percent) involved at least one pilot aboard who had a pre- or post-accident record. Entry C12 denotes those accidents where only one pilot was aboard the aircraft.

The factor and event data presented in Figures 11 through 14 follow the Figure 10 format with the row entries continuing to be identified in alpha-numeric sequence. It should be observed that Figures 11 and 12 are concerned with factors and events which were found to be present, or to have happened, in the time period preceding takeoff; Figures 13 and 14 list factors and events which occurred, so far as the crew were concerned, only after the aircraft became airborne. This approach has been selected with the long-term objective of possibly distinguishing between accidents that may occur as a result of initial conditions existing before flight, and accidents that may occur seemingly as a result of only some inflight event or factor. As one may gather from certain of the

FIGURE 11
MAJOR ORIENTATION-ERROR ACCIDENTS
- REGULAR ARMY UH-1 AIRCRAFT -

FY67 **FACTORS / EVENTS — BEFORE TAKEOFF**

ACCIDENT CASE NUMBER

Code	Factor	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
D	PHYSIOLOGICAL FACTOR - 1st PILOT																																																													
1	Fatigue: 140 hours or more last 30 days	1																											X																																	
2	Fatigue: between 90 and 140 hours last 30 days	9		X								X	X	X										X												X		X				X			X																	
3	Fatigue: 8 hours or more last 24 hours	3																		X																		X						X																		
4	Fatigue: other	3								X							X													X																																
5	Missed Meals	3								X							X																											X																		
6	Degraded Night Vision	2									X											X																																								
7	Other	0																																																											
E	PHYSIOLOGICAL FACTOR - 2nd PILOT																																																													
1	Fatigue: 140 hours or more last 30 days	1																											X																																	
2	Fatigue: between 90 and 140 hours last 30 days	7		X	X	X						X		X																						X				X																						
3	Fatigue: 8 hours or more last 24 hours	3																																		X		X						X																		
4	Fatigue: other	3								X							X													X																																
5	Missed Meals	2								X																																		X																		
6	Degraded Night Vision	2									X											X																																								
7	Other	0																																																											
F	PSYCHOLOGICAL FACTOR - 1st PILOT																																																													
1	Apprehension	2						X									X																																													
2	Anger Irritation: crew dissension	1																								X																																				
3	Anger Irritation: other	1															X																																													
4	Personal Problems	1															X																																													
5	Other	0				X								X																																																
G	PSYCHOLOGICAL FACTOR - 2nd PILOT																																																													
1	Apprehension	1						X																																																						
2	Anger Irritation: crew dissension	1																								X																																				
3	Anger Irritation: other	1															X																																													
4	Personal Problems	1															X																																													
5	Other	0																																																											
H	FACILITY FACTOR																																																													
1	Field Lighting	0																																																											
2	Field Dust Control	0																																																											
3	Ground Handling Services	2							X						X																																															
4	Other	1																							X																																					
I	SUPERVISORY FACTOR: Responsibility																																																													
1	Aircraft Commander or 1st Pilot	1									X																																																			
2	Flight Formation Leader	2																					X								X																																	
3	Air Unit Commander	9	X			X				X	X															X			X			X				X								X																		
4	Ground Unit Commander	0																																																											
5	Facility Commander	2													X																												X																			
6	Other Individual	0																																																											

Figure 11

Individual case history listing of selected accident factors and events present before, or at the instant of, takeoff on the accident flight. See text for details.

FIGURE 12

MAJOR ORIENTATION-ERROR ACCIDENTS
- REGULAR ARMY UH-1 AIRCRAFT -

FY67

FACTORS / EVENTS — BEFORE TAKEOFF

ACCIDENT CASE NUMBER

Code	Factor	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
J	MATERIEL FACTORS																															
1	Aircraft Engine System	0																														
2	Flight Controls	1												X																		
3	Flight Instruments	4						X										X				X										
4	Communication Gear	4				X				X								X					X									
5	Navigation/Landing/Search Lights	3							X						X							X										
6	Windshield Wipers	0																														
7	Other	0																														
K	MISSION PRESSURE FACTORS																															
1	Urgent Mission: med evac - search and rescue	3	X		X											X																
2	Urgent Mission: other	6						X			X		X																	X		
3	Firefly Mission	4																						X								
4	1st of a Kind Assignment	3																					X									
5	Other	2													X																	
L	PILOT PREFLIGHT FACTORS																															
1	Hurried/Rushed Preflight	1						X																								
2	Knowingly Accepted Deficient Aircraft	6				X				X				X				X				X										
3	Unknowingly Accepted Deficient Aircraft	3						X	X						X																	
4	Inadequate Power/RPM Check	2																							X							
5	Other	2									X																					X
M	MISCELLANEOUS FACTORS/EVENTS																															
1	No Copilot Aboard	2																					X				X					
2	Pilot Only Person Aboard	1																					X									
3	Marginal Aircraft Weight	4																							X			X				
4	Hurried Departure	3						X																							X	X
5	Delayed Departure	1																					X									

