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ARMY AVIATION TEST BOARD FORT RUCKER ALA  
PRODUCT-IMPROVEMENT TEST OF PILOT'S PROTECTIVE HEADGEAR RETENTI--ETC(U)  
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PRODUCT-IMPROVEMENT TEST

OF

PILOT'S PROTECTIVE HEADGEAR RETENTION DEVICE

9

Final Report of Test

1 Apr - 1 Jul 66

by

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Major Eldridge W. Brock

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25 August 1966

12 33p.

DEPARTMENT OF THE ARMY  
UNITED STATES ARMY AVIATION TEST BOARD  
Fort Rucker, Alabama 36360

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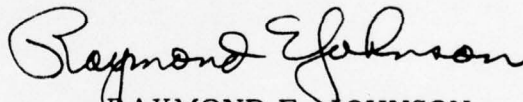
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USATECOM PROJECT NO. 4-6-4252-01

"PRODUCT-IMPROVEMENT TEST

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PILOT'S PROTECTIVE HEADGEAR RETENTION DEVICE"

Final Report of Test

by

Major Eldridge W. Brock

25 August 1966

DEPARTMENT OF THE ARMY  
UNITED STATES ARMY AVIATION TEST BOARD  
Fort Rucker, Alabama 36360

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## ABSTRACT

The US Army Aviation Test Board (USAAVNTBD) conducted the product-improvement test of the Pilot's Protective Headgear Retention Device at Fort Rucker, Alabama, during the period 1 April 1966 to 1 July 1966. The purpose of this test was to determine whether the retention device is an improvement over the present nape and chin straps used in the APH-5 Helmet. Twenty of the devices were installed and worn by personnel assigned to the USAAVNTBD. Data were obtained from the crewmembers by questionnaires and personal interviews. Five deficiencies and three shortcomings were discovered. The deficiencies were: (1) the nylon netting of the retention device was highly flammable, (2) the chin-strap pad was too large, hard, and rough and the edges and corners were sharp, (3) the chin-strap pad applied excessive pressure on the throat, (4) the nape-strap net harness knotted and folded, chafed the skin, pulled the hair, and cut into the neck, and (5) the chin-strap fastening point was not readily accessible. It was concluded that the proposed retention device, although having an improved retention capability, is unacceptable for Army use because of the discomfort and inherent design deficiencies and that the device does not provide an overall improvement over the standard APH-5 chin and nape straps. It was recommended that the retention device, as tested, be considered unsatisfactory for Army use with the APH-5, that the deficiencies be corrected and the shortcomings be corrected as practicable, that additional design refinements be incorporated to reduce crewmember discomfort, and that the device be re-tested after modification.

## FOREWORD

The product-improvement test of the Pilot's Protective Headgear Retention Device was directed by the Commanding General, US Army Test and Evaluation Command (USATECOM), in letter, AMSTE-BG, Headquarters, USATECOM, 3 February 1966, subject: "Test Directive, USATECOM Project No. 4-6-4252-01, Product Improvement Test of Pilot's Protective Headgear Retention Device."

The USAAVNTBD was responsible for preparing the test plan, executing the test, and preparing the test report.

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SECTION 1 - INTRODUCTION

## 1.1. BACKGROUND.

1.1.1. Accident experience accumulated by the US Army Board for Aviation Accident Research (USABAAR) indicates that the present APH-5 Helmet is susceptible to being dislodged from the head of the wearer in accidents involving only moderate crash forces. The nape strap of the suspension system of the APH-5 Helmet is not adjustable and properly fits only 63 percent of the helmet wearers. Even though the nape strap was fitted properly, in some instances it slipped over the head of the wearer during an accident, allowing the helmet to be torn free.

1.1.2. A new retention device was developed by the US Army Natick Laboratories (USANLABS) as a product improvement of the chin and nape straps and pads currently used with the APH-5 Helmet. The device was evaluated by USABAAR and showed that the fire-retardant qualities of the material (nylon) were unsatisfactory (reference 1, appendix III, section 3). It should be noted, however, that the current standard nape and chin straps of the APH-5 Helmet are also made of nylon and are not fire retardant. USANLABS are currently examining new fire-retardant materials as possible replacements for the nylon material in the new device.

1.1.3. USABAAR recommended that the new device be further tested and evaluated on an expedited basis in order to provide improved helmet retention that will substantially reduce head injuries to occupants of aircraft involved in survivable accidents.

