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A FIELD EVALUATION OF THE COMPATIBILITY OF THE PROTECTIVE INTEGRATED HOOD MASK WITH ANVIS NIGHT VISION GOGGLES (U)

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An evaluation was conducted to determine potential compatibility problems found while wearing the Protective Integrated Hood Mask (PIHM) with the Aviator's Night Vision Imaging Systems (ANVIS). The PIHM is worn under a standard HGU-55/P helmet and is designed to protect USAF aircrew members in a chemical environment. ANVIS is mounted in front of the PIHM visor using a special bracket. The evaluation consisted of tests performed at Pope AFB, NC using qualified C-130E crewmembers. Examinations of horizontal and vertical intensified fields of view, cockpit lighting compatibility, and a limited fit evaluation were conducted. Testing showed that ANVIS/PIHM viewing resulted in average losses of horizontal and vertical fields of view of 2.6 degrees and 2.1 degrees. C-130E cockpit lighting interference was not found when viewing through the ANVIS/PIHM, or under the ANVIS through the PIHM visor. No significant problems in achieving proper fit with ANVIS/PIHM were found. Overall conclusions were that potential compatibility problems of ANVIS and PIHM integration can be reduced or eliminated with proper fit and adjustment of the ANVIS/PIHM.

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Summary

A field evaluation was conducted on the Protective Integrated Hood Mask (PIHM) to determine its compatibility with the Aviator's Night Vision Imaging System (ANVIS). PIHM will be used by tanker, transport, and bomber aircrews for protection in a chemical environment. ANVIS is a night vision goggle currently used by these same aircrews to aid in visual performance during night missions. The evaluation was conducted at Pope AFB, NC using qualified C-130E aircrew with ANVIS experience.

Parameters which were evaluated include: intensified field of view, cockpit lighting interference, and subjective and photographic assessments of fit. The approach for the evaluation was to compare visual performance with PIHM/ANVIS to performance through ANVIS alone. The fit assessments were completed to allow users the opportunity to comment on fit, and to document specific fit problems.

The results for the intensified field of view test showed no significant reduction in field of view when the PIHM was donned. No cockpit lighting interference was found when viewing underneath ANVIS through the PIHM visor, and viewing through the PIHM/ANVIS combination. All subjects reported no major fit problems when using PIHM/ANVIS, with the exception of some restricted head mobility when PIHM was employed.

As a result of this evaluation, it became evident that proper training procedures for donning the PIHM with ANVIS need to be developed and adopted. Optimal visual performance was primarily achieved because the subjects who participated in the evaluation had assistance in donning the equipment from a life support specialist. This specialist ensured exact fit of the PIHM and proper alignment of ANVIS. It is possible that reductions in visual performance will occur if proper PIHM/ANVIS fit is not achieved.

Preface

This evaluation was completed under work unit 7184-18-07 by members of the Crew Systems Effectiveness Branch, Human Engineering Division, Armstrong Aerospace Medical Research Laboratory, Wright Patterson Air Force Base, Ohio and Logicon Technical Services, Inc., Dayton, Ohio. Funding was provided by the Life Support Systems Programs Office (HSD/YAGD).

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Introduction

The Aircrew Eye Respiratory Protection System (AERPS) is designed to protect USAF aircrew members in a potential or known chemical environment without imposing physiological burdens or degrading mission capability. The Protective Integrated Hood Mask (PIHM) is the candidate subsystem of AERPS for use by aircrew members of tanker, transport, and bomber aircraft. The PIHM is designed to be worn under a standard HGU-55/P flight helmet.

Prior to C-130E flight testing, the Life Support SPO (HSD/YAG) requested AAMRL/HE to evaluate potential compatibility problems that may result from wearing the Aviator's Night Vision Imaging System (ANVIS) with the PIHM (see Figure 1). While wearing the PIHM, ANVIS is mounted to the helmet using a special bracket that allows the night vision goggles (NVGs) to be positioned just in front of the PIHM visor. The mounting bracket used was designed by the Special Mission Operational Test and Evaluation Center (SMOTEC) for pilots of special operations aircraft. Integration of the PIHM with ANVIS results in the PIHM visor being located between the user's eye and the ANVIS objective lens. Since there are normally no obstructions between the eye and ANVIS, integration of the PIHM with ANVIS could result in visual limitations during NVG missions. Specific concerns raised by HSD/YAG included: reductions in ANVIS intensified field of view, loss of visual acuity, cockpit lighting interference produced by glare from the visor, PIHM/ANVIS combination fit, and distortion and transmissivity of the PIHM visor.