Code	Factor	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
J	MATERIEL FACTORS																														
1	Aircraft Engine System																														
2	Flight Controls																														
3	Flight Instruments													X																	
4	Communication Gear																														
5	Navigation/Landing/Search Lights																														
6	Windshield Wipers																														
7	Other																														
K	MISSION PRESSURE FACTORS																														
1	Urgent Mission: med evac - search and rescue																														
2	Urgent Mission: other												X		X																
3	Firefly Mission				X				X					X																	
4	1st of a Kind Assignment	X						X																							
5	Other			X																											
L	PILOT PREFLIGHT FACTORS																														
1	Hurried/Rushed Preflight																														
2	Knowingly Accepted Deficient Aircraft													X																	
3	Unknowingly Accepted Deficient Aircraft																														
4	Inadequate Power/RPM Check			X																											
5	Other																														
M	MISCELLANEOUS FACTORS/EVENTS																														
1	No Copilot Aboard																														
2	Pilot Only Person Aboard																														
3	Marginal Aircraft Weight			X						X																					
4	Hurried Departure																														
5	Delayed Departure																														

Figure 12

Continuation of the Figure 11 listing of before-takeoff factors and events.

case briefs, for example Case 67-15, the initial conditions before takeoff can be conducive to the _a priori_ prediction of a high accident probability.

In Figures 11 and 12, factors and events present before takeoff are listed under physiological, psychological, facility, supervisory, materiel, mission pressure, pilot preflight, and miscellaneous. The D and F headings pertain to physiological and psychological factors, respectively, associated with the first pilot while the E and G headings list the same factors for the second pilot. This separate listing allows a heavier weighting to be given these factors when both pilots, rather than only one, experience the related difficulties.

Relative to physiological problems that existed prior to takeoff, fatigue was found to be the most obvious factor. Four entries, D1-D4 for the first pilot and F1-F4 for the second pilot, have been allotted to the description of this problem. Entries D1 and E1 denote aviators with greater than 140 total flight hours during the 30 days preceding the accident. Army regulations for Vietnam flight operations set this figure as the upper limit which cannot be exceeded except during tactical emergencies. Although it is possible to obtain permission at the battalion level to exceed this limit, the regulations direct the commanders to use the utmost discretion when granting this waiver. For that fiscal year there was only one flight, Case 67-27, in which both pilots had had more than 140 flight hours the previous 30 days. The same Army regulations also state that a crew member who accumulates 90 hours in a 30-day period will be closely monitored by the unit commander and the flight surgeon. This monitoring requirement is thus an implied recognition of individual susceptibility to fatigue. For this reason, the authors have chosen to also identify those accidents involving aviators with a workload greater than 90 hours, and less than 140 hours, the previous 30 days. The related D2 and F2 fatigue entries indicate 9 first pilots and 7 second pilots experienced this workload. In terms of both pilots, there were 13 (29.5 percent) accidents where either one or both of the aviators had flown more than 90 hours during the 30-day period preceding the accident.

A third fatigue classification, D3 and E3, involves the identification of aviators who had flown 8 hours or more the 24 hours preceding the accident. Three first pilots and 3 second pilots experienced this workload. In entries D4 and E4, miscellaneous fatigue factors mentioned by the accident board, for example, long duty hours or interrupted sleep, are listed. Treating the four fatigue entries as a group, there were 18 (40.9 percent) accidents in which at least one aviator was exposed to one or more of the stated fatigue listings.

Other entries listed under the physiological factor heading include D5 and E5, missed meals, and D6 and E6, degraded night vision. In D6 and E6, the entries show that some event or act occurred where it was highly probable that the night vision of the pilot was degraded. This is typified by Cases 67-9 and 67-20 where unshielded flashlights were used immediately before takeoff during the night preflight of the aircraft.

The F and G psychological factor listings are intended to identify any unusual mental condition or attitude that existed before the aircraft actually became airborne. Factors included in these initial conditions include F1 and G1, apprehension, typified by Case 67-6 where the crew was required to evacuate an aircraft from a field undergoing enemy attack; F2 and G2, crew dissension, represented by Case 67-24; F3 and G3, irritation caused by matters other than crew dissension and typified by Case 67-15 where the crew was perturbed at being ordered on a night mission; and F4 and G4, personal problems, also represented by Case 67-15. With all F and G headings treated together, there were 5 (11.4 percent) accidents in which one or more of the listed psychological factors was present. It is the opinion of the authors at this point in the analysis that the field accident-investigation teams seem in general to be reluctant to enter psychological-related information into the written record.

The H facility heading is used to denote any airfield shortcoming which the accident board considered to have some effect on either the accident proper or the course of flight action available to the pilot. The facility factors listed under this heading, distinct from those listed under the P (inflight) heading in Figure 13, relate to shortcomings present before actual takeoff of the aircraft. For example, in Case 67-7 the ground handler was not in the proper position to guide the pilot during liftoff. In Case 67-23, the tower instructed the crew to takeoff downwind; furthermore, the airfield did not have a properly located windsock that the pilot could use to establish the proper takeoff direction. There were only 3 accidents in which these forms of facility factors were coded.

