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Evaluation of the US Army Fitting Program for the Integrated Helmet Unit of the Integrated Helmet and Display Sighting System

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The fitting program for the Integrated Helmet Unit for the AH-64 developed at the U.S. Army Aeromedical Research Laboratory is documented. Recommendations for the design of training and field unit fitting programs are outlined.

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Preface

The following report is the product of the efforts of many individuals, both US Army Aeromedical Research Laboratory (USAARL) personnel and outside contractors. Special recognition is extended to then SGT Mike Noehl, assigned to USAARL from June 1984 to July 1986. Recently graduated from Officer's Candidate School, 2LT Noehl currently is assigned to the US Army Field Artillery School at Fort Sill, Oklahoma. 2LT Noehl was instrumental in handling the large volume of details involved in the establishing of the fitting program.

CW4 Joseph Licina, US Army, retired, currently is employed by Essex Corporation, Fort Rucker, Alabama.

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Introduction

In June 1985, the US Army began fielding a new aircraft known as the Advanced Attack Helicopter, the AH-64. Integral to this new aircraft is a monocular helmet-mounted display system, the Integrated Helmet and Display Sighting System (IHADSS). Along with various electronic components, the IHADSS includes a helmet referred to as the Integrated Helmet Unit (IHU), see Figure 1. The purpose of the IHU is twofold. First, and primary, is its role in providing the aviator with basic impact and noise protection. In addition, it serves as a platform for the display system, composed of a miniature, 1-inch diameter, cathode ray tube (CRT) and an optical relay device, the Helmet Display Unit (HDU). The role of the HDU in the IHADSS is presented graphically in Figure 2. The electronic image of the external scene, formed by a forward looking infrared (FLIR) sensor, is converted into a light image on the face of the CRT. This image is relayed optically through the HDU and reflected off a beamsplitter, also known as a combiner, into the pilot's eye.

Figure 1. The basic IHADSS integrated helmet unit (IHU).

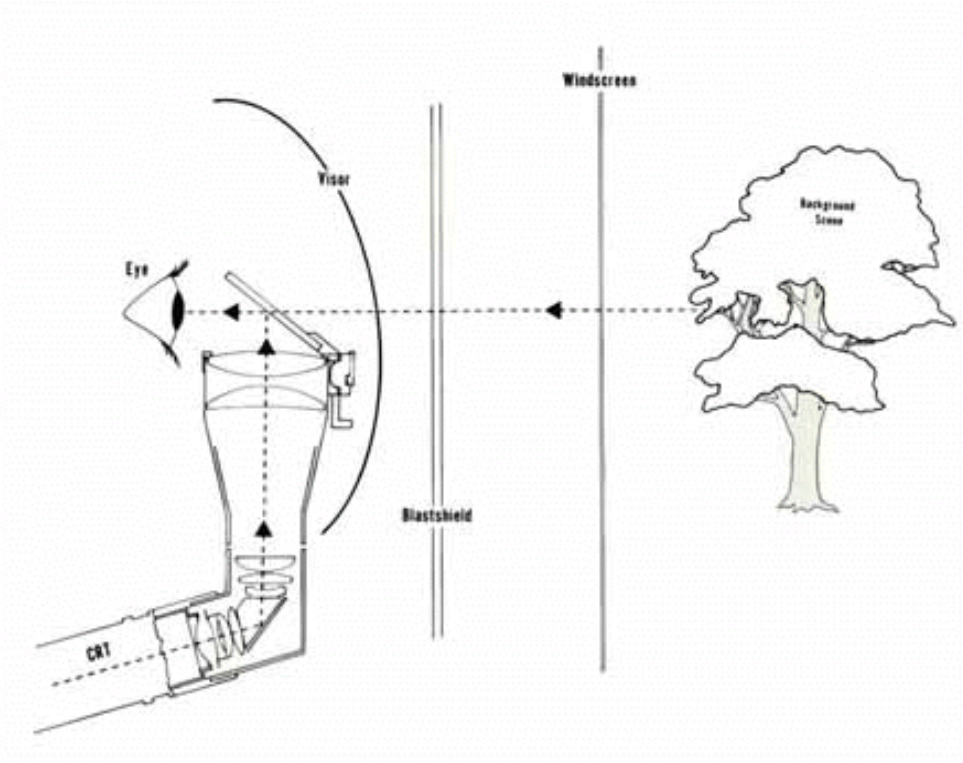

Figure 2. The role of the HDU in the IHADSS.

Therefore, it is through the HDU that the pilot receives his primary sensory data to fly the aircraft. Infrared detectors, mounted in the IHU, allow the FLIR sensor to be slaved to the pilot's head movements. Aircraft parameter symbology, along with the video from the FLIR sensor, is presented to the pilot by means of the HDU. In addition, target acquisition and weapons information also can be displayed. The display system is designed so that the image of the 30 degree vertical by 40 degree horizontal field-of-view of the FLIR sensor subtends a 30- by 40-degree field at the pilot's eye. Aviator performance and safety are dependent highly on the transfer of the sensor information to the eye. Important parameters include the quality and amount of the presented imagery.

The IHADSS helmet represents a tremendous transition in helmet sophistication. The IHU in the IHADSS plays the crucial role of linking the pilot and the aircraft. With the advent of the IHADSS helmet, Army aviation has moved from an era of the "slap-on, cinch-up" helmet to one where the helmet is a tuned piece of equipment, requiring special considerations and care. One of these special considerations is the fitting process. A process which is more demanding on time, equipment, and expertise, than required previously with Army helmets.

The basic fitting process involves numerous steps including, but not limited to, adjustments to the suspension system, proper location and alignment of the HDU, and final trimming of the helmet visor to accommodate the HDU when in the operating position. The objectives of the fitting procedure are to: a) obtain a comfortable, stable fit of the IHU, which will enable the aviator to

achieve the maximum field-of-view provided by the HDU when it is mounted on the helmet and b) achieve boresight, which permits accurate engagement of weapons systems (Honeywell, 1985).

This report documents the fitting program established at USAARL, its successes and deficiencies, and presents recommendations for designing a fitting program which, in the opinion of this laboratory, will ensure that the man-machine interface, as provided by the helmet, is optimized.

Background

USAARL has been involved in the development of the IHADSS since the early 1970s. Personnel from the Life Support Equipment Branch at USAARL contributed their expertise to the early development of the IHADSS helmet and represented the US Army's fitting capability for this helmet.

From 1980 to 1982, the IHADSS helmet underwent a major redesign to correct for a failure in the impact protection provided by the earlier helmet design and to accommodate a new communication system. In May 1982, when prototype units of the redesigned helmet were provided to this laboratory, USAARL began a long-term testing program for the IHADSS helmet. Under this program, multiple design configurations of the helmet have been evaluated for medical and safety considerations (Rash et al., 1982, 1984, and 1987). In 1983, verbal complaints concerning the comfort of the IHADSS helmets began to be heard from aviators at Mesa, Arizona. US Army and Hughes Helicopter, Inc. acceptance pilots were complaining of "severe hot spots" and headaches and of having to refit their helmets after each flight. Independently, reports began to surface concerning certain aviators who were extremely difficult to fit into the available helmet sizes. However, a joint engineering assessment conducted by the contractor and USAARL revealed that the helmets being produced met the required specifications.

Further investigation led to the theory that the anthropometric data specifified by the Army, and cited in TR 72-52-CE, Anthropometry of U.S. Army Aviators 1970, was no longer representative of the current aviator population. This was confirmed in November 1984, when USAARL conducted a limited head anthropometry survey on 500 pilot subjects at Fort Rucker. The results, depicted in Table I, showed significant differences between the data measured for the current population survey and those cited in the 1970 study. It was found that male 99th percentile values from the 1970 study correlated withthe male 95th percentile values from the more current study. The situation was complicated further in that a given aviator may exceed the 95th percentile value in one or more dimensions. This means that the available sizes of the IHADSS helmet, manufactured to the specified 1970 study, would not accommodate a significant percentage of the current aviator population. Also, the development of an under-the-helmet chemical protective mask, the M-43 (Figure 3), further reduced the number of aviators who could, when wearing the chemical mask, be fit with the available IHADSS helmet sizes (Gower, 1986). In 1985, an agreement was reached, by consensus of the Army and the contractors, that an extra-large helmet was required.