The AAMRL Night Vision Operations (NVO) Laboratory, in support of the AERPS evaluation, conducted both on-site and laboratory testing to assess these compatibility issues. The on-site evaluation was completed at Pope AFB NC using qualified C-130E pilots to examine the PIHM/ANVIS intensified field of view, cockpit lighting compatibility, and PIHM/ANVIS fit. The results of the laboratory evaluation are described in a separate AAMRL technical report [1].

Figure 1.1: PIHM/ANVIS Combination

Method

2.1 Subjects

Two C-130E pilots and three C-130E navigators participated in the evaluation. All subjects had a minimum of 100 hours of NVG flight experience. Each subject was fitted with a HGU-55/P helmet and the proper PIHM prior to the evaluation. Three subjects wore a medium PIHM and two wore a large PIHM. Life support specialists from Eglin AFB assisted each subject in donning the PIHM and achieving a proper fit.

2.2 Apparatus

The evaluation was conducted in a darkened hangar at Pope AFB after dusk. Natural lighting conditions approximated a quarter moon illumination level, thus requiring no additional lighting during the evaluation. Intensified field of view measurements were obtained for each subject using a 5 ft. square visual field (see Figure 2.1). A light emitting diode (LED) positioned in the center of the field was used as a fixation point. A second LED which moved along a vertical and horizontal scale, was used to measure the vertical and horizontal intensified fields of view. The crewstation of a C-130E (shown in Figure 2.2) was used for the cockpit lighting interference evaluation.

2.3 Procedures

Intensified Field Of View (FOV) Measurements

Measurements of the horizontal and vertical intensified FOV were performed on each subject wearing the HGU-55/P helmet and the ANVIS. A baseline measurement without the PIHM was recorded first, followed by a measurement with the PIHM/ANVIS combination. Subjects were seated so that the ANVIS oculars were at a distance of 6 ft. from the LED