Factor I deals with supervisory errors considered by the accident board to have taken place before the flight became airborne. The listings under this heading denote the individuals assigned primary responsibility for the error. The preflight nature of these factors is represented by Case 67-27 where the air unit commander assigned pilots to a mission even though their total flight time the past 30 days exceeded the 140-hour maximum limit, and by Case 67-1 where two noninstrument-rated pilots were assigned a night mission in heavy fog even though an IFR-rated pilot was available. A supervisory factor before takeoff was involved in a total of 13 (29.5 percent) accidents.

Materiel deficiencies that existed before takeoff are listed under the J heading in Figure 12. The function here is to identify the accident where a materiel factor was known to be present, but not necessarily known to the aviators, before the aircraft became airborne. These factors are distinguished from the materiel failures that may have occurred while inflight and are listed under the R heading in Figure 13. It should be observed that an entry in one of the J listings does not imply that the materiel deficiency necessarily affected or effected the accident. The only implication is that there was some difficulty associated with the listed materiel item. Typical materiel deficiencies existing before takeoff are represented by Case 67-16 where it was known before takeoff that the FM receiver had intermittent reception difficulties and that the AC altitude indicator had been removed for maintenance. (Information pertaining to the crews' knowledge of such deficiencies prior to takeoff is listed in the L2 and L3 entries under pilot preflight factors.)

The K, mission pressure, heading is included as a preflight factor in an attempt to weight the crews' concept of the importance, the uniqueness, or the urgency of the mission. Though such a stress factor could be properly listed under the psychological heading, a separate listing is provided to distinguish among various operational situations. The K1 entries denote urgent med-evac or search and rescue missions in which the life of an injured person or a downed aircrew is at stake. Urgent missions of other forms are listed in K2, being typified by Case 67-28 where troops were being flown to a base camp undergoing attack.

A special entry, K3, is made for the night gunship mission commonly identified as a Firefly flight. This relatively hazardous mission involves two or more gunships flying at low level and beneath another helicopter equipped with a bank of high-intensity searchlights used to detect enemy ground targets. Upon detection of a target by the lightship, the gunships begin a series of low-altitude firing runs. In general, these gunships do not use their own searchlights during these runs so that they are entirely dependent upon the lightship for area illumination. Since the target runs can take them into and out of the high-intensity light beam, degraded night vision of the gunship pilots is an inherent hazard of the mission. Reflections inside the lightship cockpit as well as the general high level of the outside illumination also decrease the night vision capability of the lightship crew. The problems of Firefly missions are typified by Cases 67-22 and 67-38. The former was an unusual accident in that the lightship pilot suffered vertigo, turned off his high-intensity lights, and was able to recover from his orientation difficulties. When confronted with the resulting total darkness, the gunship pilot, however, eventually flew his aircraft into the ground. The orientation-error hazard of these Firefly missions is well recognized in the field. In fact, many crews use the phrase "I've got it" to indicate that one pilot recognizes that he has vertigo and that the other pilot is to relieve him at the flight controls.

The K4 listing under mission pressure describes "first-of-a-kind" situations represented by the pilot in Case 67-21 who had never flown solo in the UH-1 before this accident. Pressure factors of other forms are listed in K5 and are represented by Case 67-13 where the student pilots had already downed one aircraft during a preflight and, since they were behind schedule, were not inclined to down a second aircraft because of a seemingly minor materiel deficiency. A second pressure factor of this form is typified by Case 67-33 where a general officer and his staff were aboard an aircraft. In this case, the crew made several attempts to takeoff in the dust, even though they should have immediately lightened their load by offloading some of the staff following the first takeoff failure. Taking into account all of the K factors, 18 (40.9 percent) accidents involved one or more of these mission pressure listings.

Section L deals with the crew preflight of the aircraft. The L1 entry denotes a hurried or rushed preflight situation, and, as noted previously, entries L2 and L3 indicate the pilots' knowledge of any materiel problems that existed prior to takeoff. The objective here is to establish different factor weights for the situation wherein this operational deficiency is not recognized until after the flight becomes airborne. The section M heading is reserved for miscellaneous factors, events, or conditions that may have been present at the time of or before takeoff.

Factors similar to those in Figures 11 and 12 are outlined in Figures 13 and 14 but apply to the inflight phase of the 44 accidents. The N physiological factor and O psychological factor headings pertain to either pilot in this section since the accident review indicated that, in general, the inflight occurrence of such factors affected both pilots. The predominant physiological incident detected to occur in flight, other than the basic orientation-error event, involved night flights where some form of degraded night vision was highly probable. As indicated by the N1 entry, 11 of the 26 night accidents involved this factor. The main criterion used in classifying this as a factor was that the crew had to be exposed to some form of high-intensity illumination, which was then turned off shortly after the initial exposure. The previously mentioned Firefly accident, Case 67-22, is one example. Other examples include Cases 67-16 and 67-44, where the landing lights were turned off following bright reflections off dust clouds; Cases 67-9 and 67-42, where the lights were turned off as a result of reflection off fog or haze; and Case 67-15, where the crew asked that the tower lights be turned off because they "blinded them." The only other inflight physiological factor listed in section N involved the fatigued pilot in Case 67-8 who stated he could not focus his eyes properly on the aircraft instruments or other aircraft in his formation.