Following the early complaints about size and fit problems, and while conducting the 1984 head anthropometry study already described, USAARL investigators became more actively involved in fitting the IHADSS helmet. This provided USAARL with a better understanding of the helmet and its complexities and allowed USAARL personnel to increase their abilities to interact with the contractor in the continuing development of the helmet.

Table 1
Comparative data from 1970 and 1984 male head anthropometry studies

		Percentiles								
		1	5	10	25	50	75	90	95	99
Head Length	1970	18.0	18.6	18.8	19.3	19.1	20.2	20.6	20.8	21.1
	1984	18.3	18.9	19.2	19.6	20.1	20.5	20.9	21.3	21.9
Head Width	1970	14.1	14.4	14.6	14.9	15.3	15.6	16.0	16.2	16.6
	1984	14.0	14.6	14.8	15.1	15.5	16.0	16.4	16.6	17.1
Circumference	1970	52.6	53.8	54.4	55.3	56.3	57.4	58.3	58.9	60.0
	1984	53.9	55.0	55.5	56.4	57.4	58.5	59.5	59.9	61.0
Bitrag-Cornal Arc	1970	32.8	33.5	34.0	34.7	35.5	36.3	37.0	37.5	38.6
	1984	32.3	33.2	33.5	34.5	35.5	36.5	38.0	38.3	39.4

Note: All measurements are in centimeters.

Figure 3. The M-43 chemical protective mask.

Several important lessons were learned during this period. For the first time, the impact that head anthropometry has on helmet fit was recognized. Not only were there problems associated with one or more extreme head dimensions, but there were additional problems related to head abnormalities, e.g., one ear lower than the other, tapering forehead, bulges, etc. All of these variations increased the detailed attention required to provide the pilot with a comfortable and stable helmet fit. The requirement to provide a stable fit is essential due to the interfacing between the head and the helmet mounted display system. The helmet must be fit in such a way that the pilot's eye is centered in the exit pupil of the display. The helmet must remain stable, maintaining the exit pupil position in the presence of head movements and aircraft vibration.

The facial anatomy of the pilot also was discovered to be crucial to the ability to provide a proper fit and HDU interface. If the pilot's eye is not located in the exit pupil plane, but is at some distance behind it, a "knothole effect" is experienced. The field-of-view provided to the pilot is decreased, in the same manner as that experienced when a person looking through a knothole begins to move away from the knothole. The presence of a protruding cheekbone can prevent the HDU from being positioned close enough to obtain the full field-of-view. Even a very small displacement can reduce substantially the available field-of-view.

Because of their experience with the IHADSS helmet, their developed expertise in the area of fitting, and their location at Fort Rucker, early in 1985, USAARL personnel volunteered to establish and maintain the Army's initial IHADSS fitting program. The goals of the program were to provide

an adequate fit for the aviator, to evaluate the US Army's requirements for fitting the IHADSS helmet (e.g., training, personnel, equipment, etc.), to assist in ensuring that the initial phase of the fielding of the AH-64 be as problem free as possible, and to use the fitting program to continue to build a database on the IHADSS helmet.

Overview of fitting program

The establishment of the fitting program required identification of personnel, allocation of physical facilities, the training of personnel, procurement of fitting equipment, and coordination between USAARL and other Apache program elements. The task of directing the program was assigned to the Life Support Equipment/Crew Injury Epidemiology Branch of the Biodynamics Division.

Initially, seven individuals were selected to be the Army's core of IHADSS "fitter-instructors." Two of these individuals were from the US Army Aviation and Logistics School at Fort Eustis, Virginia. Following training, they returned to Fort Eustis to teach the Aviation Life Support Equipment (ALSE) course. The other five individuals consisted of Fort Rucker personnel, two from USAARL, two from the US Army Aeromedical Center (Lyster Army Hospital), and one from the ALSE Branch at Hanchey Army Airfield.

Formal training of the above personnel was conducted at USAARL by Honeywell engineers. This training consisted of a 3-day course of instruction. On the first day, the morning was spent in a formal presentation and the afternoon in a staged fitting demonstration by the Honeywell engineers. The subjects covered in the lecture and demonstration included helmet and HDU overview, system nomenclature, helmet maintenance p~ocedures, helmet fitting techniques, and IHU/HDU alignment verification. The second day was spent in a hands-on fitting session, with rated aviators serving as subjects for the fitter-trainees. The third day was spent practicing the procedure of alignment verification.

With only five qualified fitters, it quickly became necessary to attempt to locate and train additional personnel. Flight line ALSE and hospital personnel were requested to assist in the fitting program. Due to low priority of the IHADSS program, as viewed by organizations outside of USAARL, these personnel were unavailable for pretraining and, basically, only received on-the-job training. Personnel who served as trainees in a morning fitting session were often pressed into service to perform actual fittings the same afternoon. This was often necessary because the number of aviators requiring fittings outnumbered available fitters, and aviators' schedules failed to allow for sufficient time for fitting.

The same perception of low priority, which prevented proper training of new fitters, also resulted in the inability to use these individuals when needed. Consequently, every fitting session resulted in an insufficient number of qualified fitters and new, untrained personnel being provided by outside organizations, despite several attempts by USAARL to explain the necessity of retaining trained personnel. Currently, only one of the originally Honeywell-trained individuals still is available and will be leaving in the summer of 1987.

One laboratory area within the Life Support Branch was selected for use as the fitting facility. It was the largest available space, but still was inadequate for the often large number of aviators requiring fittings. The space also did not allow any degree of isolation of the aviators. This resulted in considerable nonproductive communication between aviators, which proved to be a severe detriment to an efficient fitting.

Two kits were developed to provide the equipment necessary to perform the helmet fitting process, the IHADSS IHU/HDU alignment verification kit and the IHADSS fitting kit. These kits were procured from Honeywell, Inc. by the Advanced Attack Helocopter Program Manager's Office, St. Louis, Missouri. A list of contents for each kit is provided in Appendix A.

The IHADSS fitting kit was designed to provide all of the necessary tools and supplies to perform the selection of proper helmet size, the required adjustments to the suspension system, the proper positioning of the HDU, and the final trimming of the helmet visor. At the request of the US Army, the only item in the fitting kit that was not identified as government-furnished equipment (GFE) was an HDU simulator, also referred to as a "dummy" HDU.

The IHU/HDU alignment verification kit contained the optical components necessary to validate the boresight capability. The objectives of the kit components were to allow the identification of helmet misalignment due to helmet shell distortion, improperly positioned helmet electronics, or damaged HDU receiver assembly, and HDU optical axis misalignment due to a bent combiner or internal damage to the HDU lens assembly. All components were contractor supplied.

The scheduling of a fitting session required coordination between numerous organizations. Before the AH-64 candidates, assigned to "D" Company, 7th Aviation Battalion, arrived at USAARL for fitting, their head dimensions were measured by ALSE personnel from Hanchey Army Airfield and the required size helmet was issued by Central Issue Facility (CIF) at Fort Rucker. The established procedure was for the helmets to be inspected for defects by USAARL personnel at least 1 day prior to the scheduled fitting session.

Fitting sessions were scheduled approximately once every 2 weeks. Two sessions, one in the morning and one in the afternoon, normally were required to accommodate a class size of 16-20 aviators. The time required for a complete fitting by an experienced fitter typically was 2-3 hours. The fitting process was divided into eight general segments: documentation, measurement and size verification, education, contouring of helmet suspension assembly and earcups to the aviator, helmet reassembly, HDU optical alignment and measurement of field-of-view, alignment verification, and visor trimming (Figures 4a-h). The result of a completely fitted aviator is shown in Figure 5.

Since its conception in May 1985, the USAARL fitting program has fitted approximately 400 aviators. During this period, much has been learned concerning the fitting of a helmet designed to function both as a helmet mounted display platform and a protective device.

Evolution of the fitting program

When the fitting program was first conceived, there was general agreement among its developers that the program would be an evolutionary one. Indeed, as the fitting program progressed, the need for various modifications and improvements became apparent. Attempts were made to continuously refine and improve upon the many aspects of the program in order to make the fitting process more efficient and reliable. In addition to changes implemented during the course of the program, there were other identified improvements which could not be accomplished due to constraints on personnel, physical facilities, equipment, etc.

