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ANNUAL PROGRESS REPORT, 1 OCTOBER 1976 - 30 SEPTEMBER 1977,(U)
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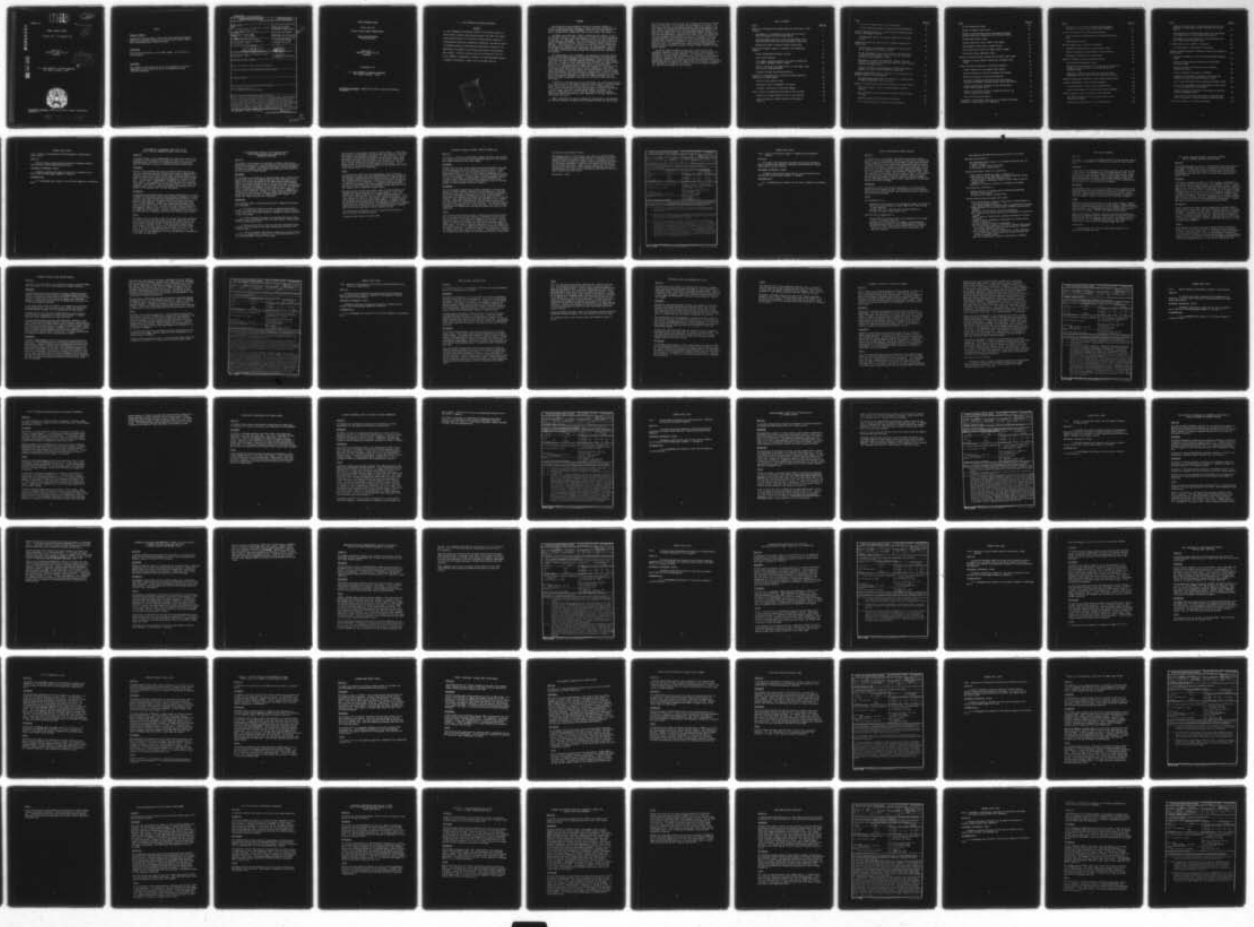

OCTOBER 1977

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# ANNUAL PROGRESS REPORT

1 October 1976 - 30 September 1977

Reported by:
Stanley C. Knapp, COL, MC
Commander



U. S. ARMY AEROMEDICAL RESEARCH LABORATORY
Fort Rucker, Alabama 36362

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UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
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| 1. REPORT NUMBER | 2. GOVT ACCESSION NO. | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle) (6) Annual Progress Report, 1 October 1976 - 30 September 1977, | | 5. TYPE OF REPORT & PERIOD COVERED Annual Progress Report 1 Oct 1976 - 30 Sep 77 |
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Annual Progress Report FY 77
US Army Aeromedical Research Laboratory

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Conduct fundamental and applied research on the medical aspects of Army aviation airborne and ground operations that affect the health, welfare and efficiency of the soldier; perform medical research on visual/auditory functions; man/machine integration; the medical aspects of nonmedical materiel; physiological/psychological response to the operational environments; and military operational training impacts upon ecology. Provides technical advisory and consultant services to all elements of Department of Defense and other government agencies in support of helicopter, combat crew and airborne medicine.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)



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# ANNUAL PROGRESS REPORT

Fiscal Year 1977

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ARMY AVIATION MEDICINE
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Reported by:
STANLEY C. KNAPP, COL, MC
Commander

30 September 1977

U. S. ARMY AEROMEDICAL RESEARCH LABORATORY
Fort Rucker, Alabama 36362

U. S. ARMY AEROMEDICAL RESEARCH LABORATORY

## MISSION

Conducts fundamental and applied research on the medical aspects of Army aviation, airborne and ground operations that affect the health, welfare and efficiency of the soldier; perform medical research on visual/auditory functions; man/machine integration; the medical aspects of nonmedical materiel; physiological/psychological response to the operational environments; and military operational training impacts upon ecology. Provides technical advisory and consultant services to all elements of Department of Defense and other government agencies in support of helicopter, combat crew and airborne medicine.

## FOREWORD

The United States Army Aeromedical Research Laboratory (USAARL) is a Class II medical research laboratory of the United States Army Medical Research and Development Command (USAMRDC), Office of The Surgeon General, and is a tenant at the United States Army Aviation Center, Fort Rucker, AL.

The USAARL was established in 1962 to perform medical research in support of Army aviation, airborne operations, and other related Army operations as directed. In recent years, the laboratory's mission has been expanded to include research, development, test, and evaluation on the medical and health aspects of nonmedical materiel, especially in advanced weapons systems and vehicles. Prime examples of this work are in the area of blast overpressure and impulse noise from modern individual and crew served weapons, analysis of the complex psychophysiologic requirements and performance of combat vehicle crews, and the impact upon ecology from selected military operations and training.

The concentration of men, equipment, and experience at the Army Aviation Center provides USAARL personnel with an ideal environment and opportunity to maintain a current knowledge of the developments in Army aviation and related activities and to provide immediate and direct support to other tenant activities. A number of other technical tenant activities are located at Fort Rucker for much the same purpose as USAARL, which is to support Army aviation in a complementary way with their own specialties. These activities include the United States Army Aviation Board, a TRADOC activity; United States Army Agency for Aviation Safety, an Inspector General activity; United States Army Research Institute (Aviation), a Deputy Chief of Staff for Personnel activity; United States Army Aircraft Development Test Activity, an United States Army Materiel Development and Readiness Command (DARCOM) activity; Deputy for Combat Developments (Aviation); and the United States Army Aviation School.

In addition to the Army activities at Fort Rucker, six allied countries maintain liaison offices at Fort Rucker along with liaison officers from the United States Marine Corps and the United States Air Force. USAARL conducts its work in close liaison with its sister aviation medicine research laboratories in the Air Force, Navy, FAA, United Kingdom, Germany, and Canada. In addition, USAARL maintains close liaison and in many situations conducts cooperative research programs with other Department of the Army laboratories and research facilities.

USAARL accomplishes its mission through the identification, investigation, and solving of medical and health related problems inherent not only to Army

aviation and airborne activities but also to combat land vehicles and their crews and other combat weapon systems and environments as directed. The laboratory's research and development programs range from fundamental and basic research to operational and applied research and development in the broad areas of physiologic optics; the psychophysiology and physics of acoustics and communication; the psychophysiologic aspects of combat crew work load and performance; biomechanics of closed, direct head trauma; the clinical, orthopedic and biomechanical effects of long-term vibration on the musculoskeletal system; medical and physiologic support of the Army crashworthiness programs; cardiovascular risk criteria associated with aviation; and clinical and biochemical indicators of fatigue and stress, to name only a few. The laboratory also conducts applied and operational problem solving as necessary to support frequent TRADOC, FORSCOM and other agency requests.

The men and women of USAARL are dedicated to the ideal that the occupation, hazards and risks associated with being a soldier deserve the laboratory's full and complete attention. The prevention of disease, injuries and individual and crew inefficiency is the object that motivates our efforts. Looking to the future, it is impossible to determine the problem areas which will be of most importance, but by maintaining a close relationship with the operational community and the occupation of soldiering, this laboratory will continue to effectively solve the problems presented to it and for which USAARL has the resources.

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# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA OD 6735 | 77 12 15 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA - CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 77 09 30 | D. Change | U(No Ch) | U | NA | NL | ☒ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E762173A819 | 00 | 015 |
| b. CONTRIBUTING | | | | |
| c. CONTRIBUTING | | | | |

11. TITLE (Precede with Security Classification Code)

(U) Research of Bioengineering Problems Medically Significant to Army Aviation

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001300 Aircraft; 002400 Bioengineering; 023300 Protective Equipment

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 66 12 | Cont | DA | C. In-House |

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER:

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: NA f. CUM. AMT.

| 18. RESOURCES ESTIMATE | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|
| FISCAL YEAR — PRECEDING | 77 | 8.8 | 345 |
| FISCAL YEAR — CURRENT | 78 | 4.8 | 95.0 |

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Lab

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TELEPHONE: (205) 255-5107

21. GENERAL USE

Foreign Intelligence Considered

20. PERFORMING ORGANIZATION

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Bioengineering & Life Spt Equip Div

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PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

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TELEPHONE: (205) 255-3001

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: HUNDLEY, T. A.

NAME: JOHNSON, J. C., CPT DA

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Aircraft; (U) Man-Machine Relations; (U) Bioengineering; (U) Human Volunteers; (U) Protective Equipment; (U) Stress Physiology; (U) Thermodynamics; (U) Safety Engineering; (U) Anthropometry; (U) Electronic and Electrical Engineering

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide valid, meaningful and medically pertinent information, new designs and equipment developments based on research with respect to immediate field aeromedical problem areas found in US Army aviation.

24. (U) The approach will always be based on sound and accepted experimental methodology, but particular techniques of application will vary as a function of the problem under investigation.

25. (U) 76 10 - 77 09. Progress in this area is reflected in the publication of four papers, continued work on helmet impact test methodologies, retest of the crashworthy troop seat, formulation of a regression equation to quantify skin temperature versus grading of skin damage, presentation of a paper on the thermal analysis program, use of in-vivo surface eletromyographic technique to assess neuro-muscular stress induced by various helmet designs. In addition, the collection of routine helmet drop test data has been programmed for computer printout. Valuable data has also been collected on the non-linear relation of the pressure-volume change in the spinal column of cats subjected to impact loads.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Research of Bioengineering Problems Medically Significant to Army Aviation

OBJECTIVE:

Provide US Army aviation medically pertinent information derived from research of bioengineering problem areas.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 3 through 7.

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

## DEVELOPMENT OF A CRASHWORTHY TROOP SEAT FOR THE UTILITY TACTICAL TRANSPORT AIRCRAFT SYSTEM (UTTAS)

### OBJECTIVE

To develop through a joint USAARL-USAAAVS and contractual effort a biodynamically sound crashworthy troop seat for UTTAS, test it statically and dynamically, and submit it to AVSCOM and Eustis Directorate Air Mobility Laboratory for dynamic evaluation and field service tests.

### BACKGROUND

Current utility passenger and troop carrying helicopter seats do not meet the crashworthy standards available with current technology and as outlined in the "Crash Survival Design Guide", Technical Report 71-22. Excessive morbidity and fatality rates result during the crash sequence. UTTAS is a new aircraft system under development as a follow-up to the UH-1. This aircraft is programmed to incorporate the latest in crashworthy design. One exception to the original design was a crashworthy troop seat. Development of the new seat constitutes a major historical landmark as the first, full-scale joint medical engineering effort to develop a safe passenger seat for Army helicopters.

### METHODOLOGY

An engineering development proposal and report, authored by Mr. Joe Haley of USAARL has been modified and revised by USAARL and USAAAVS to incorporate the latest human tolerance and orthopaedic design criteria. A joint program to fabricate aft and forward facing flight worthy prototype seats has been completed. USAARL has evaluated the prototypes using static strength analysis and the energy absorbing/attenuating characteristics have been refined. The seats have been flight evaluated for anthropometry, comfort, safety of egress, ingress and human factors in the USAARL JUH-1H helicopters. The Naval Air Rework Facility, Pensacola has fabricated four redesigned forward and four rearward facing seats.

### STATUS

The dynamic tests as outlined in the FY 76 annual report were conducted in the first quarter and the forward-facing seat passed the side load test; however, both seats failed the forward $30^0$ yaw test due to the failure of the tie-down fittings. Plans were made to repeat these tests; however, the tests could not be conducted due to other commitments by the FAA and the complete rework of their facility. It is currently planned to complete these tests in the 2d Qtr FY 78. The final report is being prepared; it will be published after incorporation of the FAA final test data.

# ELECTROMYOGRAPHIC ANALYSIS OF NECK AND BACK MUSCLE STRESS INDUCED BY WHOLE BODY VIBRATION AND ASYMMETRIC HEAD LOADS

## OBJECTIVE

The purpose of this project is to develop a reliable, sensitive and quantitative technique for evaluating muscular activity and fatigue and to apply this technique to determining the extent to which whole body vibration and asymmetric head loading effect muscular stress levels in the neck and back of human subjects.

## BACKGROUND

The inevitable use of some type of helmet mounted sight in armed rotary wing aircraft raises the following question, "Will the shift in the center of gravity of the helmet and the added weight accompanying the addition of a helmet mounted device to the existing aviator's helmet cause a significant increase in muscle fatigue of the neck and back when used in the dynamic environment of rotary wing aircraft?" The dynamics of this situation and subjective reports from the field suggest an answer in the affirmative. However, in order to make a recommendation on the medical implications of employing helmet mounted devices, one should have quantitative data to support subjective findings. This project will seek to provide this information.

## METHODOLOGY

This experiment seeks to provide data which will negate the following null hypotheses.

a. The vibration to which an aviator is exposed during normal flight in a rotary wing aircraft does not increase the muscle activity in his back or neck over that necessary to maintain a similar posture in a static environment.

b. In the vibration environment increased head mass due to heavy or asymmetrically loaded helmets does not significantly increase muscle activity in the neck or back.

c. The muscular activity of the neck and back encountered during vibration does not depend on the power-frequency distribution of the vibration input.

d. Clinically apparent physiological indications of muscle fatigue will not be accompanied by a change of one or more characteristics of the electromyographic activity of the muscle.

The first part of the project consists of three sections. In the first, head loading is maintained as a constant while the vibration, simulating that found in the helicopter environment, is turned on or off. In the second part, the vibration environment is maintained throughout while the load on the head of the test subject will be varied. In the third part, the head loading of the subject is held constant while the frequency content of the vibration environment will be varied. In the second part of the project vibration effects on the neuromuscular system of the forearm flexors is investigated.

STATUS

Six subjects were studied for electromyographic signs of vibration induced muscle stresses. The study indicated that both mean voltage and full weighted integrated EMG are reliable indicators of muscle stress. Peak voltage counting serves as an indicator of the muscle tension, but it is more difficult to implement. A statistical routine was added to the EMG analysis program; this routine determines mean and standard deviation on each EMG parameter and performs a linear regression on the time sequence data to determine fatigue effects.

EMG activity due to stress from several kinds of infantry helmets was recorded from the neck extensors of six test subjects. This study compared the stress of wearing a M-1 standard infantry helmet, a 32 $oz/ft^2$ Kevlar PASGT helmet*, and a 38 $oz/ft^2$ Kevlar PASGT helmet. This study revealed a slight, but statistically significant difference in EMG output between the 32 and 38 $oz/ft^2$ PASGT helmets. A computer program for analyzing the digitized EMG data was developed to provide a direct determination of stress differences. The reduced data which this computer program provides is compatible with the multivariant analysis program which will be used next year to further analyze the data.

This program was transferred to an ILIR account during the year, in order to receive the required funding.

*Personnel Armor System for Ground Troops.

## MATHEMATICAL MODEL OF THERMAL TRANSFER THROUGH SKIN

### OBJECTIVE

To determine mathematical relationships between heat input and resultant burn production in skin and to verify published studies of the relationship between temperature and tissue damage.

### BACKGROUND

Although there has been a considerable amount of experimental work done on burn production and thermal protective clothing, there is a great deal of disagreement over the interpretation of the results. This disagreement arises as a result of the incomplete understanding of the nature of burn production and the factors involved in thermal protection in a given environment. A computer model of the thermodynamic factors involved in burn production and thermal protection should provide valuable insights into the nature of these problems as well as improved methods for testing thermal protective clothing.

### METHODOLOGY

An initial computer program using constant parameters of conductivity, density, and heat capacity (simulating a uniform material), with heat conduction in only one direction will be written to determine whether or not an iterative method of computation will give accurate answers. Furthermore, this program will determine the increment sizes of time and distance. After these parameters have been determined a final program with heat conduction in two dimensions and with three layers of skin will be written. The results of this program will be correlated against burn data as presented by Stoll, Hardy, and Knox. The results of these correlations will demonstrate relationships between heat input and burn production.

### STATUS

The Louisiana State University School of Medicine acquired the original burn tissue specimen from the University of Rochester classic thermal work of the 50's. The tissues were remounted, cut, reread with microtechniques used for this project and added to the data base. The burn depths, corrected for shrinkage, were found to be 46 percent deeper in dermal burns. The effect of ambient temperature on pig skin temperature was studied to see if skin temperatures could be calculated on the basis of ambient temperature. A regression equation was formulated to quantify skin temperature versus depth of skin damage. Photographs were selected to represent gross burn grades and some data was selected to show patient

survivability versus degree of burn.

The expected results of this contract are critical to the development and standardization of a non-biologic method of evaluating the clinical thermal protection afforded by various fabrics. The results and conclusions of this research will hopefully form the fundamental foundation for the Medical Department's position on the selection of thermal protective clothing for flyers, combat vehicle crewman, and fire fighters. The successful completion of this burn model will perhaps lead to its standardization as a major national standardized math model of deep skin burns and burn protective fabrics.

Publications: None.

## RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA OD 6734 | 77 12 15 | DD-DR&E(AR)636 |

| 3. DATE OF NEW SUMMARY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA: CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 77 09 30 | D. Change | U(No Ch) | U | NA | NL | [X] YES [ ] NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E762158A819 | 00 | 055 |
| b. CONTRIBUTING | | | | |
| c. CONTRIBUTING | | | | |

11. TITLE (Precede with Security Classification Code)

(U) Direct Field Research Support to Immediate Army Aeromedical Problems

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001300 Aircraft; 006000 Escape Rescue and Survival; 013300 Protective Equipment

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 64 06 | Cont | DA | C. In-House |

17. CONTRACT GRANT

a. DATES/EFFECTIVE — EXPIRATION:
b. NUMBER
c. TYPE — d. AMOUNT:
e. KIND OF AWARD: NA — f. CUM. AMT.

| 18. RESOURCES ESTIMATE | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|
| FISCAL YEAR — PRECEDING 77 | 3.5 | 170 |
| FISCAL YEAR — CURRENT 78 | 6.28 | 56.5 |

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Lab

ADDRESS: Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL

NAME: KNAPP, Stanley C., COL, Cdr

TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: US Army Aeromedical Research Lab
Bioengineering & Life Spt Equip Div

ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

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TELEPHONE: (205) 255-3001

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: CURRENT, J., CPT

NAME: SLOBODNIK, B., LT

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Circadian Rhythm; (U) Aircraft; (U) Protective Equipment; (U) Human Factors Engineering; (U) Stress Physiology; (U) Machine Relations; (U) Drugs; (U) Safety; (U) Personnel Selection and Maintenance (Medical).