Section O is a listing of psychological factors that were coded as occurring inflight. Reports of 4 accidents listed apprehension as being present; in two of these accidents, Cases 67-3 and 67-10, panic was the end state. This O3 heading is included only to further weight the state of apprehension denoted by O1. A point of consideration relative to the minimal number of listings contained under the inflight psychological factors is that all of the nonnormal incidents and events that occur inflight, whether they involve some materiel problem, some communication difficulty, or some change in visibility, can certainly affect the mental outlook of the crew. In this respect, the majority of the factors listed under all the other headings will have some psychological input.

The P facility factor heading denotes airfield shortcomings or limitations that affected the accident proper, or the course of action available to the pilot, while the flight was airborne. Though certain of these facility factors involved field sites rather than established heliports, it was the opinion of the accident board that it was reasonable to expect that the specific difficulty could have been prevented. The need for improved lighting was mentioned in 4 cases, improved dust control in 9 cases, and better ground-handling services in 2 accidents. It should be noted that certain accidents involving poor facilities at a combat site, e.g., Cases 67-26 and 67-28, were not included in this listing since the accident board did not consider it to be possible to establish optimal conditions at such sites. Another example is Case 67-32 that involved student pilots practicing night landings at a flare-pot illuminated field. Though this involves poor field lighting, it is deliberate training for the tactical situations to be encountered in operational flying; thus the accident was not classified as being facility related.

Personnel responsible for inflight-related supervisory errors are denoted under the Q heading. Case 67-3 is an example where conflicting orders were issued to the pilots by a ground commander. Supervisory factors involving formation leaders are illustrated in Cases 67-8 and 67-21. In Cases 67-16 and 67-44, the accident boards assigned supervisory

FIGURE 13

MAJOR ORIENTATION-ERROR ACCIDENTS
- REGULAR ARMY UH-1 AIRCRAFT -

FY67 FACTORS / EVENTS — INFLIGHT

CODE	Factor	TOTAL	ACCIDENT CASE NUMBER (cases marked X, of 1–60)
N	PHYSIOLOGICAL FACTOR - Either Pilot		
1	Degraded Night Vision	11	6, 9, 13, 15, 16, 22, 34, 38, 42, 43, 44
2	Other	1	8
O	PSYCHOLOGICAL FACTOR - Either Pilot		
1	Apprehension	4	3, 6, 10, 42
2	Irritation	0	
3	Reached Panic State	2	3, 10
4	Other	0	
P	FACILITY FACTOR		
1	Field Lighting	4	5, 8, 15, 19
2	Field Dust Control	9	16, 19, 23, 25, 27, 29, 35, 39, 41
3	Ground Handling Services	2	16, 42
4	Other	2	39, 44
Q	SUPERVISORY: Responsibility		
1	Aircraft Commander or 1st Pilot	0	
2	Flight/Formation Leader	3	8, 21, 40
3	Air Unit Commander	0	
4	Ground Unit Commander	1	3
5	Facility Commander	2	16, 44
6	Other Individual	0	
R	MATERIEL FACTOR		
1	Engine Malfunction/Failure	1	43
2	Flight Controls	0	
3	Flight Instruments	2	6, 16
4	Communication Gear	0	
5	Navigation/Landing/Search Lights	2	7, 13
6	Windshield Wipers	1	11
7	Other	0	
S	COMMUNICATION FACTOR: Nonmateriel		
1	Wrong Frequency Used/Assigned	2	21, 32
2	Voice Procedures	1	40
3	Language Difficulties	1	13
4	Other	2	13, 40
T	SPECIAL DISTRACTING EVENTS		
1	Nearby Combat Action	3	6, 17, 28
2	Danger of Mid-Air	1	5
3	Other	6	7, 13, 17, 22, 36, 39

Figure 13

Individual case history listing of selected accident factors and events considered to have occurred, or to be first manifested to the crew, while the aircraft was in flight.

CODE	FIGURE 14 MAJOR ORIENTATION-ERROR ACCIDENTS - REGULAR ARMY UH-1 AIRCRAFT -	TOTAL
	FY67 FACTORS / EVENTS — INFLIGHT — ACCIDENT CASE NUMBER	
I	VISIBILITY FACTORS/EVENTS	
1	Degraded Night Vision	13
2	Darkness: no visible horizon	18
3	Weather: clouds, fog, haze	15
4	Weather: rain, thunderstorms	6
5	Weather: other	1
6	Ground Dust 'Ashes	16
7	Poor Field Lighting	9
8	Landing Search Lights: reflections	7
9	Landing Search Lights: did not use	2
10	Cockpit Reflections	2
11	Water Glare Reflection	1
12	Firefly Lights Involved	2
13	Glaring Blinding Ground Lights	2
14	Windshield Chin Bubble Obscured: other than rain	1
15	Windshield Wipers: malfunction	1
16	Windshield Wipers: did not use	1
17	Other	0
V	MISCELLANEOUS FACTORS EVENTS	
1	Weather: poor visibility	16
2	Weather: turbulence gusty winds	4
3	Weather: other	0
4	Flight Over Water Involved	6
5	Down Wind Takeoff Involved	2
6	Go-Around Involved	2
7	Formation Difficulties	3
8	Navigation Difficulties	3
9	Prolonged Flight/Behind Schedule	2
10	Marginal Fuel	2
11	Inflight Engine Failure Occurred	1
12	Rotor Downwash Present: other aircraft	1
13	Given Improper Order	3
14	Disobeyed Specific Order	1
15	Inflight Turn: in progress	11
16	Inflight Turn: just completed	4
17	Hovering Turn: in progress	3
18	Aircraft Drift From Hover	15
19	Erratic Flight Motion Observed	3
20	Misleading Ground Lights Present	2
21	Misleading Visual Horizon Present	2
22	Misleading Visual Motion Cue Present	2
23	Misleading Body Motion Sensation Present	[illegible]
24	Inflight Crew Report of Vertigo Disorientation	6
25	Postflight Crew Report of Vertigo Disorientation	3
26	Accident Board Mention of Vertigo Disorientation	28