The most important element of the fitting program is the fitter. As with most tasks, the fitting of the IHADSS helmet requires some minimum skill levels on the part of the individual performing the task. Because of the sophistication of the IHADSS helmet, the characteristics of a "qualified" fitter preclude the

Figure 4a. Fitting process: Documentation.

Figure 4b. Fitting process: Measurement and size verification

Figure 4c. Fitting process: Education.

Army's current philosophy of listing the fitting task as "other duties as assigned." It has become apparent that in order to successfully accomplish the fitting task, the designated fitter must possess reasonable technical and mechanical capabilities. These are required to perform the necessary adjustments and modifications to the helmet. Very important, a third capability is one of communication skills. Interaction between the fitter and the aviator during the fitting process is imperative to obtain a stable, comfortable, and reliable fit.

In addition, the fitter must perceive this responsibility as critically important to the performance of the aviator in the AH-64 aircraft. He must be well trained in the various segments of the fitting process and must possess an understanding of the operation of the IHADSS helmet and its role in the aircraft. The fitter must be afforded the opportunity to practice and use these acquired skills routinely in order to maintain an acceptable level of efficiency. .

The major personnel problems existing in the current fitting program are the inability to retain qualified fitters, the lack of followup training to maintain competency, and the failure of the chain-of-command of external organizations to recognize the importance of the fitting task.

The procurement of the IHADSS fitting and alignment verification kits benefited the fitting process by making available to the fitter the required tools and equipment. The kits provided were found to be adequate except in one respect.

Figure 4d. Fitting process: Contouring of suspension assembly and earcups to aviator.

Figure 4e. Fitting process: Helmet reassembly.

When designing the fitting kit, the decision was made by the Army, based on cost, to use a simulated or "dummy" HDU, instead of a production HDU and simulated CRT flashlight. This turned out to be a mistake. The "dummy" HDU differed in size and did not provide the see-through function of the real HDU. The use of the "dummy" HDU was inadequate in positioning and aligning the HDU to the degree necessary to ensure the aviator's ability to obtain maximum field-of-view when in the aircraft. It was determined that the steps performed using the "dummy" HDU contributed significantly to the time required for the original fitting, but had to be repeated once the pilot was confronted in the aircraft with the real HDU.

Only two fitting kits were available for use in the USAARL fitting program. A typical fitting session often involved four to six fitters. Since each fitter was attempting to perform the same task simultaneously, there were significant delays due to the limited number of tools available in only two kits. This was overcome to some degree by the procurement of the basic tools, i.e., screwdrivers, Allen wrenches, scissors, etc., by the individual fitters. This supplementing of equipment and tools could not be accomplished in the areas of HDUs and the verification kit components. For the fitting steps requiring these items, the fitting session changes in nature from parallel to serial, greatly increasing the fitting period. The availability of one fitting kit per fitter would contribute to a more efficient fitting session. For cost considerations, this may not be practical With the verification kits. However, staggering the individual fittings within a fitting session would reduce the impact of a limited number of verification kits.

Figure 4f. Fitting process: HDU optical alignment and measurement of field-of-view.

Figure 4g. Fitting process: HDU optical alignment and measurement of field-of-view.

As mentioned previously, it was learned that anthropometry significantly impacted the ability to provide an optimum fit to the aviator. These factors coupled with the use of the "dummy" HDU precluded any comparison to the actual field-of-view the aviator would achieve in the aircraft. The limited physical eye relief distance available when using the HDU raised the question as to whether or not aviators were capable of achieving the designed 30- by 40-degree field-of-view. Because of this question, it was deemed necessary to include a measurement of field-of-view into the fitting process. This would allow the fitter to provide a more accurate fit, minimizing the adjustments required in the actual aircraft.

Currently, field-of-view measurements are accomplished using a single prototype HDU with an illuminated ringed target projected through the HDU optics using a flashlight source. Maximizing the field-of-view is an iterative process often requiring several adjustments to the helmet fit. Verifying the field-of-view using a real HDU makes more efficient use of an individual fitter's time and reduces problems in the field. It is believed firmly that the "dummy" HDUs in the fitting kits should be replaced with production HDUs. It is suggested other than "first quality" items may be used for this purpose. Also, further it is suggested that replacing the ringed projection target with simulated IHADSS video imagery would allow the aviator to acquire a better appreciation for the value of the field-of-view adjustment during the fitting process.

Figure 4h. Fitting process: Visor trimming.

An additional segment of the fitting process which could be improved involves the customizing of the visors. This procedure requires the visor be notched by cutting a segment away from the lower right portion to allow the visor to be deployed with the HDU in position. There is no standard pattern provided as guidance to the fitter when performing this step. The result is a wide variation in the configuration of the visor trim. Often the trimming provided is so customized for the HDU being used for the fitting, that incompatibilties may arise when other HDUs are encountered. At this point, no resolution to this problem has been suggested.

Currently, aviators are fitted with their IHADSS helmet during the first day of the Program of Instruction (POI).

Consequently, at the time of the fitting, they have little or no knowledge of the function and purpose of the helmet system. Therefore, during the fitting session, in order to obtain a proper fit, it becomes necessary that the complexities and interactions of the various helmet components be explained. This additional requirement placed upon the fitter significantly increases the duration of the fitting session. One possible solution may be to have aviators attend a short orientation class prior to the helmet fitting session. In this class the objectives would be to: a) familiarize the aviator with the basic components of the helmet, b) explain the function of the helmet in the AH-64 system and c) describe the relationship of a proper fit to helmet performance. Other solutions that would remove the educational responsibility from the fitter would be equally acceptable.

Figure 5. The result of a completely fitted aviator.

The problem of education is not limited to the aviator. USAARL currently has no formalized training program for the fitters pressed into service here at Fort Rucker. The Army's formal training of IHADSS fitters is provided by the Aviation Life Support Equipment (ALSE) course taught at Fort Eustis, Virginia. A 6-hour block is allocated for the course. It consists of a 2-hour formal presentation discussing the parts and function of the IHADSS helmet and the relationship of the helmet to the AH-64 aircraft. Following a short film describing the fitting process, students particpate in disassembly and assembly of a helmet. The balance of the training is a hands-on fitting session of fellow students.

At best, the education of the ALSE school student for the fitting of the IHADSS helmet is purely introductory in nature. Only one fitting is performed, and this does not include an actual trimmimg of a custom visor or a real alignment verification. However, some practice trimming is performed on SPH-4 visors, and an introduction to the alignment verification is performed on a headform. No printed documentation is provided to the student for reference later in the field. While a general understanding of the mechanics of the IHADSS helmet is provided by the course, the ALSE specialist is not experienced enough to handle the actual details and problems associated with an actual fitting.

To compound these mentioned shortcomings, the 68J Apache Armament Specialist is the designated IHADSS fitter for the Army. These soldiers have a large volume of other duties to accomplish that take precedence over serving as an ALSE specialist for the IHADSS. Furthermore, the school-trained ALSE specialist seldom will be assigned where he can use his fitting training. The very perishable skills of helmet fitting soon could be lost and not easily retrieved. In light of the experience at USAARL, this situation will have serious consequences in the later years of the Apache program.

Other identified areas of possible improvement which have not been implemented address the physical facility used for the fitting session and the amount of time allocated by the Aviation Training Battalion for accomplishment of the fitting task. The available space used for the USAARL fitting program was limited and resulted in all participants having to work in close proximity. This resulted in excessive extraneous communication which frequently distracted from the accomplishment of an efficient and timely fitting. While it is not practical to require individual fitting rooms, it would be advantageous to maximize the isolation of the participants in order to decrease group interaction.

The current training syllabus for the AH-64 program fails to allocate sufficient time for the fitting process. This coupled with the aviator's lack of education as to the importance of the helmet fit often results in the fitting session being an uphill battle.

User evaluation of the fitting program

The success of any program depends on its ability to reach its goals. From the user's viewpoint, the primary goal of the IHADSS fitting program is to provide the AH-64 aviator with an acceptable fit with respect to comfort, stability, and performance.