Figure 2.1: Apparatus Used to Measure PIHM/ANVIS Intensified Field of View

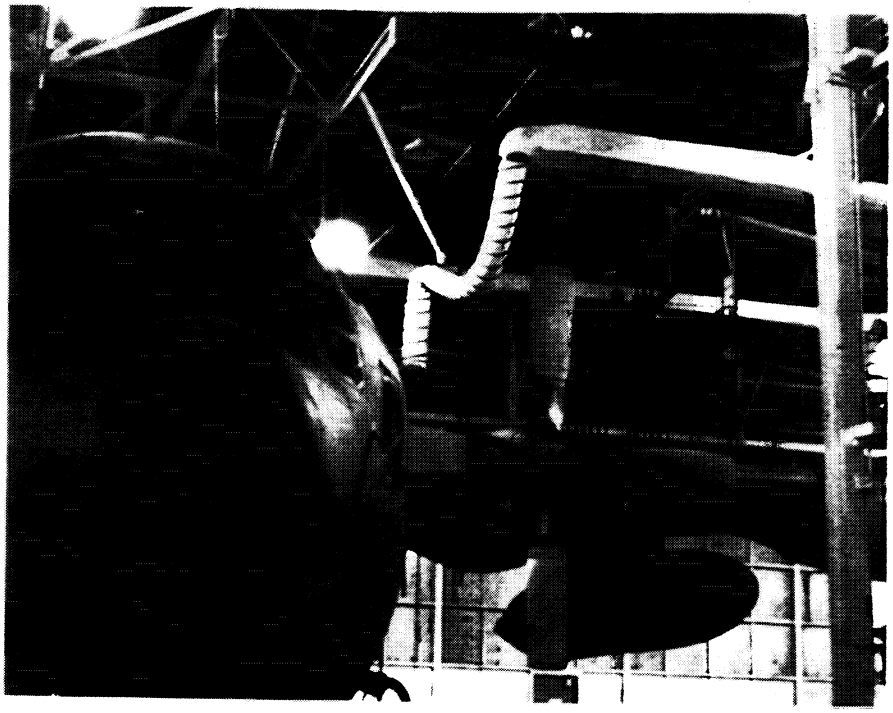

Figure 2.2: C-130 Aircraft Used for Cockpit Lighting Evaluation

fixation point. Subjects were positioned in a chin rest to restrict head movement during the measurements. After adjusting the NVGs, the subject was instructed to close one eye and fixate on the center LED. The experimenter then moved a second LED inward along a vertical or horizontal scale beginning at a 22 degree FOV. The subject indicated when the LED was just visible at the edge of the intensified field. This procedure was repeated twice for each eye in both the vertical and horizontal dimensions. The average of the two left and right side measurements was added together to obtain the total FOV for each eye. After baseline FOV was measured, the subject donned his prefitted PIHM/ANVIS combination with the assistance of the life support specialists. The FOV for the PIHM/ANVIS combination was then measured following the same procedure.

Cockpit Lighting Interference

Cockpit lighting interference was evaluated for two different viewing modes: 1) viewing through the PIHM/ANVIS combination and 2) viewing through the PIHM visor but underneath the NVGs. Subjects performed the cockpit lighting evaluation seated at the pilot's station of the C-130E cockpit. The subject was asked to set cockpit lighting at a comfortable NVG mission level. He then viewed an acuity chart positioned at eye level 20 ft. from the windscreen and indicated any reflections that were present. The sources causing the reflections were documented. Subjects then viewed the crewstation through the PIHM but underneath the NVGs and noted any reflections. If no interferences were noted, the test was terminated.

Photographic Evaluation of PIHM/ANVIS Anthropometric Fit

Front and side view photographs were taken of each subject wearing the ANVIS both with and without the PIHM. The photographs were used as documentation to assess any specific fit problems with the PIHM/ANVIS combination.

Evaluation of the PIHM/ANVIS Anthropometric Fit and Visibility

A questionnaire which addressed the PIHM/ANVIS fit and visibility was administered to each subject at the conclusion of the tests outlined above. The questionnaire is included in Appendix 5.1.

Results

3.1 Intensified Field of View Measurements

Tables 3.1 - 3.3 summarize the results of the intensified FOV measurements for each subject. Both horizontal and vertical FOVs are expressed in degrees of visual angle for the right and left eye positions, respectively. When averaging the measurements obtained for each eye, the horizontal and vertical FOVs measured for baseline were 38.8 and 38.1 degrees, respectively. The average horizontal and vertical FOVs measured for the PIHM/ANVIS combination were 36.2 and 36 degrees. Thus, the PIHM resulted in an average horizontal FOV loss of 2.6 degrees or 6.7 percent of baseline. The vertical FOV was reduced by 7 percent of baseline.

The ANVIS are designed to allow a 40 degree horizontal and vertical intensified FOV. Baseline measures were probably slightly less than 40 degrees because of individual differences in ANVIS adjustment and/or fit. It should be noted that each subject donned and adjusted his ANVIS without any assistance prior to the baseline measurements. Subjects were assisted when donning the PIHM/ANVIS combination and careful attention was given to proper adjustment.

3.2 Cockpit Lighting Interference

The results from the qualitative assessment of cockpit lighting interference indicated no problems for viewing through PIHM/ANVIS or through the PIHM and under the ANVIS. One subject reported reflections upon entering the crewstation when the lights were turned up. However, these reflections were no longer present when cockpit lighting was set to normal night mission levels. In addition, no lighting interference was produced when subjects moved their heads side to side while looking around the cockpit.

Table 3.1: Baseline (no PIHM) Horizontal and Vertical Intensified Field of View (in degrees) for Right and Left Eye Positions.

	HORIZONTAL			VERTICAL		
Sub.	Rt.	Lt.	AVG.	Rt.	Lt.	AVG.
1	37°	37°	37°	36°	36°	36°
2	40	39	39.5	39	36	37.5
3	40	40	40	40	39	39.5
4	39	39	39	37	40	38.5
5	38	39	38.5	40	38	39
AVG.	38.8	38.8	38.8	38.4	37.8	38.1

Table 3.2: Horizontal and Vertical Intensified Field of View (in degrees) for PIHM/ANVIS Viewing

	HORIZONTAL			VERTICAL		
Sub.	Rt.	Lt.	AVG.	Rt.	Lt.	AVG.
1	35°	35°	35°	33°	34°	33.5°
2	38	35	36.5	38	39	38.5
3	38	37	37.5	37	35	36
4	36	36	36	35	36	35.5
5	36	36	36	37	36	36.5
AVG.	36.6	35.8	36.2	36	36	36