1.1.4. On 27 October 1965, representatives of the USANLABS presented a briefing to Under Secretary of the Army Willis M. Hawkins and Brigadier General George P. Seneff, Director of Army Aviation, at which time the new device was demonstrated. On the basis of this briefing and the USABAAR evaluation, Secretary Hawkins directed the USANLABS to comply with USABAAR's request for 1,000 devices for further evaluation in the Republic of Viet Nam. During the latter part of fiscal year 1966, the product-improvement test was initiated by the USAAVNTBD.

## 1.2. DESCRIPTION OF MATERIEL.

The newly developed retention device is designed so that it can be attached to the helmet, in place of existing straps and pads, without

any modification of the APH-5 Helmet. The retention device is packaged in a plastic bag together with instructions for attaching it to the helmet. The device is a nape strap of olive-green nylon netting, reinforced with nylon tape, and has a tie cord for adjustment and an adjustable nylon-webbing chin strap with a foam chin pad. There are four large metal grommets in the device for attaching it to the helmet.

### 1.3. TEST OBJECTIVES.

#### 1.3.1. Purpose.

To determine whether the proposed retention device is an improvement over the present nape and chin straps used in the APH-5 Helmet.

#### 1.3.2. Objectives.

To determine:

- a. Physical characteristics.
- b. Ease of installation.
- c. Adjustability of the device to the individual crewmember.
- d. Improvement in helmet retention.
- e. Discomforts experienced by the crewmembers.
- f. Interference with performance of duty when wearing the APH-5 Helmet with the device installed.

### 1.4. SUMMARY OF RESULTS.

1.4.1. The test retention devices were highly flammable and were not uniform in size or shape.

1.4.2. Installation of the device was difficult on helmets with oxygen mask fittings, but easy on other helmets when the device was of the proper dimensions.

1.4.3. The method of adjustment was acceptable.

1.4.4. The device improved helmet retention.

1.4.5. The device was uncomfortable because of the large, rough chin-strap pad, chafing by the nape-strap netting, and the knotted draw-string grommet adjustment.

1.4.6. The discomforts caused by the device reduced the effectiveness of the crewmembers' performance of duty, and the device was rejected by most of the crewmembers.

1.4.7. The device did not physically interfere with the crewmembers' performance of duty except in one reported instance.

#### 1.5. CONCLUSIONS.

1.5.1. The proposed retention device, although having an improved retention capability, is unacceptable for Army use because of the discomfort and inherent design deficiencies.

1.5.2. The proposed retention device does not provide an overall improvement over the standard APH-5 chin and nape straps.

#### 1.6. RECOMMENDATIONS.

It is recommended that:

1.6.1. The retention device, as tested, be considered unsatisfactory for Army use with the APH-5 Helmet.

1.6.2. The deficiencies listed in appendix II, section 3, be corrected.

1.6.3. Additional design refinements be incorporated to reduce crew-member discomfort.

1.6.4. The shortcomings listed in appendix II, section 3, be corrected as practicable.

1.6.5. The device be re-tested after modification.

SECTION 2 - DETAILS OF TEST

## 2.1. INTRODUCTION.

2.1.1. The product-improvement test of the Pilot's Protective Head-gear Retention Device was conducted by the USAAVNTBD at Fort Rucker, Alabama, during the period 1 April 1966 to 1 July 1966. Twenty of these devices were installed and worn by personnel assigned to the USAAVNTBD.

2.1.2. Data were obtained from the crewmembers by questionnaires and personal interviews (appendix I, section 3) as requested by USANLABS.

## 2.2. PHYSICAL CHARACTERISTICS.

### 2.2.1. Objective.

To determine the physical characteristics of the device.

### 2.2.2. Method.

The device was weighed, measured, photographed, and examined. Weights and measurements were recorded. Significant features were noted.