The evaluation of the IHADSS fitting program was begun in May 1986 when 57 aviators, assigned to the AH-64 training program at Fort Rucker, Alabama, responded to a questionnaire designed to evaluate the fit and performance of the IHADSS helmet. A copy of this questionnaire is provided in Appendix B. In March 1987, a redesigned version of this questionnaire (Appendix C) was distributed to AH-64 aviators, instructor pilots, and student pilots at Fort Rucker and at Fort Hood, Texas. The goal of the redesigned questionnaire was to place greater emphasis on obtaining user feedback as to the quality of the helmet fit and the fitting process. From the fielded AH-64 units at Fort Hood, Texas, 50 aviators responded with completed questionnaires. These aviators represent the most recent transition graduates from the Fort Rucker training program over the past 12 to 18 months. A total of 83 questionnaires were received from training units at Fort Rucker, Alabama.

In addition, a brief data collection form was designed to track the type and quantity of adjustments and refits being required by aviators through the contractor's technical representative at Hanchey Army Airfield, Fort Rucker, Alabama. This provided data on the reliability of the original fit, as well as on the long-term performance of the helmet. A copy of this form is provided in Appendix D. Nineteen forms were returned to USAARL by the contractor's technical representative.

To define the pilot population being surveyed, the questionnaires requested certain demographic data, (e.g., age, current duty and aircraft assignment, helmet size, and corrective lens requirement). A synopsis of this data is provided in Table 2.

In both Fort Rucker surveys, the predominant age group was that of the 29-38 year olds (73.7 percent in 1986 and 62.7 percent in 1987). It may be noted that from the 1986 to the 1987 Fort Rucker surveys, the population of the youngest age group changed to 14.5 percent from 5.3 percent. This increase may have resulted from the decision to allow recently graduated rotary-wing aviators to transition directly into the AH-64 program.

The majority of the subjects at Fort Hood were also in this youngest age bracket. The greater availability of instructor pilots at Fort Rucker is reflected in the duty assignments of the subject population. Instructor pilots composed 78.2 percent of the population in the 1986 survey and 71.1 percent in the 1987 Fort Rucker survey. The greater percentage of the Fort Hood subjects were rated AH-64 aviators assigned to field companies.

The breakdown of helmet sizes was about the same at both Fort Rucker and Fort Hood, a 3:1 ratio of large to medium. No helmet size data were collected in the 1986 survey. The distribution of subjects requiring corrective eyewear also was stable across the surveys, an average of 15 percent.

Table 2

Demographic data for subject population

	1986 Fort Rucker (57 subjects) Number cases	Percent	1987 Fort Rucker (83 subjects) Number cases	Percent	1987 Fort Hood (50 subjects) Number cases	Percent
Subject age:						
19-28 years	3	5.3	12	14.5	24	48.0
29-38 years	42	73.7	52	62.7	19	38.0
39-48 years	12	21.0	19	22.9	7	14.0
Duty assignment:						
Instructor pilot	43	78.2	59	71.1	10	20.0
Student pilot	11	20.0	22	26.5	0	0.0
AH-64 pilot	1	1.8	2	2.7	40	80.0
Current aircraft:						
Surrogate	23	41.1	17	20.5	0	0.0
AH-64	33	58.9	66	79.5	49	98.0
Other	--	--	0	0.0	1	2.0
Subject IHADSS helmet size:						
Medium	--	--	20	24.1	14	28.0
Large	--	--	63	75.9	36	72.0
Subjects wearing corrective lenses:						
Yes	8	14.0	12	14.5	8	16.0
No	49	86.0	71	85.5	42	84.0

The subjects' assessment of their original helmet fitting is presented in Table 3. Subjects were requested to indicate where they received their original fit, to rate the fitter's knowledge, techniques, and ability, to indicate whether or not subsequent adjustments to the helmet were required, and to rate the overall quality of their original fit.

Of the 50 subjects at Fort Hood, 88 percent originally were fit under the USAARL fitting program. The remainder were split equally between the contractor's technical representative and flightline ALSE personnel. For the 1987 Fort Rucker survey, 36.1 percent of the subjects were fitted under the USAARL fitting program, an equal percentage were fitted by the contractor's technical representative, and 24.1 percent were fitted by flightline ALSE personnel.

Table 3

Original fit assessment

	1986 Fort Rucker (57 subjects)		1987 Fort Rucker (83 subjects)		1987 Fort Hood (50 subjects)	
	Number cases	Percent	Number cases	Percent	Number cases	Percent
Original fitting:						
USAARL	--	--	30	36.1	44	88.0
ALSE	--	--	20	24.1	3	6.0
Honeywell	--	--	30	36.1	3	6.0
Other	--	--	33	3.6	0	0.0
Did fitter explain helmet complexities?						
Yes	–	--	65	78.3	34	68.0
No	--	--	18	21.7	16	32.0
Did fitter explain combiner function?						
Yes	--	--	66	79.5	44	88.0
No	--	--	17	20.5	6	12.0
Has helmet required subsequent adjustments?						
Yes	46	80.7	68	81.9	44	88.0
No	11	19.3	15	19.1	6	12.0
Was the custom trimming of the visor adequate?						
Yes	43	78.2	73	88.0	34	68.0
No	12	21.8	10	12.0	16	32.0
Mean estimate of quality of originial fit (Scale 1-9):		--		6.8		4.7
Mean estimate of fitter's knowledge and ability (Scale 1-9):		--		6.8		5.5

This spread in the distribution most likely is because many of the instructor pilots received their original fit from the contractor prior to the initiation of the USAARL program. In addition, flightline ALSE personnel at Fort Rucker have taken a more active role in the fitting of the IHADSS helmet. Comparative data from the Fort Rucker 1986 survey were not available.

For the 1987 Fort Rucker survey, approximately 79 percent of the subjects felt that the complexities of the helmet and combiner function were explained adequately by their fitter. For the Fort Hood survey, the subjects felt that an explanation of the helmet's complexities was provided only 68 percent of the time. However, the role of the combiner was described by the fitter 88 percent of the time, the operation of the combiner being a necessary part of the fitting process. No data on these questions were available from the 1986 survey.

It was determined once a subject was fitted, subsequent adjustments to the helmet were needed. While no breakdown was available between minor adjustments and major refits, comments provided by the subjects indicated a majority of the adjustment sessions were due to discomfort and inability to obtain an adequate field-of-view present immediately after their original fitting and not due to the minor settling of the helmet system. In the 1986 survey, 80.7 percent of the subjects indicated the need for adjustments or refits to the original fit. An almost equal percentage (81.9 percent) for the 1987 Fort Rucker survey required adjustments or refits. For the Fort Hood survey, 88 percent of the subjects indicated that fitting adjustments were needed. Of the Fort Hood subjects requiring adjustments or refits, 25 percent indicated two or more adjustment sessions, and over a one-third of the Fort Hood subjects indicated that they performed self adjustments. Of the subjects indicating adjustment or refits in the 1987 Fort Rucker survey, 33 percent required two or more adjustment sessions and approximately 42 percent performed self adjustments.

In the Fort Hood survey, 32 percent of the subjects indicated the original trimming of their visors was not adequate and required retrimming. This problem was reported by 21.8 percent of the 1986 Fort Rucker survey subjects and by 12 percent of the 1987 Fort Rucker subjects.

When requested to rate the overall quality of their original helmet fit and the knowledge and ability of their fitters, the Fort Hood subjects gave their original fit an average rating of 4.7 and the fitters' ability an average rating of 5.5, based on a scale of 1 to 9 (1-unsatisfactory, 5-adequate, and 9-excellent). Subjects in the 1987 Fort Rucker survey gave an average rating of 6.8 for both their original fit and fitters' ability.

Additional data were collected to determine the quality of the current fit of the subjects' helmets. Questions were asked addressing overall comfort, chinstrap and earcup positioning, thermal comfort, noise attenuation, helmet stability, and rating of current fit. Of the subjects in the 1986 Fort Rucker survey, 77.3 percent found their current helmet to be "comfortable, or "very comfortable. However, 5.3 percent found the helmet to be "very uncomfortable. In the 1987 Fort Rucker survey, an almost equal percentage (78.3 percent) rated the helmet as "comfortable" or better and 6 percent rated it as "very uncomfortable." But, the Fort Hood data showed a reduction in "comfortable" or better rating (62 percent), with 38 percent of the subjects considering their current fit to be "uncomfortable" or worse. Subjects' comments indicated most of the complaints of discomfort were

due to pressure points. Thermal discomfort did not appear to be a problem in any of the surveys. While in the 1986 Fort Rucker survey, 21.2 percent indicated a thermal comfort problem, only 10.8 percent of the subjects in the 1987 Fort Rucker survey and 8 percent in the 1987 Fort Hood survey cited such problems.