Figure 14

Continuation of the Figure 13 listing of in flight factors and events.

responsibility to the facility commanders considered responsible for the facility factor shortcomings outlined in section P. In total, the accident boards classified inflight supervisory error in 6 of the 44 accidents.

Section R deals with materiel malfunctions or difficulties that were encountered while the flight was airborne. Materiel malfunctions outlined previously in the before-takeoff phase under the J heading are not entered here unless an attempt was made to use the defective materiel item while inflight. An example is Case 67-6 where, before takeoff, rain had probably filled the pitot tube of the airspeed indicator. Since this materiel problem existed before flight, an entry is made in J3. In addition, an entry is made in R3 since the instrument malfunction, as observed by the pilots, occurred inflight. In contradistinction, for Case 67-20, where there were a considerable number of aircraft deficiencies present before takeoff, no entries are made under the inflight materiel factor heading since the related equipment items were not used during takeoff. As indicated by entry R1 for Case 67-44, only one of the 44 orientation-error accidents involved total engine failure and thus resulted in an emergency autorotation landing. Inflight materiel difficulties were listed as present in only 6 of the accidents.

Section S describes inflight communication factors that were nonmateriel related. A total of 4 accidents involved this factor. Section T deals with special distraction factors that the pilots encountered while airborne. Examples include Case 67-39 where a steam roller pulled across the approach path of the landing aircraft, and Case 67-22 where the air commander of the Firefly lightship turned off his lights due to vertigo and left the gunship crew in darkness. Nine accidents were classified as involving such distracting events.

Section U deals with the key initiating factor in orientation-error accidents--degraded pilot visibility. In 41 (93.2 percent) of the 44 accidents, some form of visibility factor was involved inflight. In 18 of the 26 night accidents, visibility was sufficiently low due to darkness proper, weather, or some other factor that a visual horizon for orientation reference was not available. In addition, 13 of the night accidents involved exposure to some form of light source that degraded the night vision capability of the aviators. Decreased visibility due to weather in the form of clouds, fog, haze, rain, or snow was present in 16 accidents; rain proper was a factor in 6 of these. Other visibility factors found to be present include sun reflection or glare off water, rotor-raised windshield spray produced while hovering over water, the previously mentioned Firefly lights, and windshield wiper malfunction or nonuse.

A variety of miscellaneous factors and events related to the accidents are listed in section V. A breakdown of weather relative to visibility and nonvisibility factors is given in V1 through V3. It should be noted that only 4 cases involved turbulence or gusty winds. Entries V4 through V14 are self-explanatory. The V15 through V18 entries are the start of a compilation of data pertaining to the motion of the aircraft immediately preceding the accident. In 11 of the cases, an inflight turn was in progress at the time of the accident. Four additional cases involved the very recent completion of an inflight turn. In the case of hovering aircraft, 3 accidents occurred during a hovering turn. Thus

18 (40.9 percent) of the accidents involved rotary or angular motions of the aircraft. In addition, 15 of the accidents involved the sideward or backward drift of the aircraft while hovering. When degraded visibility occurs during hover, the situation becomes extremely hazardous since the UH-1 helicopter, as with most RW aircraft in this size class, is not equipped with any form of instrument to indicate velocity in any direction except forward. Again the need for special helicopter-oriented flight instruments comes to the fore.

Entry V19, the observation of erratic flight motion, is included to provide additional background data on control or orientation difficulties while inflight. Entries V20 through V23 pertain to any misleading sensations or illusions reported in the accident files. In 7 of the accidents, one or more of the pilots reported experiencing body sensations of motion that were in conflict with the actual motion of the aircraft. The V24 entries indicate that in 6 of the accidents, the crews recognized, while inflight, that they were experiencing orientation error, manifested classically as vertigo or disorientation. The V25 entries indicate that three additional crews made post-flight comments to the effect that they experienced vertigo. As shown by V26, the accident investigation teams or reviewing authorities made specific mention of either pilot vertigo or pilot disorientation in 28 (63.6 percent) of the 44 orientation-error accidents.

As has been stated before, this longitudinal study is aimed at the compilation of accident factor data over a five-year period. Discussion or interpretation of these data beyond the above will await the assimilation of additional data for subsequent fiscal years.