### 2.2.3. Results.

2.2.3.1. The retention device weighed 1 3/4 ounces. Typical dimensions are shown in figure 1.

2.2.3.2. The size and shape of the devices were not uniform.

2.2.3.3. The device incorporated nylon netting which was highly flammable.

### 2.2.4. Analysis.

2.2.4.1. The weight of the device was approximately the same as that of the standard device.

2.2.4.2. The devices should have been sized for each size helmet. Each size device should have been uniform.

2.2.4.3. The nylon netting of the retention device was more flammable than that of the standard chin and nape straps.

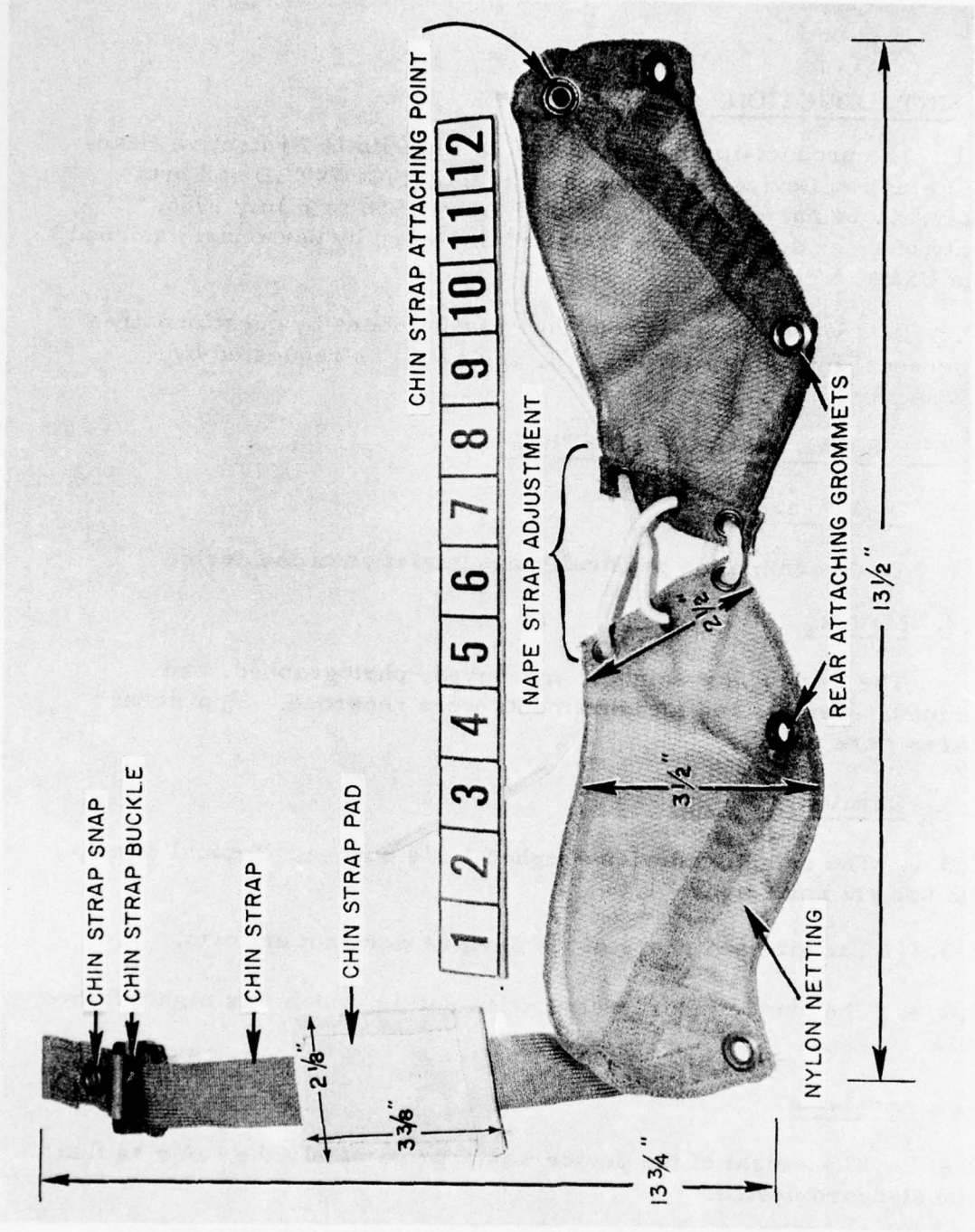


Figure 1. Newly developed retention device.

## 2.3. EASE OF INSTALLATION.

### 2.3.1. Objective.

To determine the ease of installation of the device.

### 2.3.2. Method.

Each individual installed the device in his helmet in place of the present nape and chin straps, using the installation instructions provided with the device as a guide.

### 2.3.3. Results.

2.3.3.1. One third of the crewmembers experienced difficulty in fitting the device and some devices were too small. Some chin-strap attaching points were so short they did not protrude beyond the lower edge of the helmets, and the chin straps were difficult to snap. (See figure 2.)

2.3.3.2. Some crewmembers experienced difficulty when installing the device under their oxygen mask fittings. The retaining screw was too short and too small. In other installation, it was necessary to attach the chin strap to a smaller screw (figure 2), which was not intended for this purpose. The chin-strap grommet was too large and the screw too small for the attachment and yet it was necessary to use this particular screw in order to fit the device to the helmet.