Table 3.3: Percent (%) Change in Field of View from Baseline

	HORIZONTAL			VERTICAL		
Sub.	Rt.	Lt.	AVG.	Rt.	Lt.	AVG.
1	5.4%	5.4%	5.4%	8.3%	5.5%	6.9%
2	5	10.2	7.6	2.5	7.6	5
3	5	7.5	6.3	7.5	10.2	8.9
4	7.6	7.6	7.6	5.4	10	7.7
5	5.2	7.6	6.4	7.5	5.2	6.4
AVG.	5.6	7.7	6.7	6.2	7.7	7

3.3 Photographic Evaluation of PIHM/ANVIS Fit

Photographs were taken of each subject immediately following the FOV measurements while wearing the ANVIS both with and without the PIHM. Examination of the photographs revealed that the NVG oculars were in proper alignment for all of the subjects while wearing the PIHM/ANVIS combination. No problems were noted with the mounting bracket while wearing the PIHM. The ANVIS oculars did not come in contact with the visor when in the proper viewing position. To ensure optimal field of view the oculars were positioned as close to the visor as possible (approximately 10-20 mm). The photographs showed that for subjects 1 and 2 the oculars were tilted slightly upward during the baseline FOV measurements. As displayed in Table 1, the baseline vertical FOV measured for these two subjects was below the average measured. Photographs of baseline and PIHM/ANVIS fits are included in Appendix 5.2.

3.4 Subjective Evaluation of PIHM/ANVIS Fit and Visibility

The subjective evaluation indicated no significant problems in achieving a proper fit with the PIHM/ANVIS combination. One subject indicated that the mounting bracket needed more vertical adjustment range to ensure proper positioning of the NVGs in front of the eyes. The remaining subjects reported no problems in achieving a proper fit.

Two subjects reported that the visibility through the PIHM/ANVIS combination was better than through the NVGs alone because the "graininess in the NVGs was less" when viewing through the PIHM visor. The remaining three subjects reported that their visibility was unchanged by the PIHM/ANVIS combination. Two subjects reported restricted head mobility while wearing the PIHM/ANVIS combination which limited the range over which they could look from side to side. All subjects reported that the intensified FOV with the PIHM/ANVIS combination appeared to be the same as the intensified FOV without the PIHM. A complete summary of the questionnaire results is included in Appendix 5.1.

Conclusions and Recommendations

The evaluation described in this report was designed to examine the compatibility of ANVIS night vision goggles with the PIHM system. Both the data and observations indicated that the integration of ANVIS with the PIHM did not result in any significant compatibility problems. However, the results of this evaluation demonstrated the importance of following proper PIHM donning procedures and careful adjustment of the ANVIS to ensure optimal performance. The conclusions and recommendations drawn from each test objective are described separately in the following paragraphs.

4.1 Intensified Field of View

The PIHM/ANVIS combination resulted in small reductions in the horizontal and vertical intensified fields of view. The average reduction from the 40 degree optimal ranged between 2 and 4 degrees. This rather insignificant effect on the intensified FOV resulting from the PIHM/ANVIS combination can be attributed mostly to proper fit and adjustment. Each subject received assistance in donning the PIHM and adjusting the ANVIS mount from life support specialists prior to testing to ensure that the NVG oculars were centered over each eye and as close to the visor as possible. Without careful adjustment or proper fit, the PIHM/ANVIS combination could potentially reduce intensified field of view significantly.

The photographs of the baseline FOV measurements recorded at Pope AFB indicated that the NVG oculars were slightly tilted upward for two subjects, resulting in less than optimal FOV's. Loss in FOV could be magnified by an improper PIHM fit, and/or improper adjustment or alignment of the NVGs. Therefore, careful attention should be given to PIHM system fit as well as proper NVG adjustment prior to PIHM/NVG missions.

The mounting bracket should allow the NVG oculars to be positioned directly in front

of the eyes and level with the line of sight. The vertical adjustment range of the mounting bracket may have to be increased to ensure proper positioning. The NVGs should also be positioned as close to the visor as possible without damaging it. Optimal field of view will be achieved with the NVG oculars just touching the visor. Mole skin padding could be placed around the NVG lens to eliminate the risk of scratching the PIHM visor. It is recommended that proper training procedures be developed for donning the PIHM and adjusting the ANVIS.