Another area in which comfort was an issue was the earcups. While the comfort of the earcups improved in the 1987 survey from the 1986 survey, a large segment of the subject population reported earcup discomfort. In the 1987 Fort Rucker survey, 26.5 percent reported an uncomfortable fit; 46 percent reported problems from the 1986 Fort Hood survey.

Chinstrap comfort had been a early problem with the IHADSS helmet. In the 1986 survey, 45.5 percent of the subjects cited the chinstrap as a source of discomfort. During the production item testing on the IHADSS helmet, the placement of the chinstrap was recognized as a problem. At USAARL's request, a chinstrap modification was implemented by the contractor. This modification is believed to be reflected in the decrease in the percentage (38 percent) still reporting chinstrap comfort problems in the 1987 Fort Hood survey. Subjects' comments indicated that the use of a chinstrap pad to reduce the discomfort has been a typical field solution to this continuing problem.

The responding population in the 1986 Fort Rucker survey indicated that 85.8 percent considered the system configuration to be either "stable" or "very stable," with only 3.6 percent rating the helmet as "very unstable." Comparative data from the 1987 Fort Rucker survey indicated 88 percent found the helmet "stable" or "very stable" and only 1.2 percent rating the system as "very unstable." The 1987 Fort Hood survey rating for "stable" and "very stable" only totaled 80 percent, yet recorded no ratings of "very unstable."

An additional figure of merit for proper fit is the noise attenuation provided by the helmet. In each survey, a majority of the subjects reported the noise attenuation of their helmet as "quiet" or better. In the 1986 survey, 84.2 percent rated their helmets as "quiet" or "very quiet." A similar "quiet" or better rating was indicated by 79.6 percent in the 1987 Fort Rucker survey and 86.0 percent in the Fort Hood survey. However, a significant number of subjects indicated that their assessment of the noise attenuation provided was based on the additional usage of earplugs. Therefore, the high percentage of "quiet" or better ratings cannot be attributed only to fit or attenuation characteristics of the helmet.

When asked to rate (scale 1-9) the overall quality of their current fit, the average ratings were 5.7, 6.6, and 5.6 for the 1986 Fort Rucker, 1987 Fort Rucker, and 1987 Fort Hood surveys, respectively.

Table 4

Current fit assessment

	1986 Fort Rucker (57 subjects)		1987 Fort Rucker (83 subjects)		1987 Fort Hood (50 subjects)	
	Number cases	Percent	Number cases	Percent	Number cases	Percent
Overall helmet comfort:						
Very comfortable	15	26.4	14	16.9	6	12.0
Comfortable	29	50.9	51	61.4	25	50.0
Uncomfortable	10	17.5	13	15.7	16	32.0
Very uncomfortable	3	5.3	5	6.0	3	6.0
Is thermal comfort adequate?						
Yes	41	78.8	74	89.2	46	92.0
No	11	21.2	9	10.8	4	8.0
Overall stability of helmet:						
Very stable	12	21.5	13	15.7	6	12.0
Stable	36	64.3	60	72.3	34	68.0
Unstable	6	10.7	9	10.8	10	20.0
Very unstable	2	3.6	1	1.2	0	0.0
Overall helmet noise attenuation:						
Very quiet	18	31.6	13	15.7	8	16.0
Quiet	30	52.6	53	63.9	35	70.0
Noisy	7	12.3	17	20.5	6	12.0
Very noisy	2	3.6	0	0.0	1	2.0
Do earcups fit comfortably?						
Yes	22	39.3	61	73.5	27	54.0
No	34	60.7	22	26.5	23	46.0
Is chinstrap adequate and comfortable?						
Yes	30	54.5	48	57.8	31	62.0
No	25	45.5	35	42.2	19	38.0
Mean estimate of quality of current fit (Scale 1-9):	5.7		6.6		5.6	

The final user evaluation was provided by data collection forms completed by the contractor's technical representative at Fort Rucker. A form was filled out each time the representative performed an adjustment to an aviator's helmet. Only forms covering the 7-week period from 5 January to 20 February 1987 were available for inclusion in this report. Of the 19 forms collected, 4 complaints relating strictly to inability to obtain adequate field-of-view, 3 related to electronic problems, 4 reported a combination of discomfort and inadequate field-of-view, 7 presented problems related strictly to fit quality, and 1 was a request for a helmet check following use in a demonstration by other personnel. Of the 16 reported nonelectronic related problems, 9 required major refits, 5 were resolved by minor adjustments of fitting pads and earcups, 1 required only instruction in use of the HDU, and 1 (the helmet recheck) required no action.

Discussion

The fitting of the IHADSS helmet is critical to the aviator's performance in the AH-64 aircraft. As an interface between the aviator and the aircraft, the helmet is important both as a personal protective device and as a platform for the head mounted display. Skilled and qualified fitters are required to accomplish and maintain a proper fit. As the pace of the fielding of the AH-64 aircraft increases, so will the need for experienced, qualified fitters.

In early 1985, USAARL initiated an IHADSS helmet fitting program to assist the Army in establishing fitting requirements and procedures for the AH-64 program. This evaluation of USAARL's program has identified areas which are essential to the design of a successful fitting program. The evaluation has determined that the most important element is well-trained, experienced, motivated personnel. It is optimum that these individuals have the IHADSS fitting responsibility as a primary job assignment, not as an "other duty as assigned." The current situation of arbitrarily tasking individuals to be IHADSS fitters is detrimental to establishing an efficient and successful fitting program. This can be accomplished only by identifying fitting personnel, providing them with comprehensive training, and then continuous hands-on experience.

The efficency of the USAARL fitting program also has been compromised by the lack of a sufficient quantity of fitting and alignment verification kits. This significantly increased the length of the fitting sessions. In addition, the decision to subsitute a "dummy" HDU in the kits severely impacted the ability of the fitter to provide the aviator with a fit which optimized the field-of-view available with the HDU.

The user evaluation questionnaires from the 1987 Fort Rucker survey indicated an average rating (scale 1-9) of 6.8 for the original fit and 6.6 for the current fit. The majority (71.1 percent) of the subjects in this survey were experienced instructor pilots whose almost constant flight schedules precipitate the need to maintain a comfortable, properly fitted helmet. The availability of an on-site contractor's technical representative has provided aviators with the needed expertise to solve fitting related problems. This is a luxury that may not be available in the future and certainly not in the field or in combat.

The data from the Fort Hood survey indicated an average rating (scale 1-9) of 4.7 for the original fit and 5.6 for the current fit. The majority (80 percent) of the subjects in this survey were rated AAH pilots and 88 percent of the subjects were fitted under the USAARL program. The rating for the original fit (4.7) is below the middle of the rating scale and seems to indicate that the quality of the original fit being provided could be improved substantially. The higher rating value of the current fit (5.6) implies that fitting assistance was obtained at some time following the original fitting. Data indicated that 88 percent of the subjects did require adjustments following the original fitting. An obvious point is the disparity between the 1987 Fort Rucker and Fort Hood ratings for both the original and current fit. The ratings for the original fit were 6.8 at Fort Rucker and 4.7 at Fort Hood surveys. Values of 6.6 at Fort Rucker and 5.6 at Fort Hood were obtained for the ratings of the current fit. The difference in the ratings for the original fit most likely is explained by the source of the original fitting. The instructor pilots, who made up the majority of the 1987 Fort Rucker subjects, were fit by Honeywell personnel or at USAARL, using the assistance of Honeywell personnel. The original fitting of the majority of the Fort Hood subjects was provided by the USAARL program, which suffered constantly from a lack of trained, experienced fitters. The difference in the ratings of the current fit is clearly a result of the availability of fitting expertise. USAARL has the "most experienced" of the Army's fitters, and the Fort Rucker contractor's technical representative is a highly qualified fitter. We feel this is the main reason for the above average rating indicated for the current fit by the 1987 Fort Rucker survey.