2.3.3.3. The nape strap of some of the older APH-5 Helmets (figure 2) was attached below the oxygen fitting. This point was 1 3/4 inches closer to the rear attaching point than the present chin-strap attaching point (figure 2), which made the device too large.

2.3.3.4. The installation instructions provided with the device were not sufficiently detailed for some installations.

### 2.3.4. Analysis.

The chin-strap attaching point should be lengthened about one inch so that the snap will not be underneath the helmet.

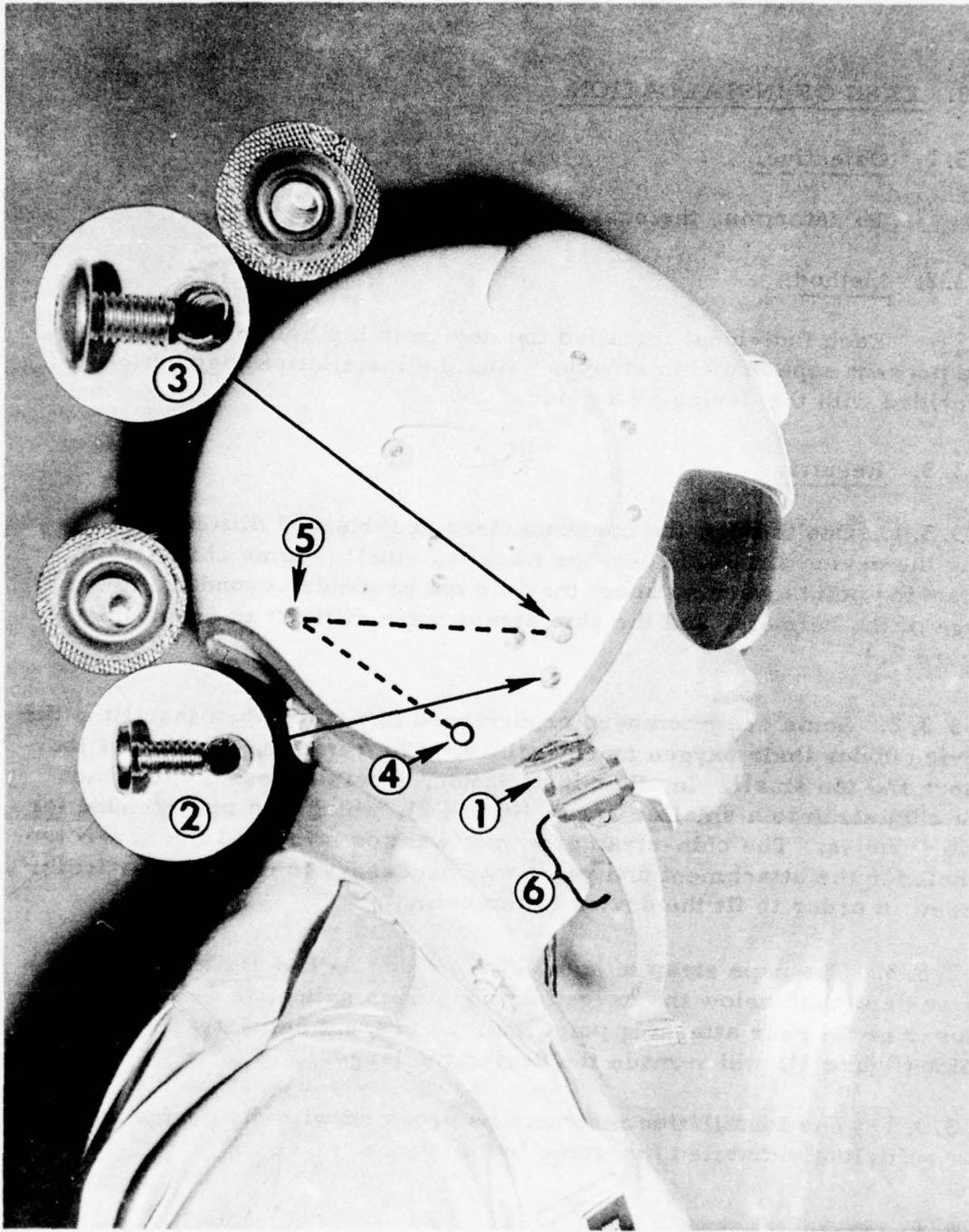


Figure 2. Crewmember wearing APH-5  
Helmet with retention device  
installed.