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) Provide US Army aviation with sound and timely bioengineering information to solve operational problems generated in the interface of the physical and life sciences.

24. (U) The techniques employed will vary, depending on the problem area, but will be based on sound accepted experimental methodology designed to provide the required information as expeditiously as possible.

25. (U) 76 10 - 77 09. Progress in this area is reflected by two publications on SPH-4 helmet usage and serviceability, one publication for the Life Support Equipment Retrieval Program (LSERP), implementation of a major injury reducing Equipment Improvement Report on LSE, and continued effort to develop an automated inflight blood pressure monitor. A polar coordinate system was outlined about a headform c.g. for use as a standard photographic documentation method for all retrieved damaged helmets. Accident and injury data from the LSERP program were presented to Generals Canedy, Harrison and Smith with appropriate emphasis placed on a centralized management system for LSE and the promotion of an enlisted MOS career field.

* Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Direct Field Research Support to Immediate Army Aeromedical Problems

OBJECTIVE:

To provide valid, meaningful and medically pertinent information based on research with respect to immediate field aeromedical problem areas found in US Army aviation.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 10 through 17.

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

## GENERAL BIOENGINEERING SUPPORT FUNCTION

### OBJECTIVE

To provide an easily accessible investigatory, educational and consultative function to government agencies in those areas of engineering, design, production and evaluation of equipment, systems and sub-systems in Army aviation for which a physiologic man-machine interface occurs. Inquiries and requests for answers to operational problems are received daily that often require literature searches, short experiments, field evaluation in-flight evaluation of aviators undergoing diagnostic work-ups at the Aeromedical Center, and attendance at equipment IPR's, material need (MN) working groups, mock-up reviews, as well as participation on multiple national and international scientific groups to include American National Standards Institute Committees, National Academy of Science, NATO-AGARD Aerospace Medical Panel, Committees or the Aerospace Medical Association and others.

### METHODOLOGY

Consultation service, well-defined experiments, on-site evaluations, specification and document reviews, coordination and liaison functions, and lecturing are some techniques used to provide practical solutions to these operational problems.

### STATUS

Voting memberships in:

- Aeromedical Consultant Board, Army Aeromedical Center, Ft Rucker, Al.
- American National Standards Institute (ANSI) Z90.1 Vehicle Crash Helmet Committee
- Chairman, ANSI, Z90.1 Sub-committee on Helmet Durability
- Chairman, Tri-Service Impact Panel (TIP)

Appointed Working Memberships to:

- National Materials Advisory Board ad hoc committee on Fire Safety Aspects of Polymeric Materials.
- Aerospace Medical Association Environmental Safety Committee
- NATO-AGARD Aerospace Medical Panel (ASMP) Biodynamics Committee
- AAH and UTTAS Source Selection Evaluation Board, ad hoc Crashworthiness Contract Review Boards, Eustis Directorate, Air Mobility Laboratory

NATO-AGARD/PEP-SMP-ASMP Working Group on Aircraft Fire Safety

Appointed Consultantships:

NATO-AGARD/ASMP Medical Aspects of Helicopter Operations and Life Support Equipment
Ft Rucker Accident Investigation Board
US Army Agency for Aviation Safety

Teaching appointments formal or by invitation:

Flight Surgeon, Aeromedical Center, Ft Rucker, AL
Global Medicine Course, Department of Preventive Medicine, Walter Reed Institute of Research, Washington, DC.
Aircraft Accident Investigators Course, Arizona State University, Tempe, Arizona
Department of Education, University of Alabama at Birmingham.

Participation by invitation to:

Working Party 61, Air Standardization Coordinating Committee
Army-Navy Research Panel
Tri-Service Life Support Equipment Panel

Directed Consultations and Support Acitivities:

UTTAS Program Manager, Technical Consultation as working member to UTTAS Source Selection Board.
UTTAS Program Manager, Co-chairman, COEA on crashworthiness features.
Edgewood Arsenal, XM 29 Gas Mask Project, Technical and Laboratory Support.
XM1 Vehicle Project Officer, Technical Consultation.
ASCC, Technical Consultation and review of standards of significance to Army.
USAAAVS, Technical Consultation, teaching and analysis of special accidents.
Aeromedical Center, Aeromedical Consultation for aviator flying status dispositions.
AAH Project Manager, Technical Consultation.
Eustis Directorate Air Mobility Laboratory, Technical Consultation and in-house laboratory support of Army safety and crashworthiness programs Specification review.
Natick Laboratories, Technical Consultation, in-house laboratory support design input, and specification review on helmet and personal equipment programs.
Night Vision Laboratories, Technical Consultation on helmets.

## CRASH INJURY ECONOMICS

### OBJECTIVE

This study is an economic and manpower analysis of Army aircrew injuries and deaths to determine their contribution to total aircraft accident costs.

### BACKGROUND

In the usual cost assessment of helicopter accidents, only the aircraft is considered. The tremendous cost of emergency medical care, medical follow-up, long term disability benefits and/or death benefits to the next of kin are not considered. Dollar values become a common denominator between people and objects and influence managerial and policy decisions which will ultimately determine Army aircraft crashworthiness and the quality of personal protective equipment.

### METHODOLOGY

Using USAAAVS files, a list of US servicemen killed or injured in Army AH-1G helicopters has been compiled for FY 71-76. Personnel costs were determined using figures published by DCSPER in DA circulars and by individual communications with military and VA hospitals to determine type of treatment, length of stay and cost of individual treatment.

### STATUS

USAARL was invited to participate in a study of AH-1 (Cobra) accidents with the US Army Agency for Aviation Safety, USAAAVS. USAARL evaluated injuries, assisted in determining cause, and estimated hospital stay/time lost from duty. This information was used to compute injury costs as specified in the August 1976 DODI "OSHA Reporting Procedures."

Requests for details concerning individual injuries and compensation were denied by USAAAVS, Veteran's Administration and the Social Security Administration due to Privacy Act restrictions. No further effort is planned on this for the immediate future due to these administrative restrictions placed on gathering detailed injury cost data.

Publications:

A report on the AH-1 (Cobra) Accident/Injury Study will be published by USAAAVS next year.

## LIFE SUPPORT EQUIPMENT RETRIEVAL AND ANALYSIS PROGRAM AND LIFE SUPPORT EQUIPMENT EXHIBIT (LSERP)

### OBJECTIVE

To perform bioengineering analysis, evaluation and injury correlation of life support equipment that has been subjected to an aircraft crash environment. To integrate hardware and material with the biological requirements of man and insert technical and scientific data into the developmental cycle that will result in product improvement and new design criteria.

### BACKGROUND

Life support equipment involved in aircraft accidents is subjected to its ultimate test with human subjects. Until November 1971, this equipment was not formally being evaluated after aircraft accidents. Improvements in life support equipment had, therefore, been made on an empirical, haphazard basis. AR 95-5 requires the president of an aircraft accident investigation board to send all pieces of life support equipment involved in either injury causation or prevention to USAARL for biomedical and engineering evaluation. From these exposures, and the uniquely valuable data resulting from their analysis, recommendations for product improvement or design criteria will be established on a sound basis. The data obtained can never be safely duplicated with human subjects.

### METHODOLOGY

AR 95-5 requires the flight surgeon assigned to the accident investigation board to examine the life support equipment involved in aircraft accidents and to send items implicated in injury causation or prevention to USAARL. A biomedical and engineering evaluation and injury correlation is performed on equipment received. Data obtained is coded and added to information stored at USAAAVS. Pathology data from AFIP (JCAP) is integrated as appropriate. Periodic statistical analysis of all data are performed by USAAAVS.

### STATUS

Major progress was made in identifying design problems in helmet retention during the accident sequence and changes are being effected which will save many aviator lives. A coordinate system was developed to enable computerization of retrieval helmet damage. Accident and injury data from the retrieval program were presented to General Canedy, General Harrison, and General Smith which placed appropriate emphasis on a Centralized Management System for LSE and the institution of an

enlisted MOS career field in LSE Army wide. National attention was focused on the ALSE maintenance and training deficiencies by Aerospace Medicine and SAFE articles published by SSG Johnson, Lt Slobodnik, and LTC Treanor. Preliminary planning to incorporate an Air Force Officer in the USAARL ALSE Retrieval Program was accomplished which will ultimately see the realization of a tri-service function at USAARL.

Publication of the following:

Treanor, J., Cold Weather Aviation Psychology: A Case Report, Aviation Space and Environmental Medicine, 48, 377-379, April 1977.

Slobodnik, B. and W. Nelson, Service Life Analysis of the SPH-4 Aviator Helmet, Aviation Space and Environmental Medicine, 48, 1058-1067, November 1977.

Johnson, G. and J. Treanor, The Helmet Protects the Aviator's Head---Or Does It?, Safe, 7, 20, Fall Quarter 1977.

## MEDICAL, PHYSIOLOGIC AND HUMAN FACTORS OF LONG RANGE, LARGE SCALE AERIAL TROOP DEPLOYMENTS

### OBJECTIVE

To delineate those factors associated with transmeridian, large scale troop deployments that will have a degrading effect on combat units and individual soldier performance, efficiency, and combat effectiveness. To study the identified parameters in detail and arrive at pragmatic operational solutions that can be implemented in existing contingency plans, deployment doctrine and medical operations annexes. To recommend implementation of solutions.

### BACKGROUND

Current national and international policy, military strategy and tactics and aviation technology indicate large troop deployments of the future will be made aerially. Problems inherent in protracted aerial flight among combat personnel are not known.

### METHODOLOGY

Study selected large scale long range deployments with the intent of identifying environmental, psychological, physiological and operational problem areas.

Develop experimental protocols to study specific problem areas.

Collate experimental results into operational recommendations.

### STATUS

A protocol has been developed to study the problem of sleep loss and time for sleep recovery. The independent variables will include, but are not limited to, exposure to altitude, environmental noise, dehydration, high density seating, long period of sitting without exercise and transmeridian translocation. Joint Army Medical Laboratory protocol to collect physiological, psychological and performance data during an operational deployment was completed and staffed at AMRDC in 1973. Readiness Command has accepted and implemented recommendations for improved troop comfort and convenience during deployments. Continual consultations will be provided to operational commands at their request.

No further effort was expended on this project.

Publications: None.

# AUTOMATED INFLIGHT BLOOD PRESSURE MONITOR

## OBJECTIVE

The objective of this project is to develop a noise and vibration immune vital sign monitor for use in the evacuation of combat casualties.

## BACKGROUND

Inflight monitoring of blood pressure in patients transported by helicopters cannot be done using conventional sphygmomanometers currently utilized in hospitals and other medical facilities. Vibration and noise inherent in rotary wing aircraft operation negate usual procedures employing a stethoscope positioned over an appropriate artery and a BP cuff secured around an extremity.

In the rotary wing aircraft environment it is impossible to ascertain with reproducibility or accuracy the systolic sounds, the muffling or Korotkoff diastolic sounds, or the disappearance of these sounds.

A method, without the constraints enumerated above, must be found so that inflight or ground monitoring within the helicopter or ground ambulance can be accomplished in a practical manner.

If actual blood pressure data were made continually available so that shock trends could be spotted promptly, flight personnel could elect to land at a safe spot for patient stabilization or employ inflight measures to stabilize the patient enroute to a place of definitive medical treatment. Without this blood pressure information it is possible to compromise the patient, while treatment would allow these individuals to arrive at their ultimate medical destination in a condition better able to withstand the medical rigors they have yet to endure.

## METHODOLOGY

A standard Sphygmomanometer cuff will be used to occlude the brachial artery as in the standard method of blood pressure determination using auscultation. However instead of using a stethoscope to determine the points at which systolic and diastolic blood pressure occur, an ultrasonic blood flow monitor will be used. The relationship between the blood flow in the artery and the points of systolic and diastolic pressure will be determined. The effect of vibration and acoustical noise on the signals received from the ultrasonic flowmeter will be analyzed and from this data the necessary analog filtering and digital processing required to extract blood pressure information from the noisy signal will be developed.

Concurrent with the program to develop a high degree of noise immunity, will be a program to develop a microprocessor based controller to handle the internal operation of the monitor. The microprocessor will regulate the input of physiological data from the subject, and the pressure in the occluding cuff and from this data will compute essential life sign parameters subsequently displaying the results. In addition to this function, the microprocessor will also control inflation and deflation of the occluding cuff, and perform routine checks and adjustments in the calibration of processing electronics.

Once the signal conditioning and control electronics have been designed a breedboard circuit will be assembled and tested. Further refinements will then be made as required to attain the desired degree of noise and vibration immunity. Following this phase a contract will be let to produce a portable unit which may be tested under actual field conditions in rotary wing aircraft ground ambulances and armored personnel carriers.

STATUS

The memory and interfacing capability of the prototype microprocessor-based control unit for the blood pressure device has been expanded. The unit now has 4,096 words of non-volatile memory which will hold the controller software. Digital input/output has been combined with an analog-to-digital conversion module to process analog (i.e., pressure, doppler blood flow) signals. System software such as tape handlers, assemblers, and debug routines have been ordered to facilitate writing of controller software.

An automated non-ausculatory blood pressure device advertised as noise immune was field tested. Results showed its total unacceptability in the helicopter environment.

Graduate student research has been initiated at Wright State University to develop a suitable cuff for holding the ultrasonic doppler probe.

## RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA OE 6733 | 77 12 15 | DD DR&E(AR)636 |

| 3. DATE PREV SUMRY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8A. DISP'N INSTR'N | 8B. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 77 09 30 | C. Change | U(No Ch) | U | | NL | ☒ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 61101A | 3A161101A91C | 00 | 287 |
| b. CONTRIBUTING | | | | |
| c. CONTRIBUTING | | | | |

11. TITLE (Precede with Security Classification Code) (U) Research of Bioengineering and Vibration problems medically significant to Army aviation

12. SCIENTIFIC AND TECHNOLOGICAL AREAS
001300 Aircraft; 002400 Bioengineering; 015600 Solid Mechanics

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 74 07 | Cont | DA | C. In-House |

17. CONTRACT/GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: NA f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 2.4 | 20 |
| | CURRENT 78 | 2.4 | 88.6 |

19. RESPONSIBLE DOD ORGANIZATION
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21. GENERAL USE
Foreign Intelligence Considered

20. PERFORMING ORGANIZATION
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Bioengineering & Life Spt Equip Div
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SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS
NAME: JOHNSON, John C., CPT, MS
NAME: ERHARDT, Thomas M. SP5

22. KEYWORDS (Precede EACH with Security Classification Code)
(U) Man-Machine Relations; (U) Protective Equipment; (U) Stress Physiology; (U) Safety Engineering; (U) Anthropometry; (U) Musculoskeletal Systems

23. TECHNICAL OBJECTIVE. 24. APPROACH. 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To determine the short-term clinical effect of helicopter vibration on the musculoskeletal system and to develop an orthopaedically, anthropometrically sound helicopter crew seat to reduce vibration effects.

24. (U) Prospective clinical and epidemiologic study using physical examination subjective reporting forms, Norland Bone Mineral analysis, biochemistry, and x-ray techniques. Seat design and validation will be accomplished statically and dynamically on a three degree of freedom, man-rated vibration table using dynamic EMG techniques Pilot performance and efficiency are studied. Animal models are used and the techniques of tetracycline bone labeling and scanning electron microscopy of the joint surfaces are employed.

25. (U) 76 10 - 77 09. FY 77 ILIR funds have enabled the completion of several projects on the Multi-Axis Helicopter Vibration Simulator (MAHVS). The simulator was approved for human use for two projects. All fail-safe systems were fully implemented and tested. The following projects were completed using the vibration facility this FY: "Development of Measurement Techniques for Medical Assessment of Visually Coupled System Components" (separately reported on by the Bio-Optics Division). "Electromyographic Analysis of Neck and Back Muscle Stresses Induced by Whole Body Vibration and Asymmetric Head Loads" and Preparation for animal modeling studies on the effects of vibration of joints was completed with the animal exposure starting at the beginning of FY 78. Investigation in the area of joint surface changes was conducted primarily with scanning electron microscopy techniques. A clinical study to examine various influences on bone growth and remodeling by bone mineral densitometry was begun. The human use approval for this project delayed the start initially, but the project involving 150 subjects just entering basic training is now underway.

*Available to contractors upon originator's approval

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A 1 NOV 68 AND 1498-1 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE

* U.S. GPO: 1974-540-843/8691

GENERAL DETAIL SHEET

TITLE: Research of Bioengineering and Vibration Problems Medically Significant to Army Aviation

OBJECTIVE:

To provide valid, meaningful and medically pertinent information based on research with respect to immediate field aeromedical problem areas found in US Army aviation.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 20 through 25.

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

# ARMY-AIR FORCE VIBRATION STUDY

## OBJECTIVE

To determine the effects of helicopter vibration on bone-growth dynamics and possible damage to joint surfaces.

## BACKGROUND

The effect of vibration as a work hazard has far reaching consequences for both military and civilian occupations. While the military aviator experiences vibration in all aircraft, it is greatest in the helicopter environment. The results of long-term, low frequency vibration are unknown; however, recent studies on animals at Wright-Patterson Air Force Base indicate that musculoskeletal changes to the intervertebral disc do take place. Chronic vibration of various character and frequency affects the musculoskeletal system in a number of ways.

A recent study of 128 pilots disclosed that 87.5% suffered from back pain generally after 300 hours of flying time. Pilots with slight pathologic conditions of the spinal column began to complain of recurrent low back pain after 50 to 100 hours of flying time. The average figure cited in this study indicates that the threshold of appearance of "pain" occurs when one flies four to five hours per day, 40 to 50 hours per month.

## METHODOLOGY

The clinical study involved a group of new aviators and a non-flying control group. These groups were observed to determine any vibration related changes. The groups were examined at similar intervals corresponding to the beginning of flight training, after two months of flight training, and after about 18 months at the termination of the study. Anthropometric measurements, radiological studies, blood chemistry, and bone mineral density determinations, as measured by photon absorption, were made.

The pilot animal study was done using miniature swine as a model for studying the early effects of vibration on the skeletal system before classical radiological changes are present. In this study three pairs of animals were used and exposed to vibration on the helicopter vibration simulator. Surgical implantation of accelerometer mounts allowed the collection of joint transfer function data. Tetracycline bone labeling techniques were used to determine bone growth measurements and scanning electron microscopy was utilized to identify joint surface damage.

STATUS

The first fluorescent-labeled bone specimens were studied at our facility. The miniature swine were carefully fed to avoid any unwanted drugs in many prepared foods. Improved sample preparation methods were developed employing critical point drying techniques and human normal and pathological joints were studied for comparison purposes. A paper describing the clinical study of bone density in aviators was presented to the Symposium in Biodynamic Models and Their Applications in Dayton, Ohio, February 1977. Four pairs (8 pigs) of miniature swine were selected for animal modeling of vibration effects. Further evaluation of catheterization methods was conducted and one additional animal was labeled with tetracycline and DCAF for development of the bone labeling procedure. The Multi-axis Helicopter Vibration Simulator (MAHVS) facility was converted back for animal use and a narrow band white noise source installed.

A detailed handbook entitled, "Multi-axis Helicopter Vibration Simulator Operations and Service Manual," for the vibration facility was begun.

The vibration tests on the miniature swine are scheduled to begin 17 Oct 77.

# ORTHOPAEDIC VSTOL AIRCREWMEMBER SEAT DESIGN

## OBJECTIVE

The objective of this project is to develop and validate an orthopaedically sound helicopter crew seat that meets or could incorporate all other human factors, engineering and crashworthy requirements. Goals in orthopaedic design are to reduce involuntary antigravity muscle activity in both static and dynamic (vibration) conditions through optimization of seat angles and measurements (surfaces) and providing arm, leg and neck support.