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APPENDIX A

BASIC QUESTIONNAIRE USED BY ACCIDENT CLASSIFIER

File Number	ORIENTATION—ERROR ACCIDENT ANALYSIS	BASIC DATA	Project Investigators: W. Carroll Hixson and Jorma I. Niven	Sheet Number 1

USABAAR CODE	Year	Month	Day	Event	ACCIDENT	Major O	Minor O	Incid. O	AIRCRAFT TYPE:	DOLLAR DAMAGE:
OCCUPANT INJURY	Total Aboard	Total Minor	Total Major	Total Fatal	Total Missing	OFFBOARD PERSONNEL INJURIES				
ACCIDENT LOCATION	Viet Nam O	Europe O	USA O	Other: O	LOCAL TIME OF ACCIDENT:	O Day-time Accident	O Night-time Accident	O Poor Visibility Involved	O Bad Weather Involved	
TYPE MISSION	O Training:	O Service:	O Test:	O Combat:	O Other:					
TYPE ACCIDENT	O Collision - Aircraft:	O Collision - Terrain:	O Hard Landing:	O Other:						
FLIGHT PHASE	O In-flight:	O Takeoff:	O Landing:	O Autorotation:	O Hover:	O Other:				

O AIR COMMANDER (O-Pilot, O-Instructor, O-Student Pilot)				
AGE:	RANK:	DEGREE INJURY	None O / Minor O / Major O / Fatal O	
COCKPIT SEAT	Left O	Right O	Unknown O	Other O
THIS AVIATOR FLYING AIRCRAFT	Yes O	No O	Unknown O	
TYPE INST. RATING:	O None	No. Pre Accid.	No. Post Accid.	
FLYING EXPERIENCE	FIXED WING	ROTARY WING	THIS ACFT.	
FLYING HOURS -Total-				
INSTRUMENT HOURS -Total				
NIGHT HOURS -Total-				
FLYING HOURS -Last 30 days-				
INSTRUMENT HOURS -Last 30 days-				
NIGHT HOURS -Last 30 days-				
PILOT TIME -Last 24 hours-				

O PILOT (O-Copilot, O- Student Copilot)				
AGE:	RANK:	DEGREE INJURY	None O / Minor O / Major O / Fatal O	
COCKPIT SEAT	Left O	Right O	Unknown O	Other O
THIS AVIATOR FLYING AIRCRAFT	Yes O	No O	Unknown O	
TYPE INST. RATING:	O None	No. Pre Accid.	No. Post Accid.	
FLYING EXPERIENCE	FIXED WING	ROTARY WING	THIS ACFT.	
FLYING HOURS -Total-				
INSTRUMENT HOURS -Total-				
NIGHT HOURS -Total-				
FLYING HOURS -Last 30 days-				
INSTRUMENT HOURS -Last 30 days-				
NIGHT HOURS -Last 30 days-				
PILOT TIME -Last 24 hours-				

A	GENERAL CAUSE FACTORS (USABAAR CODED)	B	PERSONNEL ERROR FACTORS (USABAAR CODED)
1	Crew error:	1	Misuse of power plant controls:
2	Other personnel:	2	Misuse of flight controls on ground:
3	Training:	3	Misuse of flight controls in air:
4	Command supervision:	4	Exceeded stress limits:
5	Materiel failure:	5	Failure to compensate for wind:
6	Materiel malfunction:	6	Misjudged distance, altitude, position:
7	Maintenance:	7	Improper level off:
8	Chip detector light:	8	Failed to maintain flying speed:
9	Psychological:	9	Improper use/attention to fuel:
10	Physiological:	10	Failure to extend landing gear:
11	Personal equipment:	11	Retracted landing gear:
12	Design:	12	Failure to see aircraft/object:
13	Escape, egress, ejection:	13	Became lost:
14	Survival, rescue:	14	Improper instrument procedures:
15	Facilities:	15	Violation of air discipline:
16	Weather:	16	Inadequate flight preparation:
17	Other:	17	Exceeded ability/experience:
18		18	Improper use: misc. equipment:
19		19	Physical condition pilot:
20		20	Selected unsuitable terrain:
21		21	Failure to initiate go around:
22		22	Miscellaneous factors:
23		23	Failure to supervise flight:
24		24	Improper use - special equipment:
25		25	Crew factors:

File Number	FACTORS: SUPERVISORY, PRE-FLIGHT, AIRCRAFT MATERIEL, COMMUNICATIONS, FACILITY, AND MISSION	Sheet Number 2

C	SUPERVISORY FACTORS O Not present	**F**	COMMUNICATIONS FACTORS O Not present
1	Member of flight crew responsible	1	Communication gear - not installed
2	Flight/squadron leader responsible	2	Communication gear - inoperative
3	Air Unit commander responsible	3	Communication gear - operating difficulties
4	Airfield/heliport commander responsible	4	Communication gear - not used properly
5	Ground troop commander responsible	5	Communication gear - other
6	Other individual responsible:	6	Misinterpreted communications
7	Poor crew coordination	7	Disrupted communications
8	Poor formation coordination	8	Noisy communications
9	Ordered on flight beyond capability	9	Assigned wrong frequency
10	Assigned fatigued pilot to mission	10	Used wrong frequency
11	Inadequate briefing	11	Language barrier
12	Conflicting orders issued	12	Other:
13	Excessive mission priority assigned	13	
14	Misuse of aircraft	14	
15	Inadequate airfield services	15	
16	Inadequate unit maintenance services	**G**	FACILITY FACTORS O Not present
17	Inadequate unit safety program	1	Type - Combat site with minimal facilities
18	Inadequate unit training program	2	Type - Regular airfield with control tower
19	Other:	3	Type - Other:
D	PRE-FLIGHT FACTORS O Not present	4	Tower - Inadequate facilities/services
1	Faulty flight plan	5	Tower - Inadequate communications
2	Faulty pre-flight of aircraft	6	Tower - Erroneous data given to crew
3	Unknowingly accepted deficient aircraft	7	Inadequate field lighting
4	Knowingly accepted deficient aircraft	8	Inadequate ground handling services
5	Hurried departure	9	Inadequate parking area layout
6	Delayed departure	10	Inadequate dust control
7	Failed to obtain weather data	11	Fixed obstructions in aircraft area
8	Inadequate analysis of weather	12	Moving ground vehicles in aircraft area
9	Improper altimeter setting	13	Weather forecasting services - not available
10	Faulty preparation of personal equipment	14	Weather forecasting services - limited
11	Loss of night vision adaptation due to improper pre-flight lighting	15	Weather forecasting services - erroneous data
12	Other:	16	Other:
E	AIRCRAFT MATERIEL FACTORS O Not present	17	
1	Inflight power failure occurred	18	
2	Inflight equipment failure occurred	19	
3	Inflight instrument failure occurred	**H**	MISSION FACTORS O Not present
4	Problem: communication gear	1	Combat mission - completed before accident
5	Problem: navigation gear	2	Combat mission - not completed by this aircraft
6	Problem: power instruments	3	Urgent combat mission - med. evac.
7	Problem: control instruments	4	Urgent combat mission - other:
8	Problem: flight controls	5	Urgent noncombat mission:
9	Problem: aircraft lights	6	Aircraft not rated for assigned mission
10	Problem: windshield wipers	7	Pilot not rated for assigned mission
11	Problem: weapons system	8	Other:
12	Problem: other:		

File Number	FACTORS: ENVIRONMENTAL-LIMITED VISIBILITY, ENVIRONMENTAL-GENERAL, AND AIRCRAFT MOTION PARAMETERS			Sheet Number 3

J	ENVIRONMENTAL FACTORS - LIMITED VISIBILITY O Not Involved	K	ENVIRONMENTAL FACTORS - GENERAL O Not Involved
1	Ground dust - rotor, prop, jet blast produced (dustout)	1	Over hazardous terrain
2	Ground smoke - forest fires, artillery, smokescreen	2	Over hostile territory - no enemy action
3	Ground snow - rotor, prop, jet blast produced (whiteout)	3	Over hostile territory - impending enemy action
4	Weather - low ceiling	4	Over hostile territory - nearby enemy action
5	Weather - heavy overcast	5	Over hostile territory - engaged in combat
6	Weather - flying in clouds	6	Over water - ocean, lake, bay
7	Weather - rain	7	Over water - river, stream
8	Weather - thunderstorm	8	Over water - other
9	Weather - ground fog	9	Acceleration forces - inflight
10	Weather - haze	10	Aerobatics performed
11	Weather - snow	11	Gunnery/rocket run performed
12	Weather - sleet/hail	12	Vibration
13	Weather - other	13	Decompression
14	Windshield - dusty, icing	14	Cockpit interior - smoke
15	Windshield wipers - inoperative	15	Cockpit interior - dirt, dust
16	Windshield wipers - not used	16	Cockpit interior - excessive heat
17	Night flight - good visibility	17	Cockpit interior - excessive cold
18	Night flight - poor visibility	18	Windblast - from rotor
19	Night flight - inadequate field lights	19	Windblast - from prop
20	Landing light, searchlight reflection - off rain	20	Windblast - from jet
21	Landing light, searchlight reflection - off fog	21	Gusty winds
22	Landing light, searchlight reflection - off dust	22	Turbulence
23	Landing light, searchlight reflection - other	23	Other:
24	Windshield glare/reflection - from aircraft interior lights	24	
25	Windshield glare/reflection - from aircraft exterior lights	25	
26	Windshield glare/reflection - other	L	AIRCRAFT MOTION PARAMETERS O Unknown
27	Water glare/reflection	1	Give a brief narrative account of the aircraft motion parameters at the time of the accident:
28	Visibility obstruction - terrain		
29	Visibility obstruction - ground equipment/building		
30	Loss of night vision adaptation - preflight		
31	Loss of night vision adaptation - landing lights		
32	Loss of night vision adaptation - searchlights		
33	Loss of night vision adaptation - firefly lights		
34	Loss of night vision adaptation - other aircraft lights	2	Tail rotor damaged before skids impacted
35	Loss of night vision adaptation - ground lights	3	Main rotor damaged before skids impacted
36	Loss of night vision adaptation - flares	4	Attitude of aircraft at time of final impact. O -Unknown O -right skid low O -nose low O -left skid low
37	Loss of night vision adaptation - cockpit lighting		O -tail low O -level
38	Loss of night vision adaptation - other	5	Aircraft velocity at time of accident O -Unknown O -rightward
39	Visual illusion: related to ground lights		(_____ knots) O - forward O -backward O -leftward
40	Visual illusion: related to other aircraft lights	6	Aircraft performing turn at time of impact
41	Visual illusion: related to water	7	Aircraft completed turn before impact
42	Visual illusion: other		
43	Other:		