- Arrow 1. Chin-strap snap.
- Arrow 2. Retaining screw.
- Arrow 3. Chin-strap attaching  
point on new helmets.
- Arrow 4. Chin-strap attaching  
point on older helmets.
- Arrow 5. Rear attaching point.
- Arrow 6. Chin pad cutting into  
throat.

## 2.4. ADJUSTABILITY OF TEST ITEM.

### 2.4.1. Objective.

To determine whether the adjustment of the device to the individual crewmember is satisfactory.

### 2.4.2. Method.

The device was installed and adjusted by the crewmembers.

### 2.4.3. Results.

2.4.3.1. The chin strap could be adjusted adequately. The operation of the snap fastener was satisfactory; however, it was difficult to snap when the operator was wearing gloves. One of the chin-strap snaps failed after approximately 10 hours of use. The adjustment strap buckle was firm, but was acceptable for use with and without gloves.

2.4.3.2. Six crewmembers stated that the drawstrings were difficult to adjust and one stated that the drawstrings did not stay tied. The lower part of each half of the nape-strap net harness contacted the other half on some crewmembers before the drawstrings were sufficiently tightened for a snug fit (figure 3).

### 2.4.4. Analysis.

The method of adjustment was acceptable although some difficulty was experienced when attaching the snap fastener and adjusting the drawstrings. This condition should be improved if the chin-strap attaching point is extended below the helmet. The drawstrings probably became untied because they were not tied tightly.

## 2.5. IMPROVEMENT IN HELMET RETENTION.

### 2.5.1. Objective.

To determine improvement in helmet retention provided by the device.

### 2.5.2. Method.

Each crewmember was requested to grasp the standard helmet firmly with both hands over the occipital area with thumbs bent down

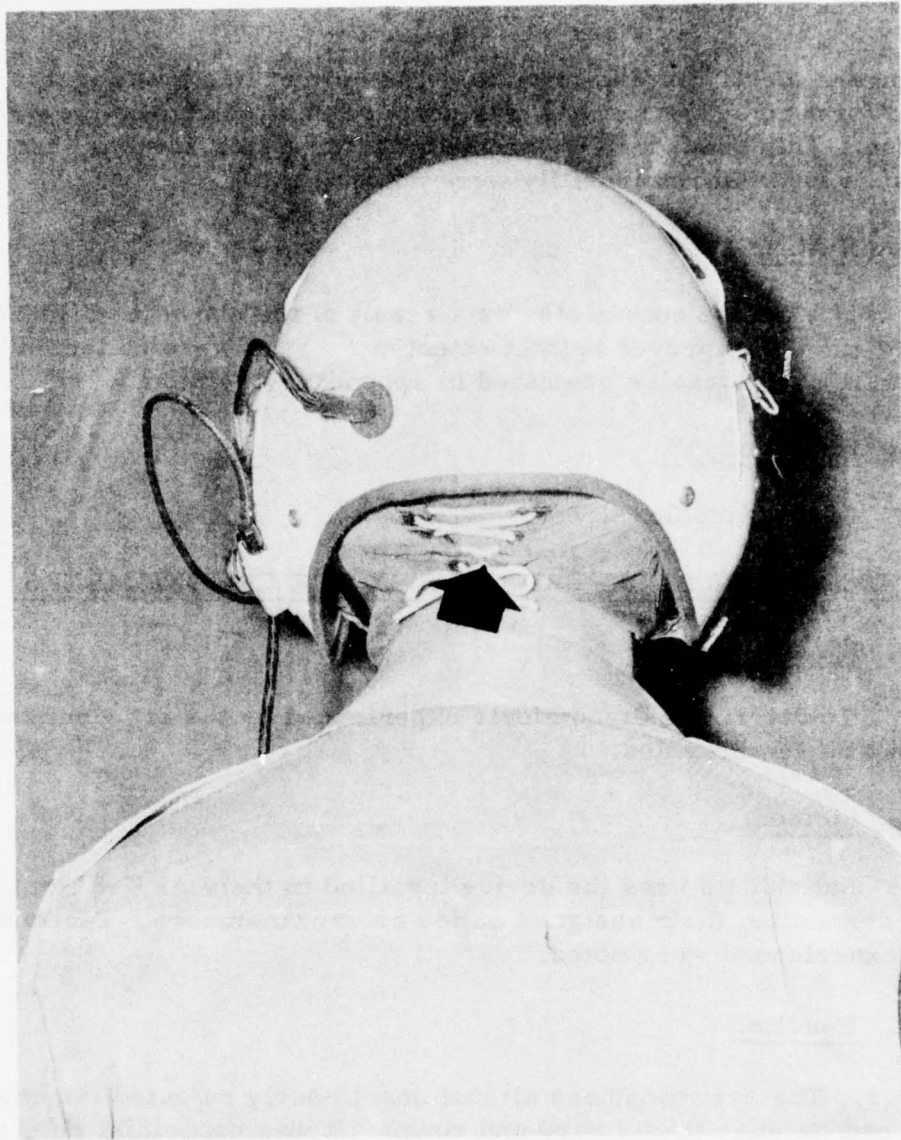


Figure 3. Lower portions of nape-strap harness contacting each other before drawstrings are sufficiently tightened.