In conclusion, based on comments provided via the questionnaires regarding needed adjustments and refits, the USAARL fitting program has not been able to provide the AAH aviator with the high quality of fit required to ensure optimum performance of the IHADSS system. However, the program has been successful in its goals to identify the US Army's requirements for fitting the IHADSS helmet and in assisting the AAH program during its initial fielding. It has obviously provided an adequate fit for entry into the training program, during which, improvements have been made to effect a better fit.

Recommendations for designing a permanent fitting program

To develop a successful fitting program for the IHADSS helmet and other future helmets utilizing helmet mounted displays, the Army must develop a philosophy which recognizes the role of a proper helmet fit in the performance of the aviator. The importance of the helmet fit and the personnel who accomplish the fit were major "lessons learned" during the USAARL IHADSS helmet fitting program. Recommendations which can serve as a guideline for the Army to establish a successful long term fitting program for the IHADSS helmet are as follows:

Designate the fitting task as a primary responsibility

A well-trained, experienced fitter is required. The fitting task must be a primary job assignment. Fitting personnel must be afforded the opportunity to practice and maintain their fitting skills. Emphasis must be placed on retaining trained personnel in this critical position. ALSE personnel should have the responsibility for fitting and maintaining the helmet. In a training environment, consideration should be given to the use of civilian personnel to provide greater program stability.

Expand the formal training provided for IHADSS fitters

The block of instruction currently taught at the ALSE school must be expanded to include actual training in the trimming of the visors and verification of helmet alignment. Multiple hands-on fitting sessions to provide practical experience are necessary. The most experienced fitters available from within the Army and from the helmet's contractors should be used in the education process until the Army can develop a sufficient quantity of experienced fitters. Honeywell, Inc. has developed a 40-hour block of instruction for fitter training that should be incorporated into the current syllabus.

Place Command emphasis on the importance for a quality fit

Command emphasis is required both in the recognition of the importance of maintaining experienced fitters and in the scheduling of fitting sessions. Commanders must recognize the fitting process as one requiring a knowledgeable, experienced fitter. Sufficient time must be allowed for the fitting process in order to ensure an optimum fit. Extra time dedicated for the fitting process could save hours of frustration and delays on the flightline.

Increase availability of fitting kits

One fitting kit should be available for each fitter. By using forethought in the scheduling within a fitting session, the number of required alignment verification kits can be minimized to no less than one for every three fitters.

Provide segregated fitting areas

The actual time required for a fitting could be reduced by providing a fitting area which allows physical separation of the fitting groups. This would minimize nonproductive interaction between individuals and allow for better concentration on the desired task. This issue can easily be addressed in the POI for the AH-64 Aircraft Qualification Course once the decision is made to do so.

Provide aviators with orientation 'to helmet prior to fitting

The quality of the original fit and the length of the fitting session could be positively impacted by providing the aviator with a prefitting orientation to the helmet and its role in the aircraft.

Utilizing a real Helmet Display Unit during the fitting

The field-of-view provided by the HDU needs to be optimized during the fitting. This will provide for more compatible trimming of the visors and will reduce problems when the aviator attempts to use the helmet in the aircraft. In addition, the use of real video provided through the HDU during the fitting greatly would enhance the amount of the field-of-view which can be achieved. On many subjects, the physical eye relief of the HDU prevents the obtaining of a full field-of-view. When the M-43 mask is present, the available field-of-view is reduced further. Presenting imagery which simulates the symbolgy which must be viewed through the HDU would ensure that each aviator will receive the information necessary to fly the aircraft.

Establish a central facility for fitting control

In order to establish quality control over the fitting program, it is necessary to establish a central facility which can provide fitting adjustments. Centralizing of this function has several benefits. First, by providing a place where proper fitting adjustments can be made by trained personnel, the detrimental effects of well intentioned "self help" can be reduced. Second, a systematic recording of fitting problems can establish a method of quality control on the fitting program. Third, well trained personnel will be able to identify product defects and provide valuable feedback to program managers.

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Appendix A

List of contents for IHADSS alignment

Verification and fitting kits

Alignment verification kit

Sensor alignment verification scope
Helmet Display Unit alignment verification scope Simulated CRT
IHADSS alignment chart
Carrying case

Fitting kit

Helmet Display Unit simulator
Tape measure*
Ruler, 6-inch*
Screwdriver, Phillips*
Screwdriver, flathead*
Wrenches, Allen (2)*
Dremel kit*

Pen, grease*
Sandpaper, fine*
Sanding drum, fine*
Sanding drum, coarse*
Scissors*
Goggles*
Carrying case

* Designates government furnished equipment.

Appendix B.
1986 Fort Rucker fitting questionnaire

IHADSS fitting evaluation questionnaire

Purpose

The operation of the IHADSS requires a special integrated helmet. The fit of this helmet is critical to the performance of the aviator in the AH-64 aircraft. An optimal fit must address comfort and stability. The purpose of this questionnaire is to assess the quality of your original fit and the long-term fitting characteristics of this fit.

Your cooperation in this survey will assist in establishing a quality IHADSS helmet fitting program which will benefit you and future Apache pilots.

If you have any questions concerning this questionnaire or this survey, they may be directed to the following individuals at the US Army Aeromedical Research Laboratory (USAARL):

Mr. Ed Rash AV 558-6814
Maj. Dan Gower AV 558-6895

US Army Aeromedical Research Laboratory
Box 577
Fort Rucker, Alabama 36362-5292

PRIVACY ACT STATEMENT

1. Authority
   a. Section 301, Title 5, United States Code.
   b. Section 3101, Title 44, United States Code.
   c. Section 1071-1087, Title 10, United States Code.

2. Principal purpose. The purpose for requesting personal information is to provide various types of data needed to satisfy the scientific objectives of the study.

3. Routine uses.
   a. This information may be used to--

   (1) Provide full documentation of investigative studies.

   (2) Conduct further investigations.

   (3) Compile statistical data.

   b. Even though permitted by law, when possible, this personal data will not be released without your consent.

4. Mandatory or voluntary disclosure and effect on persons not providing information.

   a. I understand that a copy will be retained permanently by the investigator and by the US Government.

   b. I have received, or have declined to accept, a copy of the Privacy Act Statement, Volunteer Agreement Affidavit, and Volunteer Agreement Explanation.

_____
Typed or printed name of subject
or legally authorized representative

SSN:_____

_____
Signature Date

INSTRUCTIONS: Please circle the correct answer where appropriate. If possible, look over entire questionnaire before proceeding.

DEMOGRAPHIC DATA

1. Age_____ 2. Hat size_____

3. Helmet size: Medium Large X-Large

4. Do you wear glasses? No Yes

If YES, do you wear bifocals? No Yes

5. Current aircraft duty:

Instructor pilot Student pilot

AH-1 surrogate AH-64 Other

ORIGINAL FITTING

6. Where did you receive your original helmet fitting?

USAARL Flight line ALSE

Honeywell Tech Rep Other

7. Rate the quality of your original fit (1-9): _____

1 = unsatisfactory 5 = adequate 9 = excellent

8. Rate the ability and knowledge of your fitter (1-9): _____

1 = unsatisfactory 5 = adequate 9 = excellent

9. Did your fitter explain the complexities of the helmet to you? No Yes

10. Did your fitter explain the adjustments of the HDU and combiner to you? No Yes

11. Do you have any suggestions which might improve the fitting process?

No Yes Remarks _____

HELMET USAGE

12. Has your helmet been adjusted by anyone other than the US Army Aeromedical Research Laboratory (USAARL)?

No Yes

If YES, who accommodated your problem? (No personal names.) (More than one may apply.)

Flight line ALSE IP Honeywell Tech Rep

Fellow aviator Self Other_____

13. Has the IHADSS suspension system rigid inner liner been modified in any manner? (i.e., cut, ground, shaved, etc.)

No Yes

If YES, circle: (More than one may apply.)

Front Middle Top Rear Left/Right Bottom

Who performed these modifications? (No personal names.)