File Number	FACTORS: PSYCHOLOGICAL, PHYSIOLOGICAL, AND MISCELLANEOUS	Sheet Number 4

M	PSYCHOLOGICAL FACTORS O Not involved	N	PHYSIOLOGICAL FACTORS (Continued)
1	Hurry to get home	13	Hypnotic state
2	Visual illusions	14	Hypoxia
3	Orientation illusions	15	Hyperventilation
4	Boredom	16	Common cold
5	Inattention	17	Night vision adaptation, loss of
6	Channelized attention	18	Vision (eye sight, not visibility)
7	Distraction	19	Hearing
8	Preoccupation - personal problems	20	Carbon monoxide
9	Excessive motivation to succeed	21	Disorientation/vertigo
10	Overconfidence	22	Flicker vertigo
11	Lack of self confidence	23	Pressure vertigo
12	Lack of confidence in equipment	24	Physical condition
13	Lack of confidence in crew	25	Other
14	Lack of confidence in mission	26	
15	Apprehension	27	
16	Fear	P	MISCELLANEOUS FACTORS O Not involved
17	Panic	1	Fuel state - marginal
18	Crew dissension	2	Fuel state - near exhaustion
19	Impatience	3	Aircraft weight - marginal
20	Anger irritability	4	Aircraft weight - overloaded
21	Horseplay	5	Formation flight problem
22	Emotional state	6	Transfer of control occurred - orderly
23	"First of its kind" situation	7	Transfer of control occurred - confusion
24	Neurosis/psychosomatic	8	Both pilots on controls
25	Nearing discharge/transfer date	9	Navigation - pilot not sure of exact position
26	High ranking officer aboard	10	Navigation - pilot definitely lost
27	Indirect pressure - from fellow pilots	11	Navigation - pilot delayed asking for ground aid
28	Indirect pressure - from commanding officer, flight leader	12	Navigation - other
29	Other:	13	Misread instruments
30		14	Misinterpreted instrument reading
31		15	Misled by faulty instrument
32		16	Incorrectly adjusted altimeter
N	PHYSIOLOGICAL FACTORS O Not involved	17	Given erroneous altitude data
1	Food poisoning/indigestion	18	Weather accidents: Mission required flight into marginal Wx
2	Motion sickness	19	Weather accidents: Mission did not require flight into marginal Wx
3	Other sickness	20	Weather accidents: Crew inadvertently flew into marginal Wx
4	Disease/defect	21	Weather accidents: Crew willfully flew into marginal Wx
5	Hangover	22	Weather accidents: Crew did not properly check Wx in advance
6	Alcohol	23	Dust accidents: Crew aware of dust in area
7	Sleep deprivation	24	Dust accidents: Crew not aware of dust in area
8	Fatigue, other	25	Change in flight plan after takeoff
9	Missed meals	26	
10	Drugs, prescribed	27	
11	Drugs, other	28	
12	Unconsciousness	29	

File Number	NARRATIVE STATEMENTS	Sheet Number 5

Q 1. Quote directly all statements of pilots, crew members, witnesses, flight surgeon, etc., pertaining to the motion of the aircraft, disorientation, vertigo, visual illusions, visibility, etc.

File Number	OFFICIAL ACCIDENT FACTORS	Sheet Number 6

R 1. List all official accident factors determined to be present by the Accident Board including any reviewer comments.

File Number	ACCIDENT PREVENTION RECOMMENDATIONS	Sheet Number 7

S 1. List all recommendations made by the Accident Board, USABAAR, and any official review authority pertaining to the prevention of similar accidents.

File Number	REVIEWER COMMENTS	Sheet Number 8

T 1. Describe any unusual accident or background factors that may not have been listed or detailed elsewhere. Make any additional comments as desired.

Unclassified
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13. ABSTRACT

This report is one of a longitudinal series of reports dealing with the pilot disorientation/vertigo accident problem in Regular Army UH-1 helicopter operations. Individual case history data extracted from the USABAAR master aircraft accident files are presented on 44 UH-1 major orientation-error accidents that occurred during fiscal year 1967. Summary data listings involving a variety of operational and pilot-related accident factors are presented for each of the 44 cases. The listings are arranged to distinguish between those factors and events present before takeoff, i.e., the initial conditions associated with a given accident, and those that occurred or were manifested during the actual airborne phase of the accident flight.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Army aviation						
Aviation medicine						
Aviation safety						
Aircraft accidents						
Pilot disorientation						
Vertigo						
Accident factors						
Helicopters						