and fingers meeting at the midline. The helmet was then vigorously tugged forward while the head was snapped to a looking-at-the-ground position. This procedure was repeated after the device was installed and differences in retainability were noted.

#### 2.5.3. Results.

Qualitative comments, as a result of the above test, indicated that the device improved helmet retention. Data were collected by the use of the questionnaire contained in appendix I, section 3.

#### 2.5.4. Analysis.

Not applicable.

### 2.6. DISCOMFORTS EXPERIENCED BY THE CREWMEMBERS.

#### 2.6.1. Objective.

To determine discomforts experienced by the crewmembers with the device installed.

#### 2.6.2. Method.

Individuals used the device installed in their APH-5 Helmets while conducting their assigned duties as crewmembers. Discomforts experienced were noted.

#### 2.6.3. Results.

2.6.3.1. The crewmembers almost unanimously rejected the chin-strap pad because it was hard and rough. It was especially objectionable to men with heavy beards. It was too large and caused the sharp edges and corners to cut into the throat (figure 2). The line of pull of the new chin strap was not as vertical as that of the old chin strap, causing excessive pressure primarily against the throat rather than against the jawbone (figure 4).

2.6.3.2. The tie cord of the nape-strap netting collapsed and folded as the strings were tightened for adjustment. This caused knots that pressed against the neck and pulled the hair. The harness tended to displace the earphones of one crewmember as he turned his head.



Figure 4. Line of pull of old chin strap (arrow 1) and line of pull of new chin strap (arrow 2).

2.6.3.3. The discomforts were such that most crewmembers only conditionally accepted the devices for wear during the test. They removed the devices from their helmets as soon as test data were obtained.

2.6.4. Analysis.

The device irritated and distracted the crewmembers after prolonged use. Some crewmembers elected to loosen the device to relieve the discomfort and thus made it ineffective.

2.7. INTERFERENCE WITH THE CREWMEMBERS' PERFORMANCE OF DUTY.

2.7.1. Objective.

To determine interference with the crewmembers' performance of duty.

2.7.2. Method.

While performing their duties, crewmembers noted any interference, including the use of oxygen masks, caused by the device.

2.7.3. Results.

No interference with the crewmembers' performance of duty occurred other than the distracting discomforts discussed in paragraph 2.6.3.

2.7.4. Analysis.

Not applicable.

SECTION 3 - APPENDICES

APPENDIX I - TEST DATA

Crewmember Questionnaire for  
Nape/Chin Strap Helmet Retention Device

General. The Army is testing a new nylon nape/chin strap helmet-retention device for possible adoption as a modification to the APH-5 protective helmet. It is believed that this device will improve helmet retention qualities. Your assistance is needed to gather the best information possible. Using your present chin and nape straps and later the test device, you are asked to perform the following actions to evaluate the comparative retention capability of each:

Step 1. With your helmet donned, grasp it firmly over the rear with both hands; thumbs pointed down and fingers meeting in the helmet midline. Simultaneously snap your head forward while vigorously tugging forward on the helmet.

Step 2. Adjust the chin and nape straps as you normally wear them. Compress the helmet with both hands as to simulate an aircraft crash impact. Then rotate the helmet forward and evaluate the straps for retention capability.

Step 3. Install the new retention device per instructions contained in the package and adjust as necessary.

Step 4. Repeat Step 1.

Step 5. Repeat Step 2.

1. Ease of Installation

a. Date chin/nape strap was installed \_\_\_\_\_.

b. Time required to install the retention devices (not including time used for retention tests) \_\_\_\_\_.

c. Were difficulties encountered with installation? Yes \_\_\_\_\_  
No \_\_\_\_\_

REMARKS \_\_\_\_\_

2. Adjustability of Test Item

a. Was helmet fit checked at the time of installation? Yes \_\_\_\_\_  
No \_\_\_\_\_. If Yes, by whom? flight surgeon \_\_\_\_\_ supply specialist  
\_\_\_\_\_ self \_\_\_\_\_ other \_\_\_\_\_. Was adjustment needed? Yes \_\_\_\_\_  
No \_\_\_\_\_.

b. When the helmet was being worn, could the following be  
adjusted adequately? Chin strap, Yes \_\_\_\_\_ No \_\_\_\_\_. Nape strap,  
Yes \_\_\_\_\_ No \_\_\_\_\_.