## BACKGROUND

Analysis of interference between man-model body segments and the seat, MIL-STD relationships between the Eye Reference Point (ERP) and Seat Reference Point (SRP) are assumptions based on limited data. Until sufficient data are available to determine exactly what these relationships should be as well as the location of the major joints of the human spine in a seated position, the present assumptions will suffice.

The relationship of the aircrewmember to the hand and foot controls is based on MIL-STD 1333, "Aircrew Station Geometry for Military Aircraft." The criteria for determining this MIL-STD are traced back to 1959 and do not take into consideration certain accepted orthopaedic principles of body support such as seat back angle and the preferred lumbar and thoracic bend angles.

Accurate seat joint positional data are essential to Cockpit Geometry Evaluation as well as to many other man-machine interface studies. The flying position in most helicopters induces low back muscle fatigue, since the pilot must rest his wrist on the distal thigh to provide adequate stability for cyclic control.

## METHODOLOGY

The hypothesis to be tested, is that a seat-control configuration incorporating orthopaedic principles will decrease antigravity muscle activity. Muscle activity will be measured by dynamic EMG activity and comfort evaluation in static and three-axis degree freedom vibration conditions and compared to the standard UH-1 seat-control configuration. Data will be collected on: (1) comfort, (2) cushion evaluation, and (3) anthropometry evaluation.

STATUS

The vibration table is fully operational and man rating is complete. Human Use approval has been granted and EMG studies of muscle activity in both static and dynamic configurations are underway. Due to lack of personnel, no seat design or analysis has been conducted this year.

By request, a kinematic analysis was done on the "dynamic overshoot" inherent in the 6" thick soft foam cushions used in the cockpit of the Air Force CH-3 helicopter. A letter report was sent to the Air Force showing why two pilots had received spinal column fractures in a relatively mild crash.

## BIODYNAMIC EVALUATION OF PROTECTIVE HEADGEAR

### OBJECTIVE

Design, develop, and validate headgear evaluation methods to fulfill the needs of head protection in Army Aviation. Determine the bump and impact protection provided to the helmet wearer. Evaluate the degree of protection provided in accordance with technical performance criteria outlined in American National Standards Institute (ANSI), Department of Transportation (DOT) and Wayne State University (WSU) documents. These documents are analyzed and changes are recommended as the needs of the Army dictate.

### BACKGROUND

Impact tests on helmets are conducted primarily under the ANSI-Z90.1 methodology. Z90.1 was generated for road user helmet testing, but the impact conditions used are similar to aircraft crash conditions in many respects. USAARL is analyzing new test methods which will consider the unique aspects of the aircraft crash; specifically, USAARL is charged with evaluating the biodynamic aspect of head injury causation as related to the design of protective helmets. USAARL also has mission authority for the quality assurance evaluation of all Army helmets in relation to medical and protective performance criteria.

### METHODOLOGY

Headgear are evaluated by various physical tests such as: bump and impact weight and center of gravity, POL effects on material and retention characteristics. On the basis of such tests, the relative protective merit of various types of headgear are evaluated. Coordination and liaison have been established with all interested or responsible federal and civilian agencies. New helmet designs are also inspected to determine how well the assembled hardware will fulfill the medical MN requirements, i.e., excess pressure points, durability of materials, toxicology, and fitting adequacy.

### STATUS

The SPH-4 Helmet Maintenance Study was undertaken to determine to what extent the protective performance of the SPH-4 aviator helmet decreases with field use in the absence of periodic maintenance. This maintenance study indicated a deterioration of chin strap and nape strap strength with age; however little effect was noted on the impact attenuation characteristics of the helmets. The results of this study were reported at the 48th Annual Scientific Meeting of the Aerospace Medical Association.

Studies on the "In-Vivo Dynamic Materiel Properties of the Central Nervous System (CNS)" under a Tulane University School of Medicine Contract were continued. This effort was reviewed in detail by Dr. Y. King Liu, Ph.D., the primary investigator, in February. The elastance of the central nervous system in 11 cats and 2 rhesus monkeys as defined by the spinal column and cranium pressure-volume curves was determined. The procedure consisted of infusing saline at the cisterna magna at variable rates and the pressures were measured at the region of infusion and in the brain tissue by catheter-tipped micropressure transducers. Nonlinear pressure-volume curves were obtained. Additionally, a small difference was observed between the cisterna magna pressure and the intra-cranial pressure. It became apparent that most of the potential space available for fluid compensation in the spinal cord cavity was in the spinal cord area, that is, this area acts as a "dump tank" for the relatively stiff cranial cavity. This information is of considerable importance in the prevention and management of head injury. The variation of the pressure-volume curves will be further refined under this contract in the next fiscal year. This important project is on schedule.

Auburn University continued its contractual work and further refined a computer model which attempts to model drop-tower impact situations so that various helmets can be evaluated by the computer model rather than by actual helmet tests. A total of 36 experimental helmets were manufactured and delivered to USAARL in the past year. These helmets were impacted and a total of more than 200 acceleration points obtained. This data will be compared to the Auburn computer model during the next fiscal year. The experimental helmet data revealed a decided advantage for the use of thicker foam liners. For example, it was found that a helmet with a 7/8" thick foam liner reduced g levels on the head by a factor of two for drop heights up to seven feet over the standard ½" foam liner currently used in the SPH-4 helmet.

A contract to evaluate the concept of energy-absorbing, (crushable) earcups, was initiated. A total of seventeen test bed earcups have been constructed. Also, several different pressure relieve devices were designed and constructed in order to relieve the pressure in the inner ear during an impact on the crushable earcup. The contractor, Simula, Inc., plans to conduct acoustic tests on the test bed earcups in the 1st and 2d Qtrs FY 78. Upon test completion, a preliminary report comparing earcup performance will be prepared and a review made to determine the desirability of prototype construction.

Publication of the following:

Allemond, P. and J. Current, Bio-Medical Evaluation of the Standard M-1 and Candidate Personnel Armor System for Ground Troops (PASGT) Helmets-Safety Evaluation for Use in Airborne Operations, USAARL Laboratory Report 77-13, June 1977.

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0D 6894 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8A. DISP'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | D. CHANGE | U (No Ch) | | | | ☐ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E762773A819 | 00 | 006 |
| b. CONTRIBUTING | | | | |
| c. [illegible] | CARDS 114(f) | (m) | | |

11. TITLE (Precede with Security Classification Code)

(U) Medical Research of Operational Problems in Army Aviation

12. SCIENTIFIC AND TECHNOLOGICAL AREAS 001300 Aircraft; 016200 Stress Physiology; 016800 Toxicology; 008800 Life Support; 017100 Weapons Effects; 009400 Man-Machine Relations

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 76 10 | Cont | DA | C. In-House |

17. CONTRACT GRANT

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: N/A d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 10.1 | 562 |
| | CURRENT 78 | 10.5 | 310 |

19. RESPONSIBLE DOD ORGANIZATION

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20. PERFORMING ORGANIZATION

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Aviation Medicine Research Div
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SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS
NAME: Joseph C. Denniston, MAJ
NAME: Gary D. Pollard, CPT

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Biochemistry; (U) Clinical Medicine; (U) Life Support; (U) Pharmacology; (U) Stress Physiology; (U) Toxicology; (U) Oxygen

23. TECHNICAL OBJECTIVE. 24. APPROACH. 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide the US Army information and recommendation for protection of aviator health from medical hazards encountered in operational Army aviation.

24. (U) To apply accepted medical research methods in Army aviation to fulfill the above objective.

25. (U) 76 09 - 77 09. Progress is shown by: Aeromedical operational evaluation of UTTAS and advanced helicopter and fixed wing aircraft included toxicology, heating, ventilation, anthropometry, and downwash. Engine exhaust and armament gas contamination of cockpit and crew compartment required on-line sampling techniques using compact mass spectrometer and infrared spectrophotometer. Applicabilities to the AAH aircraft and ground vehicles (XM-1) were evaluated. Bleed-air contaminant analysis of the OV-1, UH-1H, and U-21 aircraft evaluated carbon monoxide levels and aircrew hazard. Evaluation of Phase I (bench) and Phase II (low pressure chamber) oxygen systems for US Army aviation--the chlorate candle oxygen generator system (COGS) and the Army molecular sieve oxygen generator system (AMSOG)--have been completed Phase II (flight evaluation) utilized the JOV-1 and JU-21 testbed aircraft. Instrumentation for in-flight oxygen supply, pressure, temperature, and percent oxygen delivered has been developed and installed. Developmental oxygen masks, the MBU-12P, are being aeromedically evaluated in Germany and Korea by ASA aviation units. Design aircrew oxygen standards for US Army helicopter and fixed wing were developed. OV-1 helicopter extraction system data base acquisition study reached final operational phase 4th quarter, FY 77. DARCOM funding not allocated.

*Available to contractors upon originator's approval


* U.S. GPO: 1974-540-843/8691

GENERAL DETAIL SHEET

TITLE: Medical Research of Operational Problems in Army Aviation

OBJECTIVE:

To provide the US Army information and recommendation for protection of aviator health from medical hazards encountered in operational Army aviation.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 28 through 34.

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

# EVALUATION OF OXYGEN SYSTEMS FOR USE IN ARMY AVIATION

## OBJECTIVE

To develop advanced oxygen systems and evaluate available oxygen systems for use in the helicopter and fixed wing operations.

## BACKGROUND

Helicopter oxygen systems have to date been non-standard and of limited use. An increased need for oxygen occurs as aircraft are now based at high altitude and must exceed the 10,000 ft. ceiling imposed by military regulation in the performance of their duties. The Air Force has required oxygen from the ground up at night for 20 years due to the night vision impairment produced by even slight oxygen tension decrease. Decreased peripheral fields are the first physiologic impairment produced by reduced oxygen tension. In the helicopter flight envelope of confined area operation, this represents a significant hazard. The lack of oxygen on board also prevents its therapeutic use for patients during aeromedical evacuation.

US Army fixed wing require routine high pressure gaseous oxygen (1800 PSIG) for combat operations. The ground support equipment and oxygen logistic problems for combat aviation have been well recognized. The USN and USAF have pursued other high energy and excessive weight oxygen sources to eliminate the fire hazard and logistic problems. The US Army is limited in energy and weight and thus must pursue other sources. The molecular sieve technology provided the most feasible available supply source.

## METHODOLOGY

Four major available oxygen system types were tested for helicopter use: low pressure (450 PSIG), high pressure (1800 PSIG), LOX, and chlorate candle generators, at altitudes from sea level to 20,000 feet. Regulators were evaluated from 0 to 40,000 feet. The systems were required to deliver crew oxygen for seven men for three hours and have a therapeutic delivery capability. Physiologic oxygen tensions were measured and compared to determine regulator economy and efficiency.

Two advanced Army molecular sieve oxygen generators (AMSOG) were evaluated in bench tests (Phase I) and low pressure chamber (Phase II). Phase III is ongoing in the USAARL In-Flight Test Bed aircraft, JU-21G and JOV-1B.

## STATUS

The initial investigation concerning selection of an available helicopter oxygen system has been completed as USAARL Report 73-16, "Preliminary Evaluation of Portable Aviation Oxygen Systems." Delivery of the systems

to the field is underway. Designated units in Alaska and Fort Lewis, WA have received initial chlorate candle systems. Use rate data is being obtained.

Future efforts are concentrated on reduction in operational costs by repackaging the candles with reusable housings and modularization to decrease space requirements.

The AMSOG has undergone bench testing and low pressure chamber testing. The AMSOG with adequate bleed air supply pressure (40 PSIG) will deliver 92% oxygen at ground level and 15 LPM (NTPD) flow. This system requires electrical power in limited quantities, and bleed air 35 lbs. per hour and 40 PSIG. The weight is approximately forty pounds for a two man system. Aviation medicine evaluation of the physiologic effects of 93% oxygen, up to 7% Argon and nitrogen washout is ongoing. A Memorandum of Agreement has been completed with the USAF School of Aerospace Medicine to insure rapid exchange of molecular sieve information and data.

JU-21G and JOV-1B in-flight evaluation has provided the first available data utilizing actual aircraft engine bleed air under full flight conditions. The data validates the use of the AMSOG, with minor modifications, in meeting oxygen requirements of US Army aircrew.

## EFFECT OF OXYGEN AND CARBON MONOXIDE ON PHYSIOLOGIC PARAMETERS

### OBJECTIVE

To study the effects of slight increases or decreases in ambient oxygen tensions on physiologic parameters such as retinal function, tissue enzymes, and pulmonary function.

### BACKGROUND

The retina is the most sensitive tissue in the body to increases or decreases in oxygen tension. It is currently believed that oxygen exerts its toxic effect directly on retinal metabolism. The metabolic changes eventually lead to disturbance of cellular function sufficiently great to produce the symptoms of oxygen toxicity which are manifested through blurred vision as well as a narrowing of the visual field.

Numerous enzymes of the tricarboxylic acid cycle containing sulfhydryl groups have been shown to be reversibly inhibited on exposure to oxygen. The mechanism of this inhibition is believed to be an oxygen induced formation of disulfide bridges resulting in enzyme inactivation. At the present time the effect of elevated and decreased oxygen tensions on sulfhydryl containing glycolytic enzymes is not known.

### STATUS

Currently lactate dehydrogenase activity from the mouse liver is being quantitated in order to determine the sensitivity of the assay as well as suitable enzyme concentrations for the assay. Lactate dehydrogenase activity from the mouse brain is also being measured so that the sensitivity of two neural tissues, the brain and the retina, to oxygen can be compared.

LDH activity in mouse brain homogenate is decreased significantly by higher than normal partial pressure of $O_2$. The presence of reduced glutathione in the homogenate suspension prior to $O_2$ exposure protects against the inhibition. Studies in liver homogenate show that $O_2$ consumption is decreased 50% after exposure to high partial pressures of $O_2$. This effect is also prevented by pre-treatment with reduced glutathione. USAARL Reports numbered 75-8, 75-10, and 75-20 provide the review of these findings.

Minimally decreased oxygen tensions can affect US Army aircrew. Additionally, literature search of additive effects of carbon monoxide have demonstrated significant hypoxic effects. Carboxyhemoglobin (COHb) curves have been derived for varying altitude levels to demonstrate relative hypoxic states. COHb measurement techniques for venous blood have been developed. Correlation with mass spectroscopy data has been undertaken.

Current emphasis of night vision and night nap-of-the-earth (NNOE) helicopter operations requires evaluation of the relative hypoxic states produced by COHb low level altitude (4,000 to 10,000 feet). The effect of this physiologic change is known to decrease night vision and visual acuity. The technology data base provided by this effort will provide a guideline for safety of flight evaluation for helicopter aircrew.

## EVALUATION OF OXYGEN MASKS FOR US ARMY AIRCREW

### OBJECTIVE

To provide US Army aircrew with advanced state-of-the-art oxygen mask for improved fit, comfort, reliability, and compatibility with equipment.

### BACKGROUND

The US Army aircrewman currently uses the US Army A-13A oxygen mask developed in the late 1940 time frame. The A-13A is furnished in three sizes only. Preventive maintenance and operational check prior to flight do not occur in the absence of an Army life support equipment system. Advances in the state-of-the-art have provided improvements in weight, helmet attachment, composite shell/mask, and inhalation/exhalation valves. This study was initiated to evaluate the USAF MBU-12/P and RAF P/Q mask for compatibility and function with US Army aircrew equipment.

### STATUS

Fifty (50) MBU-12/P masks have been obtained and distributed to operational INSCOM aviation units in Korea and Germany. Initial data acquisition by questionnaire is being evaluated. Coordination of data with the USAF is ongoing. Results of study should insure the current state-of-the-art oxygen mask is available to the US Army aviator to assure maximal crew performance.

## CLINICAL BIOCHEMICAL STUDY OF CUMULATIVE FATIGUE PARAMETERS

### OBJECTIVE

To determine the usefulness of serum and urine biochemical clinical measurements for the prediction of fatigue in Army aviators.

### BACKGROUND

The effect of cumulative fatigue on the soldier or airman's ability to perform his duty is a critical factor during combat. A specific problem of determining the point at which a pilot's psychomotor and cognitive functions are impaired exists in aviation. Research to identify those changes by readily measurable biochemical indicators of stress is ongoing.

### METHODOLOGY

The creatinine phosphokinase (CPK), lactic dehydrogenase (LDH), cholesterol, and uric acid content of blood plasma is being measured by the use of the SMA-C autoanalyzer. Plasma lactic acid is being measured by the Sigma colorimetric procedure using the Cary 14 spectrophotometer. Plasma cortisol (17-hydroxycorticosterone) is being measured by a protein binding procedure. Urinary catecholamines [epinephrine (E) and norepinephrine (NE)] are determined by the trihydroxyindol reaction.

### STATUS

Preliminary studies with biologic specimens from laboratory animals and humans have provided the following results. Stress-susceptible pigs had elevated levels of CPK, LDH, and lactic acid greater than stress resistant strains. A comparison of blood and urine chemical levels in helicopter pilots under different types of flight conditions showed that nap-of-the-earth (NOE) flight resulted in higher serum uric acid, lactic acid, LDH, CPK and urinary catecholamines than normal local area flight (1,000 feet AGL). Preflight cortisol and urinary catecholamine were higher than post-flight samples in both NOE and local area flight profiles. The urinary catecholamine levels of student parachutists were monitored prior to, during, and following their first jump. There was an increase in total catecholamine excretion as well as a change in the norepinephrine to epinephrine ratio during the jump period. The battery of tests has been conducted on the plasma and urine sleep deprived helicopter pilots. Results are being published in a USAARL Laboratory Report entitled "The Effect of Nap-of-the-Earth (NOE) Helicopter Flying on Pilot Blood and Urine Biochemicals."

Development and modification of assay techniques for E and NE quantification are underway. Radioimmunoassay is expensive but presumably the

most accurate. Application of the gas chromatography technique to the JEOL GC-MS is underway.

This effort is essential in developing the technology data base to collate aircrew performance with biochemical parameters under the combined stress of flight, to include nap-of-the-earth, thermal extremes, altitude, and sustained operations.

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA OB 6895 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | D. CHANGE | U | U | | NL | ☐ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E762773A819 | 00 | 007 |
| b. CONTRIBUTING | | | | |
| c. CONTRIBUTING | CARDS 114 (f)(m) | | | |

11. TITLE (Precede with Security Classification Code) (U) Aviation Medicine Research for Aircrew Selection, Retention, and Physical Performance Standards

12. SCIENTIFIC AND TECHNOLOGICAL AREAS 001300 Aircraft; 003500 Clinical Medicine; 012900 Physiology; 016200 Stress Physiology; 002300 Biochemistry; 012400 Personnel Selection & Maintenance 009400 Man-Machine Relations

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 76 10 | Cont | DA | C. In-House |

17. CONTRACT/GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: N/A
d. AMOUNT:
e. KIND OF AWARD:
f. CUM. AMT.

| 18. RESOURCES ESTIMATE | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|
| FISCAL YEAR PRECEDING 77 | 2.5 | 153 |
| FISCAL YEAR CURRENT 78 | 4.0 | 136 |

19. RESPONSIBLE DOD ORGANIZATION
NAME: US Army Aeromedical Research Laboratory
ADDRESS: Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL
NAME: Knapp, Stanley C., COL, Cdr
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION
NAME: US Army Aeromedical Research Lab
Aviation Medicine Research Division
ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
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SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS
NAME: Joseph C. Denniston, MAJ
NAME: John C. Kelliher, CPT

21. GENERAL USE
Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Clinical Medicine; (U) Cardiology; (U) Pulmonary Physiology; (U) Stress Physiology; (U) Pharmacology; (U) Life Support

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide the US Army information concerning the medical requirements for Army aircrew selection, retention, and physical performance.

24. (U) To apply accepted medical research methodology and technology to accomplish the objective.