4.2 Cockpit Lighting Interference Assessment

The evaluation results demonstrated no cockpit lighting interference when viewing both through the PIHM/ANVIS combination and through the PIHM visor underneath the NVGs. Crewstation lighting levels were set by each subject to preferred night mission levels. Although no interference was noted for this test, it is possible that increased cockpit illumination levels could result in reflections and/or interference with the PIHM/ANVIS combination. It is recommended that potential sources of lighting interference from the crewstation are identified and eliminated prior to NVG flights with the PIHM.

4.3 Subjective Evaluation of PIHM/ANVIS Fit

The questionnaire results and photographs indicated that the subjects were able to achieve a proper fit with the PIHM/ANVIS combination and that no discomfort was experienced. However, it is recommended that the mounting bracket be modified to allow a greater range of vertical NVG adjustment without increasing the distance at which the oculars are positioned in front of the eyes.

Bibliography

[1] Donohue-Perry, Mary M., Riegler, Joseph T., Hausmann, Martha A., "A Compatibility Assessment of the Protective Integrated Hood Mask with ANVIS Night Vision Goggles (U)", Armstrong Aerospace Medical Research Laboratory, June 1990.

Appendix

5.1 Questionnaire Results

The questionnaire administered to the five crewmembers at Pope AFB is included below. A summary of the responses made to each question is provided.

Aircrew Eye Respiratory Protection System (AERPS) NVG Compatibility Questionnaire

The purpose of this questionnaire is to evaluate the effects of viewing through the protective integrated hood/mask system (PIHM) using ANVIS night vision goggles. The questionnaire addresses visibility, field of view loss, and cockpit lighting interference while wearing the PIHM/NVG system. The results from the questionnaire will aid in determining the severity of these problems as they relate to mission success. Please use the rating scales provided and feel free to add any additional comments. Responses made on this questionnaire will be kept confidential.

Name:

Organization:

NVG Flight Hours:

Helmet Size:

Mask Size:

1. Did you notice any interference or reflectance from light sources within the cockpit when viewing:

a. through BOTH the PIHM and NVG's? Yes - 0 No - 5

b. through the PIHM but underneath the NVG's? Yes - 0 N o - 5

2. If yes, describe the sources of the interference.

"Initially with the lights up, there was interference. Decreasing the light source eliminated all reflections."

4. Describe the overall visibility through the PIHM/NVG system as compared to viewing through the NVG's alone.

(1) much worse - 0

(2) worse - 0

(3) same - 3

(4) better - 1

(5) much better - 1

"Grain in NVG is less"

5. Describe the intensified field of view when viewing through the PIHM and NVGs as compared to the NVGs alone.

(1) much worse - 0

(2) worse - 0

(3) same - 4

(4) better - 1

(5) much better - 0

6. Were you able to get a good fit with the PIHM/NVG system?

Yes - 5

"Yes, except the NVG bracket needed to be removed and screws loosened to give more vertical adjustment."

7. What were specific problems you encountered while wearing the PIHM/NVG system?

"Discomfort from PIHM wear."

"Wearing glasses, I had slight pressure on the bridge of my nose."

"Mobility"

8. How would you improve the mounting of the NVGs when used with the PIHM system?

"The Bailey mod on the Pope mount works best for 317 TAW."

"Need a bracket with more vertical range or preset brackets that can be stored for PIHM use so that they will not need to be adjusted in flight." "It was fine."

"Mounting is okay."

9. Do you have any suggestions for improvement to the PIHM/NVG system or to the NVGs alone?

"The hood unit needs to be longer to allow for the increased head movement required when wearing NVGs."

5.2 Photographic Evaluation of PIHM/ANVIS Fit

Photographs of ANVIS baseline and the PIHM/ANVIS combination fit with the HGU-55/P helmet and SMOTEC mounting bracket for four aircrew members are displayed in Figures 5.1 through 5.2.

Figure 5.1: Baseline ANVIS Fit with HGU-55/P Helmet and SMOTEC Mounting Bracket

Figure 5.2: PIHM/ANVIS Combination with HGU-55/P Helmet and SMOTEC Mounting Bracket

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