REMARKS \_\_\_\_\_

c. Check appropriate block(s) in reference to chin strap adjust-  
ing devices.

SNAP FASTENER    WITHOUT GLOVES    WITH GLOVES

(1) Difficult    \_\_\_\_\_    \_\_\_\_\_  
(2) Firm, but OK    \_\_\_\_\_    \_\_\_\_\_  
(3) Too easy    \_\_\_\_\_    \_\_\_\_\_

STRAP BUCKLE    WITHOUT GLOVES    WITH GLOVES

(1) Difficult    \_\_\_\_\_    \_\_\_\_\_  
(2) Firm, but OK    \_\_\_\_\_    \_\_\_\_\_  
(3) Too easy    \_\_\_\_\_    \_\_\_\_\_

d. Check appropriate blocks as to operation of nape strap  
adjusting draw strings.

Satisfactory \_\_\_\_\_  
Difficult to Adjust \_\_\_\_\_  
Too long \_\_\_\_\_  
Too short \_\_\_\_\_  
Didn't maintain adjustment \_\_\_\_\_

REMARKS \_\_\_\_\_

3. Helmet Retention

a. Were there any situations aboard the aircraft when the helmet tended to come off? Yes \_\_\_\_\_ No \_\_\_\_\_. If yes, why? failure of retention devices \_\_\_\_\_ failure to maintain adjustment \_\_\_\_\_. What was situation \_\_\_\_\_. During normal duties \_\_\_\_\_ hard landing \_\_\_\_\_ accident \_\_\_\_\_ object penetrating aircraft \_\_\_\_\_.

REMARKS \_\_\_\_\_  
\_\_\_\_\_

b. With retention straps fastened, could the helmet be pulled forward sufficiently to come off? Yes \_\_\_\_\_ No \_\_\_\_\_, sufficiently to contact bridge of nose? Yes \_\_\_\_\_ No \_\_\_\_\_, sufficiently to cover the eyes? Yes \_\_\_\_\_ No \_\_\_\_\_.

REMARKS \_\_\_\_\_  
\_\_\_\_\_

4. Comfort

a. Check blocks as appropriate comparing the device with old-type retention devices.

CHIN STRAP

- (1) less comfortable \_\_\_\_\_
- (2) just as comfortable \_\_\_\_\_
- (3) more comfortable \_\_\_\_\_
- (4) chafes skin \_\_\_\_\_
- (5) causes more sweating \_\_\_\_\_
- (6) binds \_\_\_\_\_
- (7) tendency to roll \_\_\_\_\_

NAPE STRAP

- (1) less comfortable \_\_\_\_\_
- (2) just as comfortable \_\_\_\_\_
- (3) more comfortable \_\_\_\_\_
- (4) pulls hair \_\_\_\_\_
- (5) chafes skin \_\_\_\_\_
- (6) binds \_\_\_\_\_
- (7) tendency to roll \_\_\_\_\_

REMARKS \_\_\_\_\_  
\_\_\_\_\_

5. While wearing the helmet with test item installed, did you encounter any difficulty in performing your assigned duties? Yes \_\_\_\_\_ No \_\_\_\_\_. If yes, explain \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

6. Estimate number of hours the chin/nape strap was worn in aircraft O-1 \_\_\_\_\_ U-6 \_\_\_\_\_ U-1A \_\_\_\_\_ U-8 \_\_\_\_\_ OV-1 \_\_\_\_\_  
CV-2 \_\_\_\_\_ OH-13 \_\_\_\_\_ UH-1 \_\_\_\_\_ CH-47 \_\_\_\_\_ OH-23 \_\_\_\_\_ UH-19 \_\_\_\_\_  
OTHER \_\_\_\_\_:

(Specify)

7. Did the device show any sign of wear? Yes \_\_\_\_\_ No \_\_\_\_\_

8. Did any of the components of the device have to be replaced?  
Yes \_\_\_\_\_ No \_\_\_\_\_

9. Is this device easy to keep clean? Yes \_\_\_\_\_ No \_\_\_\_\_

10. Do you consider this device as an improvement over the chin and nape straps on your APH-5 prior to this test? Yes \_\_\_\_\_ No \_\_\_\_\_

REMARKS \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

NAME \_\_\_\_\_

RANK \_\_\_\_\_

SN \_\_\_\_\_

ORGN \_\_\_\_\_

DUTY PHONE \_\_\_\_\_

DUTY (Check One - Pilot \_\_\_\_\_ Crewchief \_\_\_\_\_ Gunner \_\_\_\_\_ Aidman  
Observer \_\_\_\_\_.)