25. (U) 76 09 - 77 09. Progress is shown by: Analysis of cardiovascular disease in military aircrew by automated multichannel analyzer techniques indicates a lower than average level of cholesterol and triglyceride. Collation of data with age cohort is ongoing. Pulmonary function studies following 100% oxygen and AMSOG generated oxygen during prolonged unpressurized high altitude flight demonstrated minor decrement of vital capacity. Study of sarcoid and heart indicates a significant aeromedical risk. Initial study of acquired fascicular block, left anterior hemiblock (LAH), has not defined prognosis. ECG Data Retrieval and Computer Analysis (EDRA) has provided increased sensitivity of diagnosis. Effects of stress factors on biochemical and physiological parameters on laboratory animals and US Army aircrew have utilized gas chromatography-mass spectroscopy computerized techniques. Urine samples from sleep-deprived operational aircrew indicate specific additional components are excreted. Component identification is underway. Urine studies for norepinephrine associated with stress indicate accurate correlation. Urine collection from nap-of-the-earth, night nap-of-the-earth operational flights, and computer simulation are being collected for validation.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Aviation Medicine Research for Aircrew Selection, Retention, and Physical Performance Standards

OBJECTIVE:

To provide the US Army information concerning the medical requirements for Army aircrew selection, retention, and physical performance.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 37 through 38.

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

# CARDIOPULMONARY STUDIES FOR SELECTION/RETENTION OF US ARMY AIRCREW

## OBJECTIVE

To evaluate cardiopulmonary function and disease for selection/retention and preventive medicine application for US Army aircrew.

## BACKGROUND

Cardiopulmonary disease to include coronary artery disease, hypertension, arrhythmia, and chronic obstructive lung disease produces a significant loss of the highly skilled and costly trained aviator usually at the mid-point of a flying career. The aeromedical community cannot apply the usual civil clinical cardiopulmonary standards in determination of flying status due to the combination of hypoxia, vibration, thermal, and operational stresses not routinely found in the normal ground environment.

## METHODOLOGY

The Aviation Medicine Research Division utilizes accepted medical evaluation techniques in evaluation of aircrew and flight applicants. The use of pulmonary function testing, arterial blood gas, Holter dynamic ECG monitoring, resting ECG, VCG and treadmill exercise testing provides the most useful data. Computer techniques are applied to data acquisition from standard medical devices. Aeromedical clinical data from the waiver files in conjunction with the USAAAVS accident/incident data and the AFIP autopsy data provides the capability to review natural history of many diseases previously considered rare.

## STATUS

Results of studies of Coronary Artery Disease and Preventive Cardiology in Aviation Medicine were published in Aviation Space and Environmental Medicine, October 1975, pages 1299-1304. This study demonstrated a continuing rise in moderate and severe coronary artery disease (CAD) in the 20 to 34 year age group to 26.2% to 21.2%. This data did not support the Viet Nam autopsy study that CAD is decreasing. SMA-C multi-channel biochemical analysis indicates lower cholesterol and triglyceride levels in US Army aircrew compared to the average US population.

Study of Sarcoidosis and its effect on the heart demonstrates a significant incidence of electrocardiographic abnormalities of 37%. The risk of sudden death associated with these findings remains to be defined. The initial review is published in Aviation Space and Environmental Medicine, October 1977, pp 955-958. Collation of aircrew with sarcoid and sudden death is being conducted with AFIP autopsy data.

Study of physiologic cardiovascular status of aircrew by easily applied field devices using isometric handgrip is underway. Normal heart rate, blood pressure and ECG responses are being obtained.

US Army Aircrew ECG Data Retrieval and Analysis (EDRA) by computer has been initiated to establish the research technology data base. A computer program (Pipberger) has been modified for standard analysis and computer generation of the VCG. Initial clinical studies of left anterior hemiblock (LAH) have been presented.

Studies of other acquired fasicular blocks utilizing the VCG and computer technique have been initiated.

Pulmonary function study of US Army aircrew to define the effects of prolonged breathing of 100% oxygen, normal physiologic oxygen and AMSOG generated oxygen at varying altitudes in unpressurized aircraft is in progress. Early data analysis indicates slight decrease in vital capacity (VC) following four hours of diluted oxygen at 18,000-19,000 feet.

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0B 6898 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISS'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | D. CHANGE | U | U | | NL | ☐ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E762773A819 | 00 | 008 |
| b. CONTRIBUTING | | | | |
| c. [illegible] | CARDS 114(f)(m) | | | |

11. TITLE (Precede with Security Classification Code): (U) Aeromedical Evacuation, Rescue, and Life Support Equipment and Applications

12. SCIENTIFIC AND TECHNOLOGICAL AREAS: 003500 Clinical Medicine; 006000 Escape, Rescue and Survival; 008800 Life Support; 012900 Physiology; 009800 Medical and Hospital Equipment; 009400 Man-Machine Relations; 016500 Telemetry

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 76 10 | Cont | DA | C. In-House |

17. CONTRACT/GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: N/A
d. AMOUNT:
e. KIND OF AWARD:
f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 3.5 | 178 |
| | CURRENT 78 | 3.5 | 84 |

19. RESPONSIBLE DOD ORGANIZATION
NAME: US Army Aeromedical Research Laboratory
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RESPONSIBLE INDIVIDUAL
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TELEPHONE: (205) 255-5107

21. GENERAL USE
Foreign Intelligence Considered

20. PERFORMING ORGANIZATION
NAME: US Army Aeromedical Research Lab
Aviation Medicine Research Div
ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME: Pettyjohn, F. S., COL
TELEPHONE: (205) 255-5114
SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Denniston, Joseph C., MAJ
NAME: Kelliher, John C., CPT

22. KEYWORDS (Precede EACH with Security Classification Code): (U) Aircraft; (U) Helicopter Ambulance; (U) Emergency Medicine; (U) Medical Equipment; (U) Life Support; (U) Resuscitation; (U) Rescue

23. TECHNICAL OBJECTIVE. 24. APPROACH. 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide the US Army helicopter and fixed wing aeromedical evacuation up-to-date information on compatible medical rescue/life support equipment and techniques to insure advanced and rapid definitive medical treatment of the combat casualty.

24. (U) To apply accepted medical and biomedical research methodology and technology to accomplish the above objective.

25. (U) 76-10-77-10 Progress is shown by: Aeromedical evaluation of the portable oxygen systems for US Army helicopter aeromedical evacuation and rescue use. Chlorate candle oxygen generator systems have been fielded for initial in use evaluation Development of the Army Molecular Sieve Oxygen Generating System for aeromedical evacuation and therapeutic use has proven its feasibility. Available bleed air from UH-1H helicopters is limited. UH-60A (UTTAS) has adequate bleed air. Aeromedical evaluation of high performance helicopter hoist demonstrates available off-the-shelf technology capable of relieving "life or death" restriction. Improved performance, speed 250 feet per min, safety, and repairability at operator level have been demonstrated. Source selection of hoist is anticipated first quarter FY 78. Signal modulation of ECG with transmission by standard military helicopter radio (UHF, VHF) was evaluated and proven to be feasible for combat evacuation use. In-flight defibrillation/cardioversion in aeromedical evacuation helicopters was proven safe. Defibrillation at maximal discharge (300 watts sec) with simulated patient was shown to be safe for crew and aircraft instrumentation. Evaluation of thermal blanket for helicopter evacuation use has been completed. Hypothermic animal model was developed to support helicopter in-flight studies. Evaluation of the helicopter interface of in-flight oxygen analyzers, ventilation, and physiologic data monitoring equipment is continuous to insure optimized combat casualty medical care.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Aeromedical Evacuation, Rescue, and Life Support Equipment and Applications

OBJECTIVE:

To provide the US Army helicopter and fixed wing aeromedical evacuation up-to-date information on compatible medical rescue/life support equipment and techniques to insure advanced and rapid definitive medical treatment of the combat casualty.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 41 through 48.

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

## THE HELICOPTER AIR AMBULANCE IN AEROMEDICAL EVACUATION AND RESCUE--EQUIPMENT AND AIRCREW INTERFACE

### OBJECTIVE

The study provides continuing review of the air ambulance helicopter and updates the available medical equipment and procedures to provide the most definitive medical care at the earliest possible time to the patient. Special emphasis is placed on improving medical care at all levels of aeromedical evacuation.

### BACKGROUND

Helicopter aeromedical evacuation has succeeded in reducing the mortality in Republic of Viet Nam to the lowest level of 2.3%. Further efforts to improve the mortality require improved medical care in the helicopter air ambulance at the earliest possible time, i.e., immediate resuscitation and life support at time of pickup and during initial aeromedical evacuation.

Evaluation of the helicopter/medical equipment interface, as well as the equipment/air ambulance aidman interface, will be continuous.

### METHODOLOGY

Evaluation of medical equipment, interface of air ambulance aidman for helicopter use, and changing mission concepts of aeromedical combat and peacetime evacuation is an ongoing process.

Evaluation of the rapid advancing technology of emergency medical care equipment for compatibility with helicopter operations is being conducted.

Modification of existing equipment and development of new equipment and procedures for improved medical care in the helicopter environment is continuing.

### STATUS

Items evaluated include portable defibrillator/monitors, physiologic data telemetry, inflight oxygen analyzers, ventilators, and therapeutic/aircrew oxygen sources.

Biomedical evaluation of the Western Gear two speed personnel rescue hoist is complete. The hoist demonstrated improved performance to include speed and safety. Modular components and implicity provide for component exchange and cable change at user level. Advanced hoists should relieve current "life or death" restrictions. USAARL Report No. 77-7, "Aeromedical Evaluation of UH-1 Internal Advanced Personnel Rescue

Hoists, Western Gear Corporation Hoist Models 42277R1 and 42305R1, Breeze Corporation Hoist ECP-720 Modification," provides complete aeromedical evaluation data.

Signal modulation of ECG with transmission by standard helicopter radio (UHF, VHF) was evaluated and proven to be feasible for combat utilization.

Study of Canadian Armed Forces Electric Blanket for use in UH-1H and CH-47 helicopters has been initiated. Animal hypothermic model has been developed.

Study of safety of in-flight defibrillation in helicopters was completed. Safety of defibrillation at maximal discharge (300 watts second) with animal model patient on wet helicopter floor in flight was demonstrated.

These studies have provided essential patient care and helicopter air ambulance interface technology to improve critical combat and peacetime aeromedical evacuation technique.

# DESIGN, DEVELOPMENT, OPERATIONAL EVALUATION AND FABRICATION OF THE MILITARY ANTI-SHOCK TROUSERS FOR USE BY PARAMEDICAL PERSONNEL IN THE TREATMENT OF SHOCK

## OBJECTIVE

To provide paramedical personnel a rapid, simple, and effective means of treating shock syndromes in the field under combat and peacetime conditions.

## BACKGROUND

Shock may be defined as a state of circulatory collapse, frequently associated with insufficient return of blood to the heart and manifested by persisting deficiency of blood flow to the peripheral tissues.

The insufficient return of blood to the heart is associated with pooling of blood in the venous system; as the blood pools in the venous system, the pulse rate increases and the arterial blood pressure decreases eventually leading to the death of the patient unless treatment is initiated.

Since all shock treatment takes time, an expeditious way of returning the pooled venous blood to the arterial circulation would benefit the patient. A reduction of immediate mortality and increase of survival time would permit the patient to be evacuated to a definitive medical treatment facility. The simplest, most inexpensive and least time consuming treatment method is the principle of external counter-pressure applied to the abdominal area and lower extremities. The result of counter-pressure to these areas would result in decreased venous pooling, control of abdominal hemorrhage (if present), and allow available blood to circulate to critical organs. External counter-pressure to elevate blood pressure is not new. It was first described in 1903 by Crile and recently Cutler and Doggit reported several case histories of combat casualties whose blood pressures were maintained only by the addition of "G" suits to the treatment regime despite massive resuscitative measures.

## METHODOLOGY

The Military Anti-Shock Trouser has been fabricated in four prototype models based on number of chamber in the garment. Velcro fasteners provide rapid application. The counter-pressure maintains a pressure of approximately 80-104 mm Hg to the abdomen and lower extremities.

## STATUS

Phases I and II, design and fabrication of basic prototypes, have been completed.

Operational evaluation was attempted by military helicopter air ambulance units. Limited data recovery has required dependence on civilian trauma cases. Coordinated effort with USAF Air Rescue and Recovery Service and Canadian Armed Forces should provide additional clinical data.

The Military Anti-Shock Trousers have been utilized by the Miami Fire Rescue Department in civilian trauma cases. The findings have demonstrated life saving value in 36 of 53 patients. Reports of initial series have been published in the Journal of Trauma 18:843-848, October 1973 and Journal of American College of Emergency Physician, August 1976.

Study of the cardiovascular/hemodynamic effects of the MAST have been conducted using the mongrel dog and the non-terminal hemorrhagic condition. The MAST provide a rise in systolic pressure and even greater increase in diastolic pressure. Cardiac output remained unchanged or decreased slightly. Heart rate decreased with rise in pressure. The primary effect of the MAST in acute hemorrhage is an increase in peripheral resistance and retention of central core circulation. Studies have been delayed due to lack of fluoroscopic radiology facility. Completion of study is planned for FY 78. Clinical applications in the treatment of cardiogenic shock, treatment of hypotension post-abdominal aortic surgery, and as an adjunct in cardiovascular physical examination are being explored.

# AEROMEDICAL EVALUATION (ANTHROPOMETRY, THERMAL, TOXIC GAS ANALYSIS) OF CURRENT AND FUTURE ROTARY AND FIXED WING AIRCRAFT, VEHICLES AND WEAPONS SYSTEMS

## OBJECTIVE

To develop methodology and equipment for evaluation of current and proposed aircraft, vehicles and weapons systems to include anthropometry, downwash, heating, ventilation and toxicology.

## BACKGROUND

USAARL has provided "quick fix" evaluations of hazardous medical conditions discovered after aircraft have entered the Army inventory. Recent aeromedical input into future aircraft design and operational requirements has required new technology for evaluation. USAARL was tasked to aeromedically evaluate the UTTAS prototype and the 214A helicopter.

## METHODOLOGY

Anthropometry measurements utilized standard human factor engineering techniques. Downwash ventilation studies were performed using calibrated Alnor flowmeters. Heating data was obtained by YSI wet-dry-radiant heat thermocouples. Mass spectrometry and infra-red spectrometers were used for toxic cabin contaminants.

## STATUS

Anthropometric and downwash studies were accomplished for the Boeing and Sikorsky UTTAS helicopter prototypes and the Bell 214A helicopter. Evaluation of heating and ventilation for these aircraft was accomplished using available YSI thermocouples and Alnor flowmeters. To accurately evaluate toxic contaminants due to armament firing and engine exhaust, development of on-line sampling techniques by mass spectrometer was required. A compact mass spectrometer was obtained and suspension designed for continuous use in flight. Data was obtained during 40 day and night flight hours. Analysis of 800 flight profiles for the UTTAS prototypes was provided the Source Selection Board.

Acquisition of a 20 meter cell portable infra-red spectrometer has been acquired to increase the toxic gas spectrum quantification. The selected UTTAS (UH-60A) was re-evaluated following modification to improve ventilation and washout of gun gas accumulation. Data is published as USAARL Report No. 77-18.

Evaluation of toxic gas analysis during the Dragon weapons firing has been completed. Data reduction is underway.

Planning has been initiated for application of these analytic methodologies to future helicopters (AAH, ASH), tanks (XM-1), weapons systems (missiles, rockets), and specific ground combat operational scenarios [Military Operations in built-up areas(MOBA)]. Collection systems have been designed to meet the requirements of sampling in flight, in moving combat vehicles, and during weapons firing. The MS-GC and IR studies to date have provided the background technologic base for evaluation of critical total weapons systems to maximize crew performance and monitor limits.

## COMPUTER ASSISTED GAS CHROMATOGRAPHIC AND MASS SPECTROMETRIC ANALYSIS FOR STRESS RELATED BIOCHEMICAL INDICATORS

### OBJECTIVE

To evaluate biochemical compounds using computer assisted mass spectrometry (MS) and gas chromatography (GC) to survey blood, serum and urine for stress related changes.

### BACKGROUND

Present studies of stress related metabolic changes allow quantitation of suspect stress indicators without surveying for possible unknown indicators. Capillary GC has allowed other investigators to separate about 400 urinary components. Capillary GC-MS in conjunction with computer analysis provides identification and quantitation of all separable urinary components.

### METHODOLOGY

Preliminary scans were evaluated directly by capillary GC-MS or thermal vaporization programming with both urine and plasma. If the complexity of separation precludes direct analysis, only dialysis will be used initially to fractionate the specimen. This prevents molecular fracture prior to MS analysis complicating mass spectral interpretation.

### STATUS

USAARL's JMSD100 double focusing, Matsuda geometry, high resolution mass spectrometer has demonstrated resolution >20,000. A coupled HP 5711A gas chromatograph is capable of handling 100 meter 2mm capillary columns. The thermal probe allows programming from -100° to 400°C. Three channel, multiple mass monitoring is also system incorporated. The data system is a Texas Instrument 980A with 733 ASR terminal and CRT display. All portions of the system have been successfully integrated for low resolution (<5000) high speed ($\geq$2 sec/0-800 amu) and high resolution low speed ($\geq$60 sec/0-800 amu) scanning. Newly developed software allows elemental composition calculation with high resolution (10,000) and short scan times (10 sec/0-800 amu). Ninety-six specimens from 6 sleep deprived helicopter pilots have been compared to control values.

The procedures developed have identified four urinary compounds not previously described. A three-four, dimethoxy benzoic acid had control level of $\sim 2 \times 10^{-10}$ M in six subjects increasing to $\sim 8 \times 10^{-8}$ M in all subjects during hour 24 to 72 of flight during the stress and fatigue study. A second compound has been identified as an amino acid-a dipeptide with

leucine. This dipeptide quantitatively varies from $\sim 1.5 \times 10^{-9}$ M during controls to $5 \times 10^{-7}$ M at the close of sleep deprivation with the six pilot subjects.

Continued evaluation of these stress indicators during nap-of-the-earth (NOE) navigation over a 30 minute flight plan, flight simulation studies, and during in-flight use of night vision devices is underway. Quantification and identification of the urinary compounds has required development of collection and storage techniques to prevent deterioration and/or degradation.

These components and at least two others (whose identity has not been fully defined) offer promise as biochemical indicators of stress and fatigue.

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION* | 2. DATE OF SUMMARY* | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0B 6902 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY* | 6. WORK SECURITY* | 7. REGRADING* | 8A. DISB'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| | D. CHANGE | U | U | | NL | ☐ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES:* | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.11.01.A | 3A161101A91C | 00 | 292 |
| b. CONTRIBUTING | | | | |
| c. CONTRIBUTING | | | | |

11. TITLE (Precede with Security Classification Code)* (U) Saturated Heated Oxygen/Bleed Air-Nebulizer for Resuscitation of Thermal Casualties in Air Evacuation

12. SCIENTIFIC AND TECHNOLOGICAL AREAS* 001300 Aircraft (Helicopter); 016200 Stress Physiology, Aeromedical Evacuation

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 76 10 | 78 09 | DA | C. In-House |

17. CONTRACT GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER*
c. TYPE d. AMOUNT:
e. KIND OF AWARD: N/A f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 4.0 | 40 |
| | CURRENT 78 | 4.0 | 15.5 |

19. RESPONSIBLE DOD ORGANIZATION
NAME:* US Army Aeromedical Research Laboratory
ADDRESS:* P. O. Box 577
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RESPONSIBLE INDIVIDUAL
NAME: Knapp, Stanley C., COL, Cdr
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION
NAME:* US Army Aeromedical Research Lab
Aviation Medicine Research Division
ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic institution)
NAME:* Pettyjohn, Frank S., COL
TELEPHONE (205) 255-4610
SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS
NAME: Denniston, Joseph C., MAJ
NAME: Pollard, Gary D., CPT

21. GENERAL USE
Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft, (U) Clinical Medicine, (U) Thermal Physiology, (U) Aeromedical Evacuation

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To develop and test the concept of use of heated saturated oxygen/bleed-air in helicopter air evacuation/resuscitation of the hypothermic or pulmonary casualty.

24. (U) Develop new technology and equipment to use helicopter bleed-air and electrical power 28VDC or 115VAC400Hz to provide a source of heated, dry or supersaturated oxygen or air to deliver heat to the hypothermic combat casualty. The concept of the lungs as a heat exchanger employing the extremely large surface area available for the passage of blood as a distributor of heat to distal organs represents a unique application in air evacuation and resuscitation. The equipment will be designed for simplicity, low cost, and compatibility with UH-1H and UTTAS aeromedical helicopters. Compatibility with advanced oxygen systems (Chlorate Candle and Army Molecular Sieve Oxygen Generators) will be explored. Concept and prototype evaluation will be conducted using mongrel dogs as subjects. Monitoring of temperature and pulmonary effects of increased inspiratory air/oxygen during simulated and in-flight evacuation missions will be accomplished.

25. (U) Studies of UH-1H bleed-air demonstrate adequate flow and temperature to provide inhalation rewarming of the hypothermic casualty. Qualitative contaminant analysis by infrared and mass spectroscopy indicate carbon monoxide (CO), sulfur dioxide ($SO_2$) and ammonia ($NH_3$) are present. Worst case occurs during ground idle (4 ppm CO, 14 ppm $SO_2$). Animal model for clinical evaluation with two prototype delivery systems for heated bleed-air/oxygen has been developed. Clinical demonstration of effect of hypothermic treatment is ongoing.

*Available to contractors upon originator's approval


☆ U.S. GPO: 1974-540-843/8691

GENERAL DETAIL SHEET

TITLE: Saturated Heated Oxygen/Bleed Air-Nebulizer for Resuscitation of Thermal Casualties in Air Evacuation

OBJECTIVE:

To develop and test the concept of use of heated saturated oxygen/bleed air in helicopter air evacuation/resuscitation of the hypothermic or pulmonary casualty.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following page 51.

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

# SATURATED HEATED OXYGEN/BLEED AIR NEBULIZER FOR RESUSCITATION OF THERMAL CASUALTIES IN AIR EVACUATION

## OBJECTIVE

To determine if helicopter bleed air can be used alone or in conjunction with humidification and/or oxygen as an effective way of instituting inhalation rewarming of the hypothermic casualty during the initial treatment phase of aeromedical evacuation.

## BACKGROUND

US Army military personnel are faced frequently with severe cold exposure during combat, operational, and survival situations. Such exposure can result in the development of accidental hypothermia, a well recognized clinical entity characterized by whole body cooling and high mortality. The importance of initiating early rewarming is emphasized by the fact that the lethal limits of hypothermia relate not only to specific body temperature, but also to the duration of reduced body temperature. A limiting factor in the early management of hypothermic casualties has been the lack of rewarming devices usable in the field or during transit to a definitive medical facility.

## METHODOLOGY

A series of six independent subprojects were developed in order to evaluate the project objective. These subprojects included: (1) flow-pressure-temperature of helicopter bleed air; (2) contaminant analysis of bleed air; (3) development of a laboratory bleed air heated model; (4) clinical and experimental evaluation of a helicopter bleed air heated nebulizer; (5) computer modeling of hypothermic casualty; and (6) in-flight test of prototype system. Equipment will be designed for simplicity, low cost, and compatibility with UH-1H and UTTAS aeromedical helicopters.

## STATUS

Studies of UH-1H bleed air demonstrate adequate flow and temperature to provide inhalation rewarming of the hypothermic casualty. Qualitative contaminant analysis by infrared and mass spectroscopy indicate carbon monoxide (CO), sulfur dioxide ($SO_2$) and ammonia ($NH_3$) are present. Worst case occurs during ground idle (4 ppm CO, 14 ppm $SO_2$). Animal model for clinical evaluation with two prototype delivery systems for heated bleed air/oxygen has been developed.

Funds expended to date amount to $38.5K. Additional funding of 15.5K is considered necessary to provide for final interfacing of the system with the UH-1H; additional quantitative analysis of bleed air and its aeromedical hazard; and clinical validation in the animal model.

## RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION* | 2. DATE OF SUMMARY* | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0B 0891 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY* | 6. WORK SECURITY* | 7. REGRADING* | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA - CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | D. CHANGE | U (NO CH) | U | | NL | X YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES.* | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E762773A819 | 00 | 002 |
| b. CONTRIBUTING | | | | |
| c. [illegible] | CARDS 114 (F) (m) | | | |

11. TITLE (Precede with Security Classification Code)*

(U) Research of Visual Problems Medically Significant to Army Aviation

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*

001300 Aircraft; 012000 Optics; 012900 Physiology

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| | Cont | DA | C. In-House |

17. CONTRACT GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER* Not Applicable

c. TYPE d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 4.9 | 160 |
| | CURRENT 78 | 5.0 | 193.6 |

19. RESPONSIBLE DOD ORGANIZATION

NAME* US Army Aeromedical Research Laboratory

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RESPONSIBLE INDIVIDUAL

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20. PERFORMING ORGANIZATION

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Bio-Optics Division

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SOCIAL SECURITY ACCOUNT NUMBER

21. GENERAL USE

Foreign Intelligence Considered

ASSOCIATE INVESTIGATORS

NAME: GLICK, D.D., MAJ

NAME: BEHAR, I.

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Vision; (U) Man-Machine Interface; (U) Visual Psychophysics; (U) Night Vision; (U) Visual Correction; (U) Visual Protection

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide information about the visual sensory modality relating to capability of the human visual system and the impact of military equipment, environmental and operational influences on visual performance and integrity.

24. (U) The approach will include psychophysical, electrophysiological, and other objective techniques to evaluate human visual performance with quantitative measures.

25. (U) Accomplishment has been shown by USAARL Report No. 77-17, Optical Characteristics of Laser Safety Devices; and USAARL LR-77-1-7-1, Utilization of Existing Aircraft Landing Light as an Artificial Illumination Source for AN/PVS-5 Night Vision Goggles Training; USAARL LR-77-9-7-4, Ambient Light Characteristics of a Modified AN/VVS-4(XE-4) Searchlight System and a Fire-Fly Light System (FFLS); USAARL LR-77-11-7-6, Lighting Evaluation of the YUH-60A Helicopter and the YUH-61A.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Research of Visual Problems Medically Significant to Army Aviation

OBJECTIVE:

To provide information about the visual sensory modality relating to capability of the human visual system and the impact of military equipment, environmental and operational influences on visual performance and integrity.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 54 through 65

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

NIGHT VISION GOGGLE, AN/PVS-5, MODIFICATION FOR DAYTIME TRAINING

## OBJECTIVE

To reduce cost and logistical problems associated with NVG training, as well as provide an added margin of safety, by developing daytime filters for the NVG which provide reasonable approximation of night imagery during full daylight (without compromising the life of the NVG tubes).

## BACKGROUND

The Night Vision Goggles, AN/PVS-5, permit the extension of helicopter operation under night illumination levels well below those of useful naked eye visibility. While the goggles provide enhancement of sensitivity at low light levels, they do not, however, preserve the performance capability of other visual parameters; for example, the visual field of view is reduced to $40^{0}$, visual acuity is degraded to about 20/60, hue discrimination is absent, and contrast sensitivity and stereoscopic vision are markedly impaired. Furthermore, the adjustment of focus for distance and instrument viewing is time consuming and cumbersome.

In view of the drastic alteration and degradation of visual information effected by the NVGs, flying with the goggles requires a period of training. Our current experience indicates that some five hours of training is appropriate for the average aviator. However, Night Vision Goggle training at night is costly, requiring a chase ship and reduced stagefield density, and dependent upon the phase of the moon as well as weather conditions.

## METHODOLOGY

An analysis of problem areas encountered using standard neutral density filters identified the following: flare, resolution reduction, false contrast with loss of horizon, poor contrast between runway and grass, and instrument reading difficulty. Most problem areas were satisfactorily resolved by adding a sunshade and blackening all metal surfaces, and using filters with good IR blocking capability. Satisfactory filters proved to be the readily available, inexpensive welders' goggle lenses (Shade 12 for overcast days, Shade 14 for sunny days). Cross-polarizers could be added for variable density adjustment.

## STATUS

A final report on this project is contained in USAARL LR-77-7-7-2.

## HAZE EVALUATION BY VISUAL MODULATION TRANSFER FUNCTION (VMTF) CRITERION

### OBJECTIVE

To provide an actual data base relating percent haze to visual performance decrement using the precisely quantifiable VMTF as the criterion visual task.

### BACKGROUND

Plastic optical components, such as windscreens, visors, and goggle and protective mask lenses, have the property, to varying degrees, of scattering in the forward direction (as well as backscattering) some of the light incident on their surface. This property is called haze and the maximum allowable percent haze (MAPH) value is specified in AMST, ANSI, Federal Standards, and Military Specifications. The MAPH value varies for different materials and applications and presumably is related to the maximum allowable loss in visual capability.

The allowable haze value, for various Standards and Specifications is as little as 1% (MIL-G-25667B, 1970) and as high as 6% (ANSI Z87.1-1968). Only one study, that of Glover, could be found in an extensive literature search, that attempted to establish allowable limits based upon measurable visual performance decrement. Glover, however, failed to present his data, merely indicating that 0.5% is the maximum desirable limit while 2% should be the maximum allowable.

### METHODOLOGY

The USAARL VMTF task, previously used to quantitatively evaluate visual performance with the AN/PVS-5 Night Vision Goggles and XM-29 and M-24 Protective Masks, is being adapted as the criterion task for determining the magnitude of visual performance decrement for material of varying percent haze. The haze materials will be a set of haze standards normally used for calibrating haze measuring equipment.

### STATUS

Instrumentation for this project is being developed. Data collection should begin during the 2nd quarter FY 78.

# LIGHTING EVALUATION OF THE BELL 214A HELICOPTER

## OBJECTIVE

To determine the suitability of the lighting on the Bell 214A helicopter.

## BACKGROUND

The Aircraft Developmental Test Activity conducted an evaluation of the Bell 214A helicopter. As a part of this evaluation, the Bio-Optics Division of USAARL was asked to perform an evaluation of the internal and external lighting of the aircraft. This aircraft is a modified UH-1 which was developed for the Army.

## METHODOLOGY

The luminance measurements were made using a Photo Research Model 1980 photometer mounted on a tripod and placed in the cargo compartment so as to have a direct view of the instruments. The brightness of the pointer was considered to be brightness of the instrument and in most cases the 6-minute field-of-view aperture setting was used. The illuminance of the external lights was measured with the illuminance baffle attachment to the instrument.

## STATUS

This work has been completed and published as USAARL LR-77-8-7-3, "Lighting Evaluation of the Bell 214A Helicopter." It was found that the flight instruments were wedge lit whereas the engine instruments were illuminated by means of bulbs placed inside and at the bottom of the instrument and shielded from direct view of the pilot. The lighting was checked against all applicable standards and a detailed list of the exceptions was reported.

## CROSS-SECTIONAL SURVEY OF SELECTED VISUAL PARAMETERS

### OBJECTIVE

To develop a data bank of selected visual parameters which will assist in determining visual standards of medical fitness and which will provide guidance in the design of optical equipment.

### BACKGROUND

Equipment developers often request USAARL assistance in the design parameters of viewing devices. For example, design decisions must be made to incorporate interpupillary range adjustments which will accommodate most of the potential users. Likewise, the dioptric adjustment should correct the majority of users. Descriptive statistics concerning the special population represented by the military community have not previously been available. This study was initiated to fill this information gap. It is also envisioned that this study will be used to provide information concerning reasonable visual standards for medical fitness as specified in AR 40-501.

### METHODOLOGY

Over 9,000 data sheets have been collected on active duty personnel. The data has been keypunched and stored on magnetic tape.

### STATUS

The initial computer program has been written, debugged and tested. Descriptive statistics on the sample population are being generated at the present time.

# THE CIE CHROMATICITY STUDY

## OBJECTIVE

To propose a new wavelength range for the colorimetric research to be adopted as an international standard by the Commision Internationale del'Eclairage (or the CIE) which is the international committee on color.

## BACKGROUND

The conventional computation of the CIE chromaticity coordinates is to obtain the tristimulus values of an object color. The tristimulus values are the sum of the product of the spectral reflectance or transmittance of the object with spectral distribution irradiating the object weighted by the color-matching functions of the source. The question arises as (1) to what extent the wavelength range of the color-matching functions be summated and (2) to how much the effect the truncation of the wavelength range be to the chromaticity coordinate values. The first question has been investigated during the past few years. This study suggests that the wavelength range be extended from the current CIE system (380-780 nm) to a wider range (for instance, 200-1100 nm). As for the second question, the effect of truncation does play a significant role in the evaluation of the chromaticity coordinate values. The study will have a world-wide impact on colorimetric research in industries and military applications.

## METHODOLOGY

Four sets of wavelength range have been selected (1) 300-700 nm, (2) 350-750 nm, (3) 380-780 nm, (4) 400-800 nm in order to compute the effect of truncation to the values of chromaticity coordinate values. Results were statistically analyzed.

## STATUS

Portions of the study will be reported at the annual meeting of the Optical Society of America held at Toronto, Canada, 10-14 October 1977. Results revealed that the standard deviations were significant for those truncated values. Further study will include the examination of the effect of extrapolation of the range and the problem of the granule of the summating intervals to the chromaticity coordinate values.

## STUDIES OF DYNAMIC VISUAL ACUITY

### OBJECTIVE

To obtain dynamic visual acuity (DVA) thresholds as a criterion task for evaluating the importance of ocular dominance in dynamic target acquisition and to determine whether direction of target motion was a significant variable, which is a point of dispute in the Russian and American literature.

### BACKGROUND

The DVA task consists of measurement of visual resolution when there is relative motion between the observer and the object being regarded. Because helicopter profiles involve flying at extremely low altitudes, even at relatively modest airspeeds, observer-object angular velocities exceed 100°/second, indicating the requirement of good dynamic acuity for the acquisition of navigational landmarks, military targets, and detection of hazards such as power lines.

The early evaluation of DVA and its significance for military aviation was established by Drs. Ludvigh and Miller at the Naval Aerospace Medical Research Laboratory. Their research elaborated the effects of a number of experimental parameters, and although they did not test the susceptibility of DVA thresholds to ocular dominance effects, such a relationship would be expected because of the known relationship between dominance and oculomotor factors in sighting, on the one hand, and between DVA and oculomotor accuracy, on the other. Ludvigh and Miller did test for, but failed to find, a significant effect of direction of target movement; Kozyr'kova, however, found that DVA thresholds were lower for targets moving from left to right than the reverse.

### METHODOLOGY

Ocular dominance was determined using the Dyer Sighting Dominance Test. DVA thresholds were first obtained under binocular conditions during which the effects of direction of movement were determined. This also allowed the effects of practice to reach asymptotic levels. Then, differential DVA thresholds were determined for the dominant and non-dominant eye. Direction of target movement was a statistically significant determiner of DVA threshold, while in its simple effects, ocular dominance in the practiced observer was not.

### STATUS

A detailed report is in preparation. Additional factors presumed to affect aviator performance will be evaluated using the DVA threshold criterion.

## STUDIES OF CONTRAST SENSITIVITY OF MAN-MACHINE SYSTEMS: CONTRAST SENSITIVITY THROUGH THE XM-29 PROTECTIVE MASK

### OBJECTIVE

To determine the suitability of the XM-29 protective mask as an optical device.

### BACKGROUND

A standard acuity test utilizes high contrast targets and determines the minimum critical angle which the eye can resolve. An alternative, and in some ways more complete, measure of acuity is provided by the visual modulation transfer function (VMTF). In this method, the visual system's response to bars of sinusoidal brightness distribution and of various spatial frequencies is deteremined.

### METHODOLOGY

Sinusoidal bars of various spatial frequencies were generated by a Tektronix FG 502 function generator, mixed with the proper TV synchronizing and blanking signals, and displayed on a Conrac TV monitor.

The observers were seated in front of the monitor at a viewing distance of 9.25 feet. It was explained to them that sinusoidal bars of varying widths would be appearing on the monitor and that their task was to turn the potentiometer clockwise (ascending trials) until the bars could just be seen or turn the potentiometer counterclockwise (descending trials) until the bars just disappeared. Each subject was given two ascending and two descending trials per session at each of the following spatial frequencies: .5, 1, 3, 5, 7, 10, 15, 20, and 25 cycles/degree visual angle. For comparison purposes, the VMTF while wearing the M-24 protective mask and while wearing no mask were also determined. Each subject received two sessions with no mask, two sessions with the M-24 mask, and two sessions with the XM-29 mask. Sessions were counterbalanced in the manner ABCCBA.

### STATUS

This phase is complete and has been published in USAARL Report 77-14, "Visual and Optical Analyses of XM-29 and M-24 Protective Masks." It was found that at all frequencies except the lowest the no-mask condition is superior to either of the mask conditions. It was also found that at all frequencies above 5 cycles/degree the M-24 mask is superior to the XM-29 prototype mask.

## EXTENDED WEAR CONTACT LENSES

### OBJECTIVE

To examine the feasibility of wearing contact lenses in the Army aviation environment for an uninterrupted seven day period.

### BACKGROUND

The Army is using, or intends to use, several optical devices which are not compatible with spectacles. Contact lenses would permit uninterrupted use of these devices by the soldier in the field. In the past, hard or soft contact lenses had to be removed, following 12 to 16 hours wear, in order to insure corneal integrity. They also had to be chemically cleaned or heat treated daily to insure sterilization. This was not feasible for the field soldier. There are now soft lenses available for continuous wear. This study will examine these lenses for use in the military environment.

### METHODLOGY

The subjects will be selected volunteers from the Army aviation environment assigned to Fort Rucker. There will be seven groups of approximately six subjects each. The first group will wear the lenses one day, the second two days, etc., with the seventh group wearing the lenses the full seven day period.

The subjects will be thoroughly examined prior to and following their wearing period. The examination parameters include biomicroscopy, pachometry, keratometry, photoelectric keratoscopy, tear chemistry and visual acuity.

### STATUS

The project is now in the planning stage and is expected to be accomplished during FY 78.

## CONCEPT EVALUATION: BIFOCAL NIGHT VISION GOGGLE

### OBJECTIVE

To evaluate the use of a bifocal concept in the night vision goggles (NVG) allowing the Army aviator to view both inside and outside the cockpit without manually refocusing the tubes.

### BACKGROUND

The NVG are being used in Army aviation as an aid to night flight. The office of the Director for Combat Developments funded the CEP and requested our assistance in determining the feasibility of using a bifocal lens design. The optics in the current NVG require that the tubes be individually and manually refocused if the user desires a major change in his viewing distance. The bifocal design would eliminate the refocus requirement. The study is a joint effort with the Aviation Psychology Division.

### METHODOLOGY

A field study will be performed using the JUH-1H equipped with the Helicopter Inflight Monitoring System (HIMS). The subjects will be experienced NVG pilots. The NVG conditions will include bifocal height as a variable. In addition, comparisons will include plano NVG and the unaided eye. Flight parameters will include standard hover maneuvers, nap-of-the-earth and low level.

### STATUS

Some delay has been experienced in obtaining tubes of acceptable optical quality from the manufacturer. Data collection is expected in 2d quarter FY 78 with the report immediately following.

## PUPILLOGRAPHIC CORRELATION OF FLIGHT FATIGUE

### OBJECTIVE

To establish a flight fatigue index based on pupillary reflex response characteristics to light stimulation.

### BACKGROUND

The use of electronic pupillography in the study of pupillary reflex response to various stimuli has been investigated by many people. A general agreement is when a subject is fatigued (a) the size of the pupil becomes smaller; (b) the amplitude of the pupillary response to light is diminished; (c) the waveform of the pupillary reflex response to light stimulation is changed to a characteristic square, W-shape, V-shape or flattened reflex response; and (d) waves of spontaneous pupillary contraction and dilation, called hippus, accompany periods of increasing sleepiness. The purposes of the present study are to: (1) analyze pupil size and spontaneous pupillary movements to light during field testing of pilots participating in extended helicopter flights; (2) assess the validity of the data; and (3) assess the value of pupillographic measurements on the evaluation of pilot alertness. This study references a subproject of fatigue indices including biochemical, physiological, psychological and performance measurements.

### METHODLOGY

Six volunteer rotary wing aviators who had just graduated from their flight training program were the subjects for this study. Experimental procedure included 20 hours of flight and ground exercises and four hours of sleep. In each session, subjects were tested for pupillary reflex, one subject at a time, twice a day. They were dark-adapted for five minutes and then were instructed to observe a dim red fixation light. Two short flashes were presented to each subject at the beginning of each session. This was followed by 10 minutes of pupillary measurements in complete darkness. At the end of the session, two final flashes were presented.

### STATUS

Results have been analyzed and will be published as a USAARL Report (entitled "Physiological Parameters Associated with Extended Helicopter Missions: An Assessment of Pupillographic Data.") Results revealed that pupillary reflex response method can be used as one of flight fatigue indices. Positive correlations between the degree of flight fatigue and the waveform shapes of pupillography were demonstrated.

# VISUAL SELECTION CRITERIA FOR COMBAT VEHICLE CREWMEN

## OBJECTIVE

To measure and evaluate specific visual parameters from a company undergoing One Stop Unit Training, compare individual driving and firing performances with measured visual function, and determine which, if any, of the visual parameters could be used in preselecting personnel to train as tank drivers or gunners/loaders.

## BACKGROUND

This investigation was part of a larger study initiated at Fort Knox, KY to determine if certain performance, physiological, psychological or academic tests could be used to preselect individuals to undergo multi-track training which would be more task specific and efficient. Medical Research and Development Command tasked USAARL to support the clinical visual aspects of this study.

## METHODOLOGY

Research personnel conducted specialized visual screening tests on 167 trainees at Fort Knox, KY. This screening included the following parameters: visual acuity, spherical equivalent, best visual acuity with spherical equivalent, distance lateral heterophoria, near lateral heterophoria, vertical heterophoria, eye dominancy, hand dominancy, suppression, stereopsis, and night vision.

## STATUS

The results of this study are complete and published in USAARL LR-77-10-7-5, "Visual Selection Criteria for Armored Vehicle Crewmen." Low correlations were found between the various visual functions tested and the performance measures. However, it should not be concluded that vision plays an insignificant role in individual performance. The reason for the poor correlation between any one or several of the visual skill scores and performance is that many intervening and confounding variables can greatly influence performance but are not necessarily related to visual ability.

# FIELD STUDY AVIATOR OPHTHALMIC FRAME

## OBJECTIVE

To determine the acceptability (compatibility, comfort, style, color) of a new spectacle frame design and to determine the serviceability of the frame material in varying environmental conditions.

## BACKGROUND

The standard issue metal aviator's frame (FG-58) has received good acceptance from user personnel and has provided reasonable serviceability. Therefore, some design and safety deficiencies have been accepted in the past. However, recent increases in the cost of these frames and changes in the material from which they are made have forced a search for an acceptable substitute. This study is a joint Army/Air Force program in which a new frame made from thermosetting plastic is being field tested.

## METHODOLOGY

This field study requires that the test frames be issued to and worn by 300 Army personnel on active flight status. The volunteers have been obtained from the following locations: Fort Rucker (150), Fort Campbell (50), Fort Richardson (50), Fort Hood (50). The personnel will wear the test frames for a period of one year during which, at four month intervals, they will be questioned to obtain data on the test frame for serviceability and compatibility. Air Force research personnel are conducting an identical study using the same timeframe at selected Air Force bases.

## STATUS

The test frames have been issued and data collection has proceeded as scheduled. All user information will be completed during the first quarter, FY 78, with a final report due shortly thereafter.

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0B 6892 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUMRY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | D. CHANGE | U (NO CH) | U | | NL | ☐ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E762773A819 | 00 | 003 |
| b. CONTRIBUTING | | | | |
| c. CONTRIBUTING | CARDS (f.) (m) | | | |

11. TITLE (Precede with Security Classification Code)

(U) Research of Electro-Optical Systems and the Human Visual System

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001300 Aircraft; 012000 Optics; 012900 Physiology

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 76 10 | Cont | DA | C. In-House |

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER: Not applicable

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|
| FISCAL YEAR PRECEDING 77 | 4.2 | 102 |
| FISCAL YEAR CURRENT 78 | 3.75 | 131.3 |

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Laboratory

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RESPONSIBLE INDIVIDUAL

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20. PERFORMING ORGANIZATION

NAME: US Army Aeromedical Research Lab
Bio-Optics Division

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PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME: WILEY, R.W., MAJ

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SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: VERONA, R.W., CPT

NAME: HOLLY, F.F., CPT

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Electro-Optical Systems; (U) Vision; (U) Target Detection; (U) Display Color; (U) Visual Sensitivity; (U) Night Vision;

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide information about the effects of military electro-optical viewing and display systems on the human visual system and to determine optimum display characteristics to match the capabilities of the visual system.

24. (U) The approach will involve visual psychophysical procedures and the electro-optically generated targets will be verified with static and scanning photometric and colorimetric techniques.

25. (U) The instrumentation necessary to measure and record the visual display parameters has been ordered. A phototype of the system was demonstrated by the vendor. The system, a spatial and spectral scanning radiometer and photometer, will be delivered in 1st Quarter FY 78 and interfaced via a multiplex data buss to the USAARL Hybrid Computer facility by 3rd Quarter FY 78. The video test pattern generator and photographic materials necessary to generate the stimuli have been ordered. A prototype of the pattern generator and samples of the photographic materials have been received and tested by the investigators. The cathode-ray tubes with selected phosphors have been received and are undergoing acceptance tests. Background literature is still being reviewed and the experimental design and measurement techniques are being refined.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Research of Electro-Optical Systems and the Human Visual System

OBJECTIVE:

To provide information about the effects of military electro-optical viewing and display systems on the human visual system and to determine optimum display characteristics to match the capabilities of the visual system.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following page numbered 68.

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

## RESEARCH OF ELECTRO-OPTICAL SYSTEMS AND THE HUMAN VISUAL SYSTEM

### OBJECTIVE

The objective of this research program is to provide a scientific data base for government and industry visual display developers so they can obtain information relating specific display parameters to the human visual system's capabilities and limitations.

### BACKGROUND

The efficiency of the man-display system is critical if the man is to acquire all the electronic information the expensive sensor is providing. The display characteristics interact with and, therefore, must be analyzed in concert with the human visual system to maintain meaningful and realistic man-display performance measures.

### METHODOLOGY

The criteria used to measure the man-display system performance for this program include: contrast sensitivity for stationary and moving stimuli, subtended visual angles, and dark adaptation rates. The effects of parameters such as focused and collimated monocular, biocular, and binocular viewing systems on fatigue rates, retinal rivalry and depth perception are also to be investigated. Other independent variables include: phosphor color, phosphor persistence, screen brightness, contrast ratios, target velocities and viewing time.

Static and dynamic sine wave patterns will be used to measure the visual modulation transfer function (VMTF) response of the human observer for each treatment. A vehicle recognition test will also be conducted with the same levels of the independent variables. Subjective data will also be obtained from the observers based on their own preferences. Performance data will then be compared to preference data. Multivariate statistics will be used to analyze the derived data.

### STATUS

The instrumentation necessary to measure and record the visual display parameters, a spatial and spectral scanning radiometer photometer has been ordered. A video test pattern generator is now undergoing acceptance tests. The film stimuli are being generated. The flying spot scanner used to convert the 35mm slides to video and the film chain system used to convert the 16mm motion picture film to video have been received and tested. The miniature cathode-ray tubes (CRT's) have been received and are undergoing acceptance tests. Seven large CRT's with other various phosphor types have been ordered. The data collection techniques are being developed and tested.

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION* | 2. DATE OF SUMMARY* | REPORT CONTROL SYMBOL |
|---|---|---|
| DA OB 6893 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY* | 6. WORK SECURITY* | 7. REGRADING* | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA: CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | D. CHANGE | U (NO CH) | U | | NL | ☒ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES:* | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E762773A819 | 00 | 004 |
| b. CONTRIBUTING | | | | |
| c. CONTRIBUTING | CARDS 114 (f) (m) | | | |

11. TITLE (Precede with Security Classification Code)*

(U) Visual and Optical Evaluation of Non-Medical Material

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*

001300 Aircraft; 012000 Optics; 012900 Physiology

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| | Cont | DA | C. In-House |

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER* Not Applicable

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|
| FISCAL YEAR PRECEDING 77 | 5.4 | 174 |
| FISCAL YEAR CURRENT 78 | 3.24 | 118.7 |

19. RESPONSIBLE DOD ORGANIZATION

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20. PERFORMING ORGANIZATION

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PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

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SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS

NAME: GLICK, D.D., MAJ

NAME: HOLLY, F.E., CPT

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Aircraft; (U) Cockpit Lighting; (U) Optical Aberrations; (U) Vision; (U) Photometry; (U) Colorimetry; (U) Optical Transparencies

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide information on those aspects of the ambient or instrumented environment which might adversely affect or enhance the human visual system and military operational activity dependent upon visual performance.

24. (U) The approach will include physical optics techniques, photometry, spectrometry, and colorimetry to measure the fidelity, magnitude, and temporal characteristics of the visual environment and, using psychophysical procedures, determine the effects of the visual stimuli on visual performance.

25. (U) Accomplishment has been shown by USAARL LR-77-8-7-3, Lighting Evaluation of the Bell 214A Helicopter; USAARL LR-77-7-7-2, Night Vision Goggles, AN/PVS-5, Modification for Daytime Training; USAARL LR-77-10-7-5, Visual Selection Criteria for Armored Vehicle Crewmen.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Visual and Optical Evaluation of Non-Medical Material

OBJECTIVE:

To provide information on those aspects of the ambient or instrumented environment which might adversely affect or enhance the human visual system and military operational activity dependent upon visual performance.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 71 through 79.

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

## COCKPIT COMPATIBILITY WITH NIGHT VISION GOGGLES

### OBJECTIVE

To develop techniques to make the crewstation lighting of Army helicopters compatible with the use of night vision goggles.

### BACKGROUND

Army aviators are presently flying low level and nap-of-the-earth profiles at night with the aid of night vision goggles. However, crewstation lighting was not designed to be compatible with the use of these goggles. Both the instrument and warning lights are much too bright. The detrimental effects of lighting which is too bright are twofold: (1) bright lights cause the goggles to bloom which creates a blurring condition and makes legends, indicia, etc. non-legible and, (2) bright lights activate the goggles automatic gain control which reduces out-of-the-cockpit visibility. Director for Combat Developments and Director for Training Developments requested USAARL assistance in developing the improvement in cockpit lighting for night vision goggle compatibility.

### METHODOLOGY

In this work, two generations of lighting configurations were installed in test bed aircraft. The second generation system was completed during the past year and consists of:

(1) Replacing the present lighting rheostats with high quality rheostats which can be trimmed down to NVG levels.

(2) Installing a three-way switch for the RPM and FIRE warning lights which allows settings for daytime, nighttime-naked eye and nighttime-night vision goggles.

(3) Dim the Master Caution light and Caution Panel lights by adding resistance to the Master Caution light circuit and the light circuits on each of the cards in the Caution box. The BRIGHT position is retained and the DIM position now becomes an NVG DIM.

(4) Paint the crewstation black (MERDC derivative LR8/1191, MIL-L-46159A).

(5) Standardize the arrangement of the center console.

(6) Balance the light intensity between the RMI and attitude indicator.

(7) Install power supply for night vision goggles.

STATUS

It was found that the second generation system provides a nearly optimal lighting configuration and that it can be installed at relatively low cost. Documentation of this work has recently been received from the contractor leaving only the preparation of the final report remaining to be accomplished.

# OPTICAL EVALUATION OF THE AH-1S SLIGHTLY BOWED CANOPY

## OBJECTIVE

To determine the optical suitability of the slightly bowed canopy on the AH-1S prototype aircraft.

## BACKGROUND

This study was performed at the request of the US Army Development Test Activity. The AH-1S slightly bowed canopy is a modification of the original flat plate canopy which was designed for this aircraft but which was found to be unacceptable because of the internal reflection of external light sources. The slightly bowed canopy also reflects many external light sources but it was hoped that the curvature would distort these reflections enough so that they could be distinguished from the real objects. In addition to evaluating its reflections and distortion of these reflections, a number of other evaluations and tests were performed to determine the amount of distortion of straight-through rays. These tests determined the prismatic deviation, spherical and cylindrical power of the canopy. The lighting of the crewstations was also evaluated.

## METHODOLOGY

All measurements were made using a Zeiss 8X telescope with internal cross-hair reticle and an external target containing vertical and horizontal contours. Prismatic deviation was determined by first aligning the reticle on the external target with the canopy opened and then noting the magnitude and direction of displacement of the target when the canopy was in position. Refractive power of the canopies at the selected points was determined by sharply focusing on the external target first with the canopy raised and then with the canopy closed, separately for the horizontal and vertical contours. From the difference in focal distance under the two conditions, the refractive power of the canopy was calculated.

Also the aircraft was flown at night over lighted areas and the reflections and distortions thereof were noted. Also, the lighting was evaluated for compatibility with night vision goggles.

## STATUS

All of the data for this study have been collected and the final report is being written. It was found that the prism deviation of the canopy ranges from 1/10 to 1 prism diopter, and that it has a refractive power of as much as 1/4 diopter in some locations. It was also found that this canopy creates serious visibility problems for the aviator due to its internal reflection of external light sources and that it is not acceptable for flight over lighted areas at night.

## BALLISTIC TESTING OF PROTECTIVE EYE MATERIAL

### OBJECTIVE

To evaluate protective eye material with small, high speed projectiles.

### BACKGROUND

There were numerous eye injuries in recent military engagements caused by fragments and spall which penetrated the goggles worn by ground vehicle crews. A proposal was made to strengthen the goggle material, but data was not available on the efficacy of the new material against small, high speed missiles. In addition, the continued production of new optical materials, their associated coatings and toughening techniques require ballistic evaluation to insure that the soldier receives the maximum protection available.

### METHODOLOGY

A gas operated gun in which velocity is accurately controlled by pressure variation and for which interchangeable barrels of varying bore diameter are available was built for this project. Velocity is measured with a chronograph and its associated photoelectric screens.

The velocity at which fifty percent of the protectors are broken ($V_{50}$) or penetrated is used as the comparison value. For this test, each lens is struck one time. If the lens breaks, the velocity is reduced by one standard deviation or, for the next sample, increased the same amount if the lens is not broken. The unbroken samples become part of another population which is then subjected to multiple strikes to ascertain their fracture point.

### STATUS

Equipment difficulties and temporary loss of the primary investigator have delayed data collection. Continuation is expected in the 1st and 2d quarters, FY 78.

# WINDSCREEN TRANSPARENCY EVALUATION OF US ARMY UTILITY, TACTICAL AND TRANSPORT AIRCRAFT SYSTEMS YUH-60A AND YUH-61A

## OBJECTIVE

To provide the UTTAS Project Manager technical data of windscreen transparency on YUH-60A and YUH-61A.

## BACKGROUND

The US Army Aircraft Development Test Activity (ADTA) conducted an evaluation of the YUH-60A and the YUH-61A IAW para 2.6.4.2 of TECOM Project No. 4AI-170-071-004. As a part of this evaluation, the Bio-Optics Division was requested to perform an evaluation of optical characteristics and windscreen transparencies. It included two main projects: (1) optical characteristics of windscreen transparency, and (2) windscreen distortion test.

## METHODOLOGY

(1) Optical characteristics of the windscreen transparencies included: (a) field-of-view (FOV) measured by a microptic theodolite (Hilger and Watts Limit, London, England), (b) The attenuation of light transmittance due to slanting performed by a standard method in which the windscreen percent transmission is correlated with the degree of tilting. (2) The windscreen distortion test involved photographic documentation from the pilot and the copilot design eye positions and from 20 degree downward azimuthal location. A one inch grid board was used for every 5 degree of horizontal plane from left 90° to right 90° with respect to the pilot and copilot design eye positions.

## STATUS

Results have been submitted together with other studies performed by personnel from other divisions to the US Army ADTA. A USAARL letter report will be published (entitled "Optical Characteristics and Distortion Evaluation of UTTAS Aircraft YUH-60A and YUH-61A Windscreen Transparencies.")

## NONIONIZING RADIATION EVALUATION ON THE 2B51 SYNTHETIC FLIGHT TRAINER SYSTEM (SFTS)

### OBJECTIVE

To determine the potential ocular hazard from the high illumination intensity level of the terrain model board light bank of the 2B31 (CH47 Chinook) Synthetic Flight Trainer System (SFTS).

### BACKGROUND

The Terrain Model Board Light Bank (TMBLB) in the 2B31 or CH-47 Chinook Synthetic Flight Trainer System (SFTS) consists of 174 GTE Sylvania 1 Kilowatt metal-halide lamps. When the light bank is fully activated, its high intensity illumination (or nonionizing radiation) poses potential ocular hazards to the personnel working in the vicinity of the system. During the second phase of the developmental test program of the SFTS (TECOM Project No. 4-AI-10F-B31-001), the Test Project Officer at the US Army Aircraft Development Test Activity (ADTA) requested this Laboratory to provide photometric evaluation of the TMBLB.

### METHODOLOGY

The Pritchard Photometer Model 1980, manufactured by Photo Research Division of Kollmorgen Company, was used to measure the illuminance level. Fourteen data points were selected at three different distances from the TMBLB. Eight different orientations were measured for each data point. These data points constitute a three dimensional luminance profile for the TMBLB measurement.

### STATUS

Results were tabulated and a three dimensional luminance profile was drawn. Final analyses on a set of sampling luminous intensity profiles were made. From these data, the safety level for personnel protection from ocular hazards can be determined. This study has been written as a USAARL Letter Report, "High Intensity Illumination Evaluation on the Terrain Model Board Light Bank of the CH-47 Synthetic Flight Trainer System (SFTS)" which is in publication.

# INTERNAL AND EXTERNAL ARTIFICIAL ILLUMINATION SOURCES FOR AN/PVS-5 NIGHT VISION GOGGLES

## OBJECTIVE

To utilize the existing aircraft landing lights or an external light source as an artificial illumination source for night vision goggle training at night.

## BACKGROUND

Current scheduling of AN/PVS-5 night vision goggles (NVG) training conducted by the Army Aviation Center, for safety reasons, depends greatly upon the level of available night sky illumination. The second generation NVG requires a minimum of twenty percent moon illumination in order to perform certain basic landing maneuvers for helicopter night training. At the present time, the NVG training personnel use photometric measurement to monitor the night sky illumination. When the illuminance value falls below a certain critical quantity, the training has to be suspended. This critical dependence of ambient light levels creates a major difficulty for the night training program in fulfilling its training mission within a preassigned timeframe. In order to provide an active training schedule, it is necessary to circumvent the fluctuating night sky illumination by introducing a steady illumination from an artificial source. The existing aircraft landing light could serve as a possible illumination source. Nevertheless, without any modification to control its output light level, the landing light is too bright for the NVG. Three major modifications have been proposed. First is to modify the electrical system of the aircraft so that its output intensity is adjustable to a desirable level. Second is to apply a suitable filter to the NVG. The third is to apply a heat-absorbing filter to the landing light. An alternative method is to use an artificial light source other than the landing light such as the Fire-Fly Light System or searchlight.

## METHODOLOGY

Since the modification of the electrical system of the aircraft involves an extensive hardware overhaul, this study elected to flight test the second and third methods. The procedure for the landing light system is briefly as follows: (1) select suitable filter with spectral characteristics compatible to NVG electro-optical (E-O) system response, (2) design and select a suitable method of mounting in the NVG or in the landing light bracket, (3) flight test with the system using experienced pilot and qualified scientific observers. The procedure for the study of the external light source was to compare the following two different light systems: (a) Fire-Fly Light System versus (b) AN/VSS-4(XE-4) searchlight system.

STATUS

Results for the artificial light system utilizing the filter on the landing light have been published in USAARL LR-77-1-7-1, entitled "Utilization of Existing Aircraft Landing Light as an Artificial Illumination Source for AN/PVS-5 Night Vision Goggles Training." Results from the artificial light system utilizing the filter on the NVG will be published soon. In general it has been shown that the third system (i.e., the system with the appropriate filter on the landing light) provides an adequate light level for the NVG training at night. The second system (i.e., the system with appropriate filter on the NVG when the landing light is on) is impractical although it would be more economical to operate.

Results for the external light source have been published in USAARL LR-77-9-7-4 entitled "Ambient Light Characteristics of a Modified AN/VVS-4 (XE-4) searchlight system and a Fire-Fly Light System (FFLS)." It was shown that the modified searchlight system provided a better illumination pattern and was easier to operate than the FFLS.

## LASER SAFETY DEVICE EVALUATION

### OBJECTIVE

To study spectral characteristics of laser safety devices and to provide a data base for future utilization of laser-related military operations.

### BACKGROUND

Although laser safety criteria are made available in various references, the optical characteristics and the spectral transmittance of the laser safety devices are unavailable in any published form. Since the underlying laser damaging mechanisms and thresholds to the visual system remain unresolved, and since the laser radiation powers and intensities vary greatly with respect to the lasing materials and durations, there exists no single universal safety device that will meet all the US Army Safety Standards and Regulations (AR 40-46). The increasing use of lasers in military electro-optical systems, such as range finders, target designators, and weapons demands stringent safety protection for the users. This project is to quantitatively evaluate commercially available laser safety devices in terms of spectral response characteristics.

### METHODOLOGY

The light devices were tested in terms of their spectral transmittance by the Digital Processing Oscilloscope coupled to the Rapid-Scan Spectrometer (DPO-RSS System). Experimental procedures are briefly outlined as follow: (1) obtain energy power spectrum of the light source along, (2) obtain energy power spectrum of the light source through the sample, (3) compute the transmittance within wavelength range 300-1100 nm, (4) evaluate corresponding CIE chromaticity characteristics with software programming.

### STATUS

This study has been published in two USAARL reports, (1) USAARL Report 76-6 entitled "Bio-Optical Evaluation of Specialized Eyewear: Laser Safety and Dark Adaptation Devices" (Nov 75), (2) USAARL Report 77-17 "Optical Characteristics of Laser Safety Devices" (June 77). Results show that all eight devices tested were well within the safety criteria published by Army Regulation 40-46.

## RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION* | 2. DATE OF SUMMARY* | REPORT CONTROL SYMBOL |
|---|---|---|
| DA OE 6734 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PRE...ARY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY* | 6. WORK SECURITY* | 7. REGRADING* | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | D. CHANGE | U (NO CH) | | | NL | X YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES:* | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.11.01.A | 3616110A91C | | 288 |
| b. CONTRIBUTING | | | | |
| c. CONTRIBUTING | | | | |

11. TITLE (Precede with Security Classification Code)* (U) Development of Measurement Techniques for the Medical Assessment of Visually Coupled System (VCS) Components

12. SCIENTIFIC AND TECHNOLOGICAL AREAS* 004000 Components; 001400 Aircraft Flight Instrumentation (Helicopter); 007500 Human Factors Engineering; 007400 Bioengineering

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 7509 | 7809 | DA | C. In-House |

17. CONTRACT/GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:* N/A
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 2 | 48.2 |
| | CURRENT 78 | 2 | 67. |

19. RESPONSIBLE DOD ORGANIZATION
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TELEPHONE (205) 255-6415/6808
SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS
NAME: VERONA, R.W., CPT
NAME: HOLLY, F.F., CPT

21. GENERAL USE
Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)
(U) Visually Coupled System, (U) Helmet Mounted Sight, (U) Helmet Mounted Display

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To develop measurement techniques for the medical assessment of Visually Coupled System (VCS) components.

24. (U) It is possible to inadvertently compromise an aviator's safety and physiological performance when designing and fabricating a VCS. Therefore, the VCS hardware must be scrutinized carefully to insure mutual man-machine conformity. The first phase of the study will be concerned primarily with the Helmet Mounted Sight (HMS) component of the VCS. The approach during this phase will be to conduct laboratory and flight tests to determine the aiming/tracking capabilities of a crewmember using head orientation. The effects of eye dominance, helmet suspension, helmet weighting and target speed on accuracy will also be investigated. The second phase will be focused on the assessment of helmet mounted displays (HMD). Factors such as display color, image quality and size, brightness, contrast and their impact on the visual system of the crewmember and consequent performance will be investigated.

25. (U) The phase I laboratory experiment has been completed, and a preliminary report is in preparation. The aiming/tracking errors attributable to man's physiological limitations are now available to helmet sight developers and to Army project managers. The aircraft for the airborne validation of phase I and data collection in phase II has been equipped with a helmet mounted display (HMD) and LLLTV system, but funds for the helmet sight installation have not been available. Only sketchy data are available indicating a VCS can be used by the pilot to fly a helicopter at low altitudes (terrain flight). No attempts have been made to quantify factors affecting the physiology of the aviator during these high stress flights. A quantitative medical assessment of a crewmember using a VCS in a helicopter will provide a data base for input to the AAH, Cobra, and ASH Project Managers concerning the medical aspects of the VCS to be used on their aircraft.

* available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Development of Measurement Techniques for the Medical Assessment of Visually Coupled System (VCS) Components

OBJECTIVE:

To develop measurement techniques for the medical assessment of Visually Coupled System (VCS) components.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following page numbered 82.

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

DEVELOPMENT OF MEASUREMENT TECHNIQUES FOR THE MEDICAL ASSESSMENT OF VISUAL COUPLED SYSTEM (VCS) COMPONENTS

## OBJECTIVE

The objective of this research program is to provide a scientific data base for government and industry helmet mounted sight and helmet mounted display developers so they can obtain information relating specific hardware parameters and configurations to the human's psychomotor and perceptual capabilities and limitations.

## BACKGROUND

It is possible to inadvertently compromise an aviator's safety and physiological performance when designing and fabricating a VCS. This is because of the intimate and delicate interface which exists between the man and the machine in a VCS. It is therefore imperative for investigators with health sciences backgrounds as well as investigators with physical sciences and engineering backgrounds to be cooperatively contributing to the system design.

## METHODOLOGY

In the laboratory phase of the helmet sight investigation, six aviator subjects tracked a moving target with using only head movements. A sighting device was fastened to the subject's helmet and a collimated reticle was presented to the subject's eye. The subject was vibrated with the multiaxis helicopter simulator (MAHVS). The vibration used for the test was recorded on an AH-1G flying a profile designed for the sighting task. The dependent parameter for the study was aiming/tracking accuracy expressed in root mean square (RMS) radial error. The independent variables were viewing eye dominance, target speed, helmet weighting, and helmet suspension.

The second phase of helmet sight study involves an airborne validation of the MAHVS results. The helmet sight used in phase II will also be used in conjunction with a helmet mounted display (HMD) to obtain a qualitative assessment of the stress involved with flying using a VCS. If sufficient assets are available, an attempt will be made to acquire quantitative performance data also.

## STATUS

The data from the laboratory study are now being analyzed and a report is being prepared. The phase II effort is awaiting additional ILIR funds to acquire, integrate and maintain a helmet sight for the duration of the phase II test. The aircraft, sensors and displays are operational and available. A laboratory model of the sensor gimble system and the helmet sight system.

**RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY**

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0C 6885 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISB'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | D. CHANGE | U (NO CH) | | | NL | ☒ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES: | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 21X4992 | 7KE80130 | | |
| b. CONTRIBUTING | 6.27.73.A | 3E762773A819 | 00 | 017 |
| c. CONTRIBUTING | CARDS 114 (f) (m) | | | |

11. TITLE (Precede with Security Classification Code)

(U) Bio-Optical Aspects of the XM-29 Protective Mask

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

012000 Optics; 012900 Physiology; 001300 Aircraft

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 76 07 | Cont. | DA | C. In-House |

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER: Not applicable

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 2.0 | 75 |
| | CURRENT 78 | .3 | 16 |

19. RESPONSIBLE DOD ORGANIZATION

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20. PERFORMING ORGANIZATION

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SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS

NAME: GLICK, D.D., MAJ

NAME:

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Protective Mask; (U) Bio-Optical Evaluation; (U) Ophthalmic Correction

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide information and guidance of visual and optical aspects in the design and fabrication material of the XM-29 protective mask.

24. (U) The approach will include physical optics techniques, photometry, and spectrophotometry to measure the optical quality of images transmitted through the mask, and psychophysical techniques will be used to measure visual performance while wearing the mask. The effort will include a consideration of techniques to provide optical correction in the mask for those individuals with refractive errors.

25. (U) Accomplishment has been shown by publication of USAARL Report 77-14, "Visual and Optical Analyses of XM-29 and M-24 Protective Masks" which details the extensive psychophysical and physical analyses completed on the developmental mask during this past year. In addition, a prototype mask-compatible combat spectacle frame was designed and field tested. As a result of this test, a second frame has been designed and is being fabricated for field test.

AD-A064 550 ARMY AEROMEDICAL RESEARCH LAB FORT RUCKER ALA F/G 6/5
ANNUAL PROGRESS REPORT, 1 OCTOBER 1976 - 30 SEPTEMBER 1977,(U)
OCT 77 S C KNAPP

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GENERAL DETAIL SHEET

TITLE: Bio-Optical Aspects of the XM-29 Protective Mask

OBJECTIVE:

To provide information and guidance of visual and optical aspects in the design and fabrication material of the XM-29 protective mask.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 85 through 86.

RECOMMENDATIONS:

It is recommended that research in this area be funded until completion of the mask development program.

# VISUAL AND OPTICAL CONSIDERATIONS FOR THE XM-29 PROTECTIVE MASK

## OBJECTIVE

To provide medical guidance on visual and optical considerations in the development of the XM-29 Protective Mask.

## BACKGROUND

The XM-29 program is directed by the Chemical Systems Laboratory under the authority of a Required Operational Capability to develop a universal protective mask which will replace all present Army protective masks. One of the principal goals in the new mask is to provide an improved vision capability while wearing the mask. USAARL was tasked by Medical Research and Development Command to provide guidance on visual and optical aspects of the new mask configuration.

## METHODOLOGY

USAARL's initial tasking included providing assistance to the developer in the areas of domestic and foreign technology, methods to provide ophthalmic correction while wearing the mask, and visual/optical considerations in the mask design. Because of suspected visual problems with the prototype mask configuration, USAARL responsibilities were expanded from that of consultation to include extensive laboratory investigations. Data collection techniques included accepted psychophysical procedures and optical physics methods recommended by the National Bureau of Standards and publications of Military Specifications. Since no visual performance criteria were available for the XM-29 mask, all tests were duplicated with the M-24 aviator's protective mask for comparison.

## STATUS

This study is complete and the results are published in USAARL Report 77-14, "Visual and Optical Analyses of XM-29 and M-24 Protective Masks." Of the thirteen optical and performance tests completed, the XM-29 was superior to the M-24 on one, the visual field. Performance was essentially equivalent for the two masks on four of the tests. However, the XM-29 was inferior to the M-24 mask on eight of the tests.

## COMBAT SPECTACLE FRAME

### OBJECTIVE

To assist in the design and field testing of a spectacle frame suitable for use by the combat soldier.

### BACKGROUND

The combat soldier is issued a frame which is not designed to withstand the rugged activity encountered in the field. In addition, he must remove his frame when donning a protective mask and risk breaking or losing his spectactles. The protective mask optical inserts have not been satisfactory from a user's or manufacturer's point of view.

The new frame has been designed for both rugged use and for wear under the protective mask. An initial prototype was field tested in FY 77 and was generally well accepted. A second prototype, incorporating needed improvements uncovered in the first field study, is now being made.

### METHODLOGY

The new frame will be issued to approximately 800 soldiers assigned to field units. Its durability and suitability will be monitored during the study and each subject will complete a questionnaire upon termination. The frames will also be examined following the study.

### STATUS

The second prototype design has been completed and the samples to be tested are now being manufactured. They will be fielded in 2d quarter, FY 78.

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA OB 6885 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| | A. CHANGE | U | U | | NL | ☒ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES: | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.11.02.A | 3E161102BS07 | 00 | 022 |
| b. CONTRIBUTING | | | | |
| c. [illegible] | CARDS 114 (f) (m) | | | |

11. TITLE (Precede with Security Classification Code)*

(U) Military Applications of Auditory Assessment

12. SCIENTIFIC AND TECHNOLOGICAL AREAS: 000200 Acoustics; 012400 Personnel selection and maintenance (medical) 001300 Aircraft.

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 76 10 | CONT | DA | C. In-House |

17. CONTRACT/GRANT: Not Applicable

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER:*

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|
| FISCAL YEAR PRECEDING 77 | 0.0 | 0.4 |
| FISCAL YEAR CURRENT 78 | 0.3 | 20.0 |

19. RESPONSIBLE DOD ORGANIZATION

NAME:* US Army Aeromedical Research Laboratory

ADDRESS:* Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL

NAME: Knapp, Stanley C., COL, Cdr

TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME:* US Army Aeromedical Research Laboratory Bioacoustics Division

ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME:* Patterson, James H., PhD

TELEPHONE: (205) 255-4408

SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS

NAME: Nelson, William R., CPT, MSC

NAME: Burdick, Charles K., CPT, MSC, PhD

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Acoustics; (U) Personnel selection and maintenance (medical); (U) Aircraft; (U) Industrial (occupational) medicine; (U) Communications.

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To prevent hearing loss through the investigation of techniques, materials, procedures, and instrumentation for assessing auditory perception, susceptibility to acoustic insult, job performance prediction based on audiometric test results, relationship of auditory deficits and work-noise environment affecting job performance and quantification of typical hearing loss in special acoustic environments.

24. (U) Basic principles of psychoacoustics, psychophysics, audiology and standard methods for measurement of speech intelligibility and discrimination will be used.

25. (U) No progress has been made on this project during FY 77. The resources available to the Bioacoustics Division were not sufficient to support work on this project.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

Title: Military Applications of Auditory Assessment

Objective:

To prevent hearing loss through the investigation of techniques, materials, procedures, and instrumentation for assessing auditory perception, susceptibility to acoustic insult, job performance prediction based on audiometric test results, relationship of auditory deficits and work-noise environment affecting job performance and quantification of typical hearing loss in special acoustic environments.

Background, Methodology, Status:

Statements concerning the above for this area of research can be found on the following pages numbered 89 through 91.

Recommendations:

It is recommended that research in this area be funded on a continuing basis.

## ATTENUATION CHARACTERISTICS OF THE ACOUSTIC REFLEX

Background: The role of the acoustic reflex as a possible auditory protective mechanism has been suggested in the context of the blast overpressure/high intensity impulse noise problem. Little is known about the attenuation provided by activating this reflex. This sub-task is mission related and part of the in-house research program.

Military Relevance: The development of new weapons systems has brought with it increased levels of impulse noise. These levels have become so excessive that serious question exists whether adequate protection can be provided. The role of any potential hearing protective mechanism must be explored in an attempt to reduce the hazard of these new weapons to Army personnel.

Goals: To determine the amount of auditory protection afforded by activation of the acoustic reflex. This information can then be applied to benefit the artillery crews who must fire the new high powered weapons systems.

Progress: There has been no progress on this sub-task during FY 77 due to a lack of personnel resources.

## SPEECH INTELLIGIBILITY REQUIREMENTS OF ARMY AVIATION

Background: This sub-task originated with informal requests from flight surgeons for a speech intelligibility test which could be used to assist them with their decision whether to waive the hearing requirement of flight physicals. It is part of the mission related in-house research program.

Military Relevance: All Army aviators are required to undergo periodic physical examinations and meet basic requirements. When an aviator incurs hearing loss he may fail to meet hearing requirements. The flight surgeon is then faced with the decision of either removing the aviator from flight status or granting a waiver of the requirement. An error in either direction could be very costly. In one case the Army loses a highly trained aviator; in the other case an unsafe aviator may be allowed to continue flying.

Goals: To provide a method which can assist the flight surgeon in determining the functional auditory capability of Army aviators.

Progress: There has been no progress on this sub-task during FY 77 due to insufficient personnel and funding resources.

## PREVALENCE OF HEARING LOSS AMONG AVIATORS

Background: This sub-task originated in the basic mission of the Bioacoustics Division to perform medical research in acoustics. It is part of the in-house research program.

Military Relevance: The effectiveness of the Army hearing conservation program can only be measured by monitoring the hearing abilities of Army subpopulations exposed to excessive noise. Army aviation personnel form such a subpopulation which has not been monitored adequately.

Goals: To improve hearing conservation in the Army by monitoring the effectiveness of the hearing conservation measures applied to Army aviation.

Progress: There has been no progress on this sub-task during FY 77 due to insufficient personnel and funding resources.

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0B 6886 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| | A. CHANGE | U | U | | NL | ☒ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES: | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.11.02.A | 3E161102BS07 | 00 | 023 |
| b. CONTRIBUTING | | | | |
| c. CONTRIBUTING | CARDS 114 (f) (m) | | | |

11. TITLE (Precede with Security Classification Code)*

(U) Medical Assessment of Hearing Protective Devices

12. SCIENTIFIC AND TECHNOLOGICAL AREAS* 000200 Acoustics; 013300 Protective Equipment; 007900 Industrial (occupational) medicine.

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 76 10 | CONT | DA | C. In-House |

17. CONTRACT/GRANT: Not Applicable

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER*

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 3.0 | 133.6 |
| | CURRENT 78 | 5.7 | 202.0 |

19. RESPONSIBLE DOD ORGANIZATION

NAME:* US Army Aeromedical Research Laboratory

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RESPONSIBLE INDIVIDUAL

NAME: Knapp, Stanley C., COL, Cdr

TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME:* US Army Aeromedical Research Laboratory Bioacoustics Division

ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME:* Camp, Robert T., Jr.

TELEPHONE (205) 255-4408

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: Patterson, James H. Ph.D.

NAME: Nelson, William R., CPT, MSC

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Acoustics; (U) Protective Equipment; (U) Industrial (occupational) medicine; (U) Aircraft; (U) Radio Communications; (U) Weapons effects.

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) This research assesses the sound-attenuating characteristics of hearing protective devices as to their suitability to meet the needs of the Army and develops new hearing protective devices and methods for evaluating them.

24. (U) The method for assessing attenuation is the ANSI Z22.24-1957. Objective electroacoustic methods will also be used.

25. (U) Progress on this project is reflected in the following reports: (1) Investigation of the Effects of One Standard and Two Experimental Eyeglass Temples on Sound Attenuation of the SPH-4 Helmet. USAARL Letter Report 77-4-2-2, Jan 77; (2) Real-Ear Attenuation Characteristics of the Labaire Ear Protector. USAARL Letter Report 77-5-2-3, Feb 77; (3) Medical Assessment of Acoustic Protective Devices Proposed for use in a Prototype Mechanized Infantry Combat Vehicle. USAARL Report No. 77-8, March 77; (4) Frequency Dependence of Impulse Noise Attenuation. USAARL Report No. 77-15, June 77. In addition, data collection is complete and final reports are in progress on (1) Medical Assessment of the Acoustic Protective Capability of the Cosmocord NATO Earmuff; (2) Medical Assessment of the Acoustic Protective Capability of the DH-178 Protective Helmet.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

Title: Medical Assessment of Hearing Protective Devices

Objective:

This research assesses the sound-attenuating characteristics of hearing protective devices as to their suitability to meet the needs of the Army and develops new hearing protective devices and methods for evaluating them.

Background, Methodology, Status:

Statements concerning the above for this area of research can be found on the following pages numbered 94 through 97.

Recommendation:

It is recommended that research in this area be funded on a continuing basis.

## REAL-EAR SOUND ATTENUATION STUDIES

Background: DA Circular 40-18 dated 3 August 1976, "Command Emphasis on Hearing Conservation Programs" establishes the requirement for an effective hearing conservation program in the Army. This project is in direct support of the Army hearing conservation program. The information generated through this sub-task is used in the selection of hearing protective devices for use by the Army. It is part of the in-house research program.

Military Relevance: One of the cornerstones of the Army hearing conservation program is the use of personal hearing protective devices in hazardous noise environments. The success of this program depends on the availability of adequate hearing protective devices.

Goals: To provide improved hearing conservation for the Army by collecting real-ear attenuation data on a variety of hearing protectors as required for the selection of the most suitable for use by Army personnel.

Progress: During FY 77 real-ear attenuation data was obtained on the following devices:

(1) DH-132 for possible use in MICV.

(2) DH-179 for possible use in MICV.

(3) Labaire earmuff.

(4) Lightweight SPH-4 with helmet mounted sight.

(5) AO Model 1600 One-Ten 1720 Hear Guard.

(6) DH-178 with and without EAR earplugs for possible use with M198.

(7) AO 1700 earmuff.

(8) SPH-4 helmet with three types of aviator eyeglass frames.

(9) David-Clark Model 117 earmuff.

(10) Mine Safety Appliances. Noise Foe Mark IV in over the head, behind the head, and under the chin headband configurations.

(11) David-Clark E-105 earmuff.

(12) SPH-4 helmet with 75-C-2990 seals.

(13) SPH-4 helmet with XM-29 gas mask.

(14) American Optical 1200 Hear Guard.

(15) Flents 080 Model U Silenta.

(16) Willson Sound Silencer EP101B earplugs.

The following reports were completed during FY 77:

"Investigation of the Effects of One Standard and Two Experimental Eyeglass Temples on Sound Attenuation of the SPH-4 Helmet." USAARL Letter Report 77-4-2-2, Jan 77.

"Real-Ear Sound Attenuation Characteristics of the Labaire Ear Protector." USAARL Letter Report 77-5-2-3, Feb 77.

"Medical Assessment of Acoustic Protective Devices Proposed for use in a Prototype Mechanized Infantry Combat Vehicle." USAARL Report No. 77-8, March 77.

EVALUATION OF THE ADEQUACY OF E-A-R EARPLUGS AND THE DH-178 HELMET FOR ACOUSTIC PROTECTION FROM THE IMPULSE NOISE PRODUCED BY M198

Background: Late in the development cycle of the M198, 155 mm howitzer, it came to the attention of The Surgeon General's office that the impulse noise levels produced by the weapon were excessive. Preliminary indications were that the levels were between 179 and 183 dB peak pressure. This led the Surgeon General to issue a memorandum limiting the exposure of personnel to the impulse noise produced by Zone 8 firing pending a determination of what constitutes adequate hearing conservation measures. One aspect of this determination is the evaluation of the adequacy of E-A-R earplugs and the DH-178 helmet to prevent excessive threshold shifts.

Military Relevance: This study will provide an essential element of data required for redefining the firing restrictions imposed on the M198. Full fielding of the weapon cannot be accomplished until adequate hearing protection is available.

Goals: To determine whether adequate hearing protection is available for use with the M198/M203.

Progress: During FY 77 funding was made available to procure the instrumentation necessary to construct a 6-station field audiometric test apparatus. This instrumentation is on hand. Personnel resources were insufficient to begin fabrication of the field apparatus.

COMPARISON OF PHYSICAL-EAR METHOD FOR MEASURING SOUND ATTENUATION WITH THE ANSI Z24.22-1957 AND ANSI S3.19-1974

Background: For the past 20 years the standard method for measuring the attenuation of hearing protectors has been the ANSI Z24.22-1957. As part of the in-house research program, a more rapid Physical Ear Attenuation Test (PEAT) was developed as a research tool and screening method. In 1974 the American National Standards Institute adopted a new real-ear method as ANSI S3.19-1974. This sub-task is designed to generate comparative data for these three methods.

Military Relevance: The success of the Army hearing conservation program depends on having accurate information on the amount of protection afforded by hearing protective devices. This methodological study is essential to the development of this information.

Goals: To develop and standardize the PEAT for rapid measurement of attenuation of hearing protectors and to determine the relation between the attenuation measured by the three methods so that the military specifications and procurement contracts can be modified to use the newer methodology.

Progress: There has been no progress on this project during FY 77 due to a lack of personnel and funding resources.

**RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY**

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0B 6887 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUMMARY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| | A. CHANGE | U | U | | NL | ☒ YES ☐ NO | A. WORK UNIT |

| 10. NO. SUFFIXES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.11.02.A | 3E161102BS07 | 00 | 024 |
| b. CONTRIBUTING | | | | |
| c. ////////// | CARDS 114 (f) (m) | | | |

11. TITLE (Precede with Security Classification Code)
(U) Medically Significant Problems of Voice Communication Systems

12. SCIENTIFIC AND TECHNOLOGICAL AREAS 021000 Radio communications; 000100 Acoustic detection; 007900 Industrial (occupational) medicine.

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 76 10 | CONT | DA | C. In-House |

17. CONTRACT/GRANT Not Applicable
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 0.0 | 4.1 |
| | CURRENT 78 | .83 | 35.3 |

19. RESPONSIBLE DOD ORGANIZATION
NAME: US Army Aeromedical Research Laboratory
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20. PERFORMING ORGANIZATION
NAME: US Army Aeromedical Research Laboratory
Bioacoustics Division
ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME: Camp, Robert T., Jr.
TELEPHONE: (205) 255-4408
SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Mozo, Ben T.
NAME: Marrow, Ronny

21. GENERAL USE
Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Radio communications; (U) Acoustic detection; (U) Industrial (occupational) medicine; (U) Aircraft; (U) Acoustics; (U) Combat vehicle.

23. TECHNICAL OBJECTIVE. 24. APPROACH. 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) The acoustic environments associated with military training and operations in Army helicopters and tanks are usually hazardous and may cause interference with effective voice communications and the detection of warning signals. Most of the present aviation communication systems have characteristics that introduce both frequency and amplitude distortion of the speech signals.

24. (U) This research will be directed toward the development of an improved noise-cancelling microphone for use in Army aircraft. Improved radio communication systems will be developed for Army aircraft and armor vehicles (e.g., MICV). New communication devices such as contact microphones will be evaluated for their potential use in Army systems.

25. (U) There has been no progress on this project during FY 77. The resources available to the Bioacoustics Division were not sufficient to support work on all projects. Only a consultative service on this topic was provided.

* Available to contractors upon originator's approval

DD FORM 1498 MAR 68 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A 1 NOV 68 1498-1 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE

* U.S. GPO: 1974-540-843/8691

GENERAL DETAIL SHEET

Title: Medically Significant Problems of Voice Communication Systems

Objective:

The acoustic environments associated with military training and operations in Army helicopters and tanks are usually hazardous and may cause interference with effective voice communications and the detection of warning signals. Most of the present aviation communication systems have characteristics that introduce both frequency and amplitude distortion of the speech signals.

Background, Methodology, Status:

The purchase of some laboratory instrumentation and a consultative service in this area were the only activities during FY 77. Funding and personnel were insufficient to permit any research activity on this project.

Recommendations:

It is recommended that research in this area be funded on a continuing basis.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA OB 6888 | 77 10 01 | OTDR&E(AR)636 |

| | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. FORMAT | 8. DISTRIBUTION | 9. SPECIFIC DATA TYPE/FOR ACCESS | 10. LEVEL OF SUMMARY |
|---|---|---|---|---|---|---|---|
| | A. CHANGE | U | U | | NL | ** ☐ YES ☐ NO | A. WORK UNIT |

| 11. NO. CODE | PROGRAM ELEMENT NUMBER | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. SUMMARY | 6.11.02.A | 3E161102BS07 | 00 | 025 |
| b. CONTINUING | | | | |
| c. ////////// | CARDS 114 (f) (m) | | | |

12. TITLE (Include with security classification code)

(U) Acoustic Environment of Army Prototype Equipment

13. SCIENTIFIC AND TECHNOLOGICAL AREAS

000200 Acoustics; 001300 Aircraft; 003700 Combat Vehicles

| 14. START DATE | 15. ESTIMATED COMPLETION DATE | 16. FUNDING AGENCY | 17. PERFORMANCE METHOD |
|---|---|---|---|
| 76 10 | CONT | DA | C. In-House |

18. CONTRACT/GRANT: Not Applicable

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

| 19. RESOURCES ESTIMATE | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|
| FISCAL YEAR PRECEDING 77 | 4.36 | 189.1 |
| FISCAL YEAR CURRENT 78 | 2.9 | 147.3 |

20. PERFORMING ORGANIZATION

NAME: US Army Aeromedical Research Laboratory
Bioacoustics Division
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PRINCIPAL INVESTIGATOR (Provide SSAN if U.S. Academic Institution)
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SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Camp, Robert T., Jr.
NAME: Patterson, James H., Ph.D.

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Laboratory
ADDRESS: Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL
NAME: Knapp, Stanley C., COL, Cdr
TELEPHONE: (205) 255-5107

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Continue with security classification code)

(U) Acoustics; (U) Aircraft; (U) Combat vehicles; (U) Protective equipment; (U) Weapons effects; (U) Industrial (occupational)medicine.

23. TECHNICAL OBJECTIVE. 24. APPROACH. 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text with security classification code.)

23. (U) The principle technical objective of this project is to quantify the acoustic environments associated with new Army materiel in order to assess the hearing damage potential and to support the materiel developers to produce less hazardous equipment.
24. (U) Methods for measurement and analysis of high-intensity impulse noise are under development to quantify the noise characteristics of new weapons systems and other sources of impulse noise. Standard methods of measurement and physical acoustics will be employed.
25. (U) Progress on this project is reflected in the following reports: (1) Noise Levels Measured in an AH-1S Equipped with a Low Glare, Slightly Curved Canopy. USAARL Letter Report 77-3-2-1, 5 Jan 77; (2) Subjective Ratings of Annoyance Produced by Rotary-Wing Aircraft Noise. USAARL Report No. 77-12, May 77. In addition, field measurements were made on the M198, M109, Chapparal, and Dragon fired from enclosures. Data analysis is still in progress on these measurements.

26. [illegible]



* U.S. GPO: 1974-540-810/8001

GENERAL DETAIL SHEET

Title: Acoustic Environment of Army Prototype Equipment

Objective:

The principle technical objective of this project is to quantify the acoustic environments associated with new Army materiel in order to assess the hearing damage potential and to support the materiel developers to produce less hazardous equipment.

Background, Methodology, Status:

Statements concerning the above for this area of research can be found on the following pages numbered 102 through 104.

Recommendation:

It is recommended that research in this area be funded on a continuing basis.

## FIELD MEASUREMENT AT HIGH INTENSITY IMPULSE NOISE

Background: Recent developments of new weapons system, e.g. M198/M203, M109/M203, M110, have posed new problems of health hazards associated with high intensity impulse noise. AR 602-1 requires the Surgeon General to provide a hazard assessment of all new equipment. In order to assess the hazard of high intensity impulse noise, the Surgeon General must have a detailed quantitative technical data base of all relevant parameters of the impulse noise produced by these new weapons.

Military Relevance: The results of the measurements under this sub-task are necessary to the hazard assessment of new Army weapons systems.

Goals: To provide the basis for hazard assessment of new weapons systems by development of a biotechnology data base containing the peak sound pressure levels, durations, and energy density spectra of a variety of high intensity impulse noises.

Progress: During April 1977 field measurements of the M198/M203 155 mm howitzer were made at Yuma Proving Ground. Preliminary analysis of the data from those firings have been completed. These preliminary analyses indicate that the sound pressure levels in the vicinity of normal crew positions are in excess of the maximum levels permitted by MIL-STD-1474, Noise Limits for Army Materiel. A report is in progress. In May and June 1977 measurement of the noise produced by a prototype rocket motor for the Chapparal missile were made at White Sands, NM. Preliminary data analysis has been completed. A report is in progress. During July 1977 field measurements of the M109/ M119 155 mm self-propelled howitzer were made at Ft. Sill, OK. The data from this measurement have not been analyzed due to a lack of personnel resources. During February and September 1977 measurement of the DRAGON fired from an enclosure were made at Redstone Arsenal, AL. Preliminary data analysis of the first firing has been accomplished. Analysis of the second firing has been delayed due to lack of personnel resources and to equipment repairs.

## ACOUSTIC ENVIRONMENT OF PROTOTYPE ARMY AVIATION EQUIPMENT

Background: New Army aviation systems, like other Army equipment, present new noise problems during their development. Under the provisions of AR 602-1 the Surgeon General must provide medical input to these developments in the form of hazard assessment. In cooperation with USADTA, measurements of prototype aviation equipment are performed.

Military Relevance: The measurements made under this sub-task are essential to the development of new Army aviation systems by providing the necessary biotechnology data base for the required medical assessment of acoustic hazard.

Goals: To provide the basis for hazard assessment of new Army aviation systems by determining the noise spectra of the various acoustic environments they will impose on Army aviation personnel.

Progress:

On 16 December 1976, DAMA-WSA requested USAARL to assist ADTA and Aviation Test Board, Ft. Rucker, Alabama, in measuring the sound pressure levels produced by the UH-1H and OH-58C helicopters at various ranges and directions relative to the helicopter. The study was completed and the results of the data analysis were presented to the Aviation Test Board and ADTA for inclusion in their report.

A follow on evaluation of the low glare canopy for the AH-1 was completed during November and December 1976. A comparison was made of the sound pressure levels in the standard AH-1G and the AH-1S equipped with a slightly curved (1'/8" curvature) canopy. The data analysis indicated an increase in sound pressure level in the low frequency range (below 250 Hz) in the S model; however, the high frequency range (above 1 kHz) was less in the G model Cobra.

The US Army Aviation Board requested an internal sound pressure level comparison of the OV-1D with and without an IR Plume Suppressor installed. Base line data in the standard OV-1D were measured in December 1976. After the IR Plume Suppressor modification was completed, similar measurements were conducted and a comparison made between the two systems. Due to lack of personnel resources the analyses of these data have not been completed.

Internal and external sound pressure level measurements are being conducted on the first run production models of the AH-1S helicopter. These models are equipped with the slightly curved canopy. The request for measurement was made by USADTA, Ft. Rucker, AL. The measurements are complete and report is in progress.

The following report was completed during FY 77: "Noise Levels Measured in an AH-1S Equipped with a Low Glare, Slightly Curved Canopy." USAARL Letter Report 77-3-3-1, 5 Jan 77.

**RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY**

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA OB 6889 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| | A. CHANGE | U | U | | NL | ☒ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.11.02.A | 3E161102BS07 | 00 | 026 |
| b. CONTRIBUTING | | | | |
| c. [illegible] | CARDS 114 (f) (m) | | | |

11. TITLE (Precede with Security Classification Code)

(U) Military Acoustic Hazards: Mechanisms of Hearing Loss

12. SCIENTIFIC AND TECHNOLOGICAL AREAS 000200 Acoustics; 012400 Personnel selection and maintenance (medical); 007900 Industrial (occupation) medicine.

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 76 10 | CONT | DA | C. In-House |

17. CONTRACT GRANT Not Applicable

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|
| FISCAL YEAR PRECEDING 77 | 2.0 | 88.3 |
| FISCAL YEAR CURRENT 78 | 2.55 | 92.2 |

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Laboratory
ADDRESS: Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL
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TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: US Army Aeromedical Research Laboratory
Bioacoustics Division
ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME: Burdick, Charles K., CPT, MSC, Ph.D.
TELEPHONE: (205) 255-4408
SOCIAL SECURITY ACCOUNT NUMBER

21. GENERAL USE
Foreign Intelligence Considered

ASSOCIATE INVESTIGATORS
NAME: Patterson, James H., Ph.D.
NAME: Mozo, Ben T.

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Acoustics; (U) Personnel selection and maintenance (medical) (U) Industrial (occupational) medicine; (U) Aircraft; (U) Combat vehicles.

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To establish valid damage risk criteria to ensure the adequate hearing protection of Army personnel.
24. (U) Human audiometric and psychophysical procedures as well as animal behavioral and histological techniques will be used.
25. (U) Progress on this project is reflected in the following report, "Auditory Discrimination Learning by the Chinchilla: Comparison of Go/No-Go and Two-Choice Procedures." USAARL Report No. 77-16, Apr 77. In addition, one experiment on the effects of low frequency noise on hearing using chinchillas has been completed and a report submitted for publication. A follow on study using chinchillas and a collateral study using human subjects have been initiated. These studies indicate that significant hazard to high-frequency hearing may result from low-frequency noise.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

Title: Military Acoustic Hazards: Mechanisms of Hearing Loss

Objective:

To establish valid damage risk criteria to ensure the adequate hearing protection of Army personnel.

Background, Methodology, Status:

Statements concerning the above for this area of research can be found on the following pages numbered 107 through 111.

Recommendation:

It is recommended that research in this area be funded on a continuing basis.

THE EFFECT OF EXPOSURE TO LOW-FREQUENCY NOISE ON THE THRESHOLD OF HEARING

Background: Currently, all damage risk criteria for continuous noise are expressed in terms of A-weighted sound pressure levels. The effect of A-weighting is to de-emphasize the important of low-frequency sound as a possible contributor to hearing hazard. This procedure of using A-weighting networks when measuring noise may result in potentially hazardous levels of low-frequency noise being overlooked. This sub-task is the first in a series of experiments to better define the potential hazard from low-frequency noise. It is part of the mission related in-house research program.

Military Relevance: It has been found that many military vehicles, particularly armored vehicles and helicopters produce intense noise which is predominantly low-frequency. Army personnel who are exposed to this noise may not be adequately protected by the current Army hearing conservation criterion.

Goals: To reduce noise induced hearing loss in the Army by determining the validity of damage-risk criteria specified in terms of A-weighted levels and determining what intensity levels of low-frequency noise will cause permanent hearing loss.

Progress: Behavioral audiograms were obtained on eight binaural chinchillas trained on a shuttlebox avoidance procedure. Four of the animals were exposed to three successive levels of an octave band of noise centered at 63 Hz: 100 dB SPL (74 dBA), 110 dB SPL (84 dBA), and 120 dB SPL (94 dBA). The other four animals were also exposed to three successive levels of an octave band of noise centered at 1000 Hz: 75 dB SPL (75 dBA), 85 dB SPL (85 dBA), and 95 dB SPL (95 dBA). All exposure durations were 72 hours. The major results were: (1) A permanent high-frequency hearing loss to a low-frequency noise. (2) Noise bands matched within 1 dBA were not equally hazardous as dictated by damage-risk criteria. The 63 Hz noise band produced nearly twice the hearing loss of the 1000 Hz band. A paper entitled, "Threshold Shifts to Low-Frequency Noise: I. Chinchillas Exposed to Octave Bands of Noise Centered at 63 and 1000 Hz for Three Days," has been submmitted for publication.

## HEARING LOSS AND EXPOSURE TO LOW-FREQUENCY NOISE

Background: Previous results indicated that chinchillas exposed to low-frequency noise for three days incurred high-frequency hearing loss. It was also found that two noise bands matched within 1 dBA were not equally hazardous as dictated by damage-risk criteria. Questions remained concerning the characteristics of the growth pattern of the high-frequency hearing loss. This sub-task is part of the mission related in-house research program.

Military Relevance: It has been found that many military vehicles, particularly armored vehicles and