USAARL Flight line ALSE IP Self

Honeywell Tech Rep Fellow aviator Other _____

14. Rate the quality of your current fit (1-9): _____

1 = unsatisfactory 5 = adequate 9 = excellent

15. Have you experienced any breakage, binding, slipping, or other malfunction with any of the following?

Visors	No	Yes
Visor activators	No	Yes
Chinstrap	No	Yes
Suspension assembly	No	Yes
Tempest microphone	No	Yes
Microphone Boom	No	Yes
Earcups	No	Yes
Helmet internal speakers	No	Yes
HDU mounting bracket	No	Yes
Communication cable	No	Yes
Electronics cable	No	Yes

Remarks: _____
_____

HEADS-UP DISPLAY UNIT

16. Do you have any objections to the way the HDU is mounted on the helmet?

No Yes

Remarks: _____

17. Have you experienced any discomfort while using the HDU?

No Yes

Remarks: _____

18. Have you experienced any difficulty installing or removing the HDU from the helmet?

No Yes

Remarks: _____

19. Does the HDU preset position remain the same from aircraft to aircraft?

Surrogate: No Yes

AH-64: No Yes

If NO, what do you do to accommodate this? _____

20. Has the HDU ever inadvertently released during flight?

No Yes

If YES, how often:

Very seldom	Occasionally	Very Often
1	5	(Once per flight period =9)

21. Has the HDU helmet mounting bracket ever moved, slipped, or detached from the IHADDS?

No Yes

If YES, did you replace it or have it replaced? _____

How was this done? (circle one or more)

Screw Bolt Elmer's glue Super glue

Unknown adhesive Replace helmet Other_____

22. Have you encountered any other problems of incompatibiltiy between the helmet and HDU?

No Yes

Remarks: _____

VISION

23. Did you achieve a full FOV (field-of-view) in the AH-1 surrogate trainer?

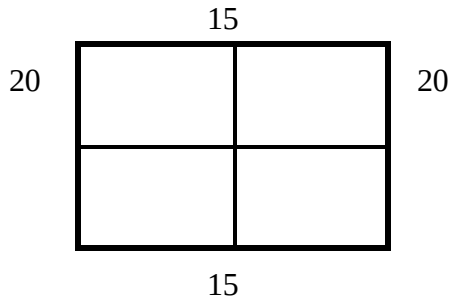
No Yes

A. If O, assess what items of information you were not seeing: -

_____

_____

B. Indicate surrogate FOV by marking diagram:



24. If no longer in surrogate, do you currently achieve a full FOV?

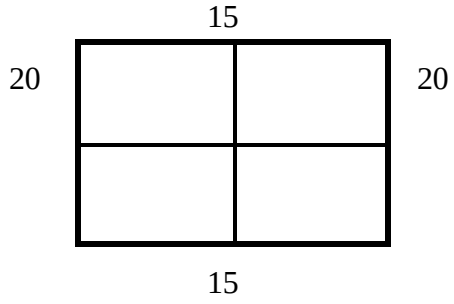
No Yes

A. If NO, assess what items of information you are not seeing:

_____

_____

B. Indicate current FOV on diagram:



25. How does your FOV in the HDU change when your head is moved laterally?

Left movement?
A. Increase FOV
B. Decrease FOV
C. No change

Right movement?
A. Increase FOV
B. Decrease FOV
C. No change

26. How does your FOV in the HDU change when your head is moved vertically?

Up movement?
A. Increase FOV
B. Decrease FOV
C. No change

Down movement?
A. Increase FOV
B. Decrease FOV
C. No change

27. Do the laser protective spectacles inhibit HDU instrument readability?

No Yes

VISOR

28. Was the custom trimming of the visor accurate and adequate?

No Yes

Remarks: _____

29. Were any difficulties encountered in using the visor assemblies?

No Yes

Remarks: _____

30. Assess your percentage of wear of the visor assemblies:

Day wear clear visor	_____%
Day wear tinted visor	_____%
Did not use visor down	_____%
TOTAL	_____ 100 %
Night wear clear visor	_____%
Night wear tinted visor	_____%
Did not use visor down	_____%
TOTAL	_____100%

Remarks: _____

31. Is the tint on the sun visor dark enough?

No Yes

Remarks: _____

32. Does the visor come down far enough?

No Yes

Remarks: _____

33. Has the visor ever inadvertently retracted?

No Yes

If YES, how often: _____(Rate 1-9)

Very seldom	Occasionally	Very often
1	5	9

Remarks: _____

34. Does the visor adversely rub your nose or face when extended?

No Yes

Remarks: _____

35. Is the visor easily scratched?

No Yes
Remarks: _____

36. Do you wear laser protective spectacles?

No Yes

If YES, what percent of the time do you wear them when they are needed?

Day % _____ Night % _____ (100% possible on each answer)

If worn less than 100%, what are the reasons for not using this protection?

_____

HELMET PERFORMANCE

37. How would you rate the overall comfort of this helmet?

Extremely Comfortable	Very Comfortable	Comfortable
_____	_____	_____

Uncomfortable	Very Uncomfortable	Extremely Uncomfortable
_____	_____	_____

If there is any discomfort, what causes it? _____

38. Do you consider the thermal comfort adequate?

No Yes
Remarks: _____

39. How many IHADSS helmets have you been issued for your personal use in the AH-64 program?
_____

40. Do you feel that you currently need a different size IHADSS helmet?

No change Smaller Larger

41. How would you rate the stability of this helmet?

Extremely Stable	Very Stable	Stable	Unstable	Very Unstable	Extremely Unstable
_____	_____	_____	_____	_____	_____

42. Have you had any problems with boresight?

No Yes

If YES, explain what the problem was? _____

What was done to correct the problem? _____

Any suggestions on how to better correct this problem? _____
_____

43. Have you encountered any interface problems of incompatibility of helmet with the aircraft systems (only helmet problems)?

No Yes

Remarks: _____

44. How would you rate the overall noise protection that you have experienced in flight?

Extremely quiet	Very quiet	Quiet	Noisy	Very noisy	Extremely noisy
_____	_____	_____	_____	_____	_____

45. Have you encountered any problems with aircraft vibration noise being transfered to your head through the electrical helmet connections?

No Yes

Remarks: _____

46. Have you had any problems with the communications in the helmet?

No Yes

If YES, what problem? _____

How many times has this occurred? _____

What was done to correct the problem_____

Do you see this as a possible continuing problem in the field?

No Yes

What can be done to correct this deficiency? _____

47. Do the earcups fit comfortably?

No Yes

48. Does one earcup fit better that the other?

No Yes

Remarks: _____

49. Have you encountered any problems with the cables and connectors on the helmet?

No Yes

Remarks: _____

50. Can you wear the chinstrap as snug as your old SPH-4?

No Yes

51. Do you consider the chinstrap placement and comfort adequate?

No Yes

Remarks: _____

52. Have you encountered any problems with the cables and connectors on the helmet?

No Yes
Remarks: _____

53. Do you consider the chinstrap placement and comfort adequate?

No Yes

Remarks: _____

54. Any other additional comments:
_____
_____

Appendix C.
1987 Fort Hood/Fort Rucker fitting questionnaire

The AH-64 Integrated Helmet and Display Sighting System (IHADSS) helmet currently is pending a major revision and upsizing modification proposal. Concerns currently being staffed will provide a design and helmet, as well as improvements to the existing helmet, that will remain as the standard for the service life of the AH-64 Apache aircraft.

The following questionnaire is designed to provide input for considerations in this program while still in its preliminary design phase. Drawing on the experience of the existing AH-64 pilot population, we hope to qualify certain deficiencies and explore commentary that you might expand upon.

We ask your diligence in responding to this questionnaire and ask for your comments as appropriate.

We are asking for your name on the cover sheet. This will be used for input credibility, followup coordination, and clarification on specific questions as needed. After the sheet analysis is completed in the laboratory, this cover sheet will be removed and this will totally become an anonymous questionnaire.

Name _____

Rank _____

SSN_____

Duty Station (location) _____

1. Age_____2. Hat size_____3. Height_____ 4. Weight_____

5. Do you wear glasses? No_____ Yes_____

If you wear glasses, do you wear bifocals?

No_____ Yes_____

6. Current aircraft duty:
AH-1 surrogate_____
AH-64 _____
Other _____
Instructor pilot _____ Student pilot _____

FITTING

7. Note: IHADSS fitting will be moved to Hanchey ALSE by 1 June 1986. Beside minor administrative changes, what could be included or deleted in the initial fitting procedure that would improve the ultimate quality of fit?