DATE \_\_\_\_\_

## APPENDIX II - DEFICIENCIES AND SHORTCOMINGS

A. Deficiencies. The following deficiencies were discovered during the conduct of this test:

<u>Deficiency</u>	<u>Suggested Corrective Action</u>	<u>Remarks</u>
1. The nylon netting of the retention device was highly flammable.	None.	
2. The chin-strap pad was too large, hard, and rough. The edges and corners were sharp.	Use present chin-strap pad or make a contoured pad without a rough surface and sharp edges.	Crewmember discomfort was such that the chin straps were loosened or unsnapped, thereby nullifying the retention capability of the device.
3. The chin-strap pad applied excessive pressure on the throat.	None.	
4. The nape-strap net harness knotted and folded. It chafed the skin, pulled the hair, and cut into the neck.	Reinforce the device to prevent folding as it is tightened. Possibly add pad and use flat shoestring laced through vertical rectangular grommets.	The device caused discomfort and was removed by most crewmembers as soon as test data were obtained.
5. Chin-strap fastening point was not readily accessible.	Lengthen the chin-strap attaching point one inch.	

B. Shortcomings. The following shortcomings were discovered during the conduct of this test:

<u>Shortcoming</u>	<u>Suggested Corrective Action</u>	<u>Remarks</u>
1. The device fitted the helmet poorly.	Make one size device for each size helmet in the system. Insure that all devices of the same size are uniform.	All devices were issued as one size, but were not uniform.
2. Snap fastener failed.	None.	Only one occurrence.
3. Installation instructions were inadequate for some installations.	Make installation instructions comprehensive to cover all installation.	

### APPENDIX III - REFERENCES

1. Letter, BAAR-HF, US Army Board for Aviation Accident Research, 13 August 1965, subject: "Nylon Net Helmet Retention Device."
2. "Proposed Qualitative Materiel Requirement (QMR) for Aircrewman Protective Headgear," Headquarters, US Army Combat Developments Command, 15 November 1965.
3. Letter, US Army Natick Laboratories, 20 December 1965, subject: "Request for Product Improvement Test of Retention Device for Helmet, Flying Protective."
4. Plan of Test, USATECOM Project No. 4-6-4252-01, "Product Improvement Test of Pilots Protective Headgear Retention Device," US Army Aviation Test Board, 28 March 1966.

APPENDIX IV - DISTRIBUTION

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13. ABSTRACT The US Army Aviation Test Board (USAAVTBD) conducted the product-improvement test of the Pilot's Protective Headgear Retention Device at Fort Rucker, Alabama, during the period 1 April 1966 to 1 July 1966. The purpose of this test was to determine whether the retention device is an improvement over the present nape and chin straps used in the APH-5 Helmet. Twenty of the devices were installed and worn by personnel assigned to the USAAVTBD. Data were obtained from the crewmembers by questionnaires and personal interviews. Five deficiencies and three shortcomings were discovered. The deficiencies were: (1) the nylon netting of the retention device was highly flammable, (2) the chin-strap pad was too large, hard, and rough and the edges and corners were sharp, (3) the chin-strap pad applied excessive pressure on the throat, (4) the nape-strap net harness knotted and folded, chafed the skin, pulled the hair, and cut into the neck, and (5) the chin-strap fastening point was not readily accessible. It was concluded that the proposed retention device, although having an improved retention capability, is unacceptable for Army use because of the discomfort and inherent design deficiencies and that the device does not provide an overall improvement over the standard APH-5 chin and nape straps. It was recommended that the retention device, as tested, be considered unsatisfactory for Army use with the APH-5, that the deficiencies be corrected and the shortcomings be corrected as practicable, that additional design refinements be incorporated to reduce crewmember discomfort, and that the device be re-tested after modification. (U)		

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
US Army Aviation Test Board						
Fort Rucker, Alabama						
Product-improvement test						
Pilot's Protective Headgear Retention Device						
Physical characteristics						
Ease of installation						
Adjustability						
Helmet retention improvement						
Discomfort						
Interference with performance of duty						
Nape and chin straps						
Deficiencies						

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