AA_____
B. _____
C. _____
D. _____

Will any of the above require additional fitting time?

Yes_____ No_____

8. Have you had any additional fitting requirements after initial fit?

No_____Yes_____Number of refits_____

Reasons: _____

Time to accomplish refitting task 1st time: _____

9.Has your helmet been adjusted by anyone other than USAARL?

No_____Yes_____

If YES, who accommodated your problem? (No personal names.) (More than one may apply.)

A. Flight line ALSE_____
B. IP_____
C. Honeywell Tech Rep_____
D. Self_____
E. Fellow aviator_____
F. Other_____

10. Has the IHADSS suspension system rigid inner liner been modified in any manner? (cut, ground, shaved, etc.)

No_____ Yes_____ If YES, circle:

Front	Top
Rear	Middle
Left Right	Bottom

(More than one may apply.)

Who performed these modifications? (No personal names.) (More than one may apply.)

A. USAARL_____
B. Flight line ALSE_____
C. IP_____
D. Honeywell Tech Rep_____
E. Fellow aviator_____
F. Self_____
G. Other_____

11. Rate the quality of your current fit. (1-9) _____

1 = unsatisfactory
5 = adequate
9 = excellent

12. Have you experienced any breakage, binding, slipping, or other malfunction with any of the following?

No Yes If YES, please explain:
_____

Visors _____

Visor activators _____

ChinStrap _____

Suspension assembly _____

Tempest microphone _____

Microphone boom _____

Earcups _____

Helmet internal speakers _____

HDU mount _____

Communication cable _____

Electronics cable _____

Remarks:_____

HEADS-UP DISPLAY UNIT

13. Do you have any objections to the way the HDU is mounted on the helmet?

No _____ Yes _____

Remarks:_____

14. Have you experienced any discomfort while using the HDU?

No _____ Yes _____

Remarks:_____

15. Have you experienced any difficulty installing or removing the HDU from the helmet?

No _____ Yes _____

Remarks:_____

16. Does the HDU preset position remain the same from aircraft to aircraft?

Surrogate: No _____Yes _____ Why _____

AH-64: No _____Yes _____ Why _____

17. What do you do to accommodate this?_____

18.How often have you had this problem?

1	5	9
Very seldom	Occasionally	Very often (Each aircraft change)

Suggestions:_____

19. Has the HDU ever inadvertently released during flight?

No_____ Yes _____

if YES, how often:_____

1	5	9
Very seldom	Occasionally	Very often 9 (Once per flight period)

20. Has the HDU Helmet mounting bracket ever moved, slipped, or detached from the IHADSS?
No _____Yes_____

Did you replace it or have it replaced?
How was this done?_____

A. Screw
B. Bolt
C. Elmer's glue
D. Super glue
E. Unknown adhesive
F. Replaced helmet

21. Have you encountered any other problems of incompatibility between the helmet and HDU?
No _____ Yes _____

Remarks:_____

VISION

22. Did you achieve a full FOV in the AH-1 surrogate trainer?

No _____ Yes _____

A. If NO, assess what items of information you were not seeing:_____

B. What quadrant/quadrants did you lose?

23. Do you achieve a full field-of-view (FOV) currently?
No _____ Yes _____

A. If NO, assess what items of information you were not seeing:_____

B. What quadrant/quadrants did you lose?_____

24.Does your FOV in the HDU change when your head is moved laterally?
No _____ Yes _____

25. Does your FOV in the HDU change when your head is moved vertically?
No _____ Yes _____

Up? A. Increase FOV _____
B. Decrease FOV _____
C. No change _____

Down? A. Increase FOV _____
B. Decrease FOV_____
C. No change _____

26. Do the laser protective spectacles inhibit HDU instrument readability?
No _____ Yes _____

VISOR

26. Was the custom trimming of the visor accurate and adequate?

No _____ Yes _____

Remarks:_____

27. Were any difficulties encountered in using the visor assemblies?

No _____ Yes _____

28. Assess your percentage of wear of the visor assemblies:

Day wear clear visor _____%
Day wear tinted visor _____%
Did not use visor down _____%
Total _____ 100 %

Night wear clear visor _____%
Night wear tinted visor _____%
Did not use visor down _____%
Total _____ 100 %

Remarks: _____

29. Is the tint on the sun visor dark enough?

No _____ Yes _____

Remarks:_____

30. Does the visor come down far enough?

No _____ Yes _____

Remarks:_____

31. Has the visor ever inadvertently retracted?

No _____ Yes _____
If YES, how often:_____ (Rate 1-9)

Very seldom Occasionally Very often (Once per flight period)
1 5 9

32. Does the visor adversely rub your nose or face when it is extended?

No _____ Yes _____

Remarks:_____ _____ _____ _____ _____

33. Is the visor easily scratched?

No _____ Yes _____

Remarks:_____ _____ _____ _____ _____

34. Do you wear laser protective spectacles? No _____ Yes _____
If YES, what percent of the time do you wear them when they are needed:_____

Day _____ % Night _____ % (100% possible on each answer)
If worn less than 100%, what are the reasons for not using this protection? _____
_____
_

HELMET PERFORMANCE
35. How would you rate the overall comfort of this helmet?

Extremely comfortable	Very comfortable	Comfortable	Uncomfortable	Very uncomfortable	Extremely uncomfortable

If there is any discomfort, what caused it?_____

36. Do you consider the thermal comfort adequate? No _____ Yes _____
Remarks:_____

37. How many IHADSS helmets have you been issued for your personal use in the AH-64 program?
_____

38. How many of these IHADSS were the earlier phase II (preproduction) helmets?_____

39. Was there any difference in your size requirements between the phase II (preproduction) IHADSS and the current issue helmet? No _____ Yes _____ NA _____

If YES, did you need a smaller or larger helmet when you went to the current issue helmet?
_____

40. Do you feel that you currently need a different size IHADSS helmet?_____

No change _____ Smaller _____ Larger _____
What size do you now wear? _____

41.How would you rate the stability of this helmet?

Extremely stable	Very stable	Stable	unstable	Very unstable	Extremely unstable
_____	_____	_____	_____	_____	_____

42. Have you had any problems with boresight?

A. No_____ Yes _____

B. If YES, explain what the problem was?_____

C. What was done to correct the problem?_____

Any suggestions on how to better correct this problem._____

43. Have you encountered any interface problems or incompatibility of the helmet with the aircraft systems (only helmet problems)? No _____ Yes _____

Remarks: _____

44. How would you rate the overall noise protection that you have experienced in flight?

Extremely quiet	Very quiet	Quiet	noisy	Very noisy	Extremely noisy
_____	_____	_____	_____	_____	_____

45. ave you encountered any problem with aircraft vibration noise being transferred to your head through the electrical helmet connections? No _____ Yes _____

Remarks:_____

46. Have you had any problems with the communications in the helmet?
No _____ Yes _____

If YES, what was the problem?_____

How many times has this occurred? _____

What was done to correct the problem? _____

Do you see this as a possible continuing problem in the field?

No _____ Yes _____

What can be done to correct this deficiency?_____

47. Do the earcups fit comfortably? No _____Yes _____

48. Does one earcup fit better than the other? No _____ Yes _____

Remarks:_____

49. Have you encountered any problems with the cables and connectors on the helmet?

No _____ Yes _____

Remarks:_____

50. Can you wear the chinstrap as snug as your old SPH-4?

No _____ Yes _____

51. Do you consider the chinstrap placement and comfort adequate?

No _____ Yes _____

Remarks:_____

Appendix D.
Contractor data collection form

Date _____ Pilot name _____

Nature of complaint with IHADSS helmet _____

_____

How long has helmet been worn (Total flight hours)_____

(Average #hrs per session)_____

How long since last complaint/problem (# flight hrs)_____ (# of days)_____

Where was original fitting:
(circle one) USAARL IP Flight line ALSE

Honeywell tech rep. Other

Helmet size (circle one): Medium Large X-large

Analysis/cause of current complaint
_____

_____

Action taken to correct complaint:
_____

_____

Additioanl Comments:
_____

_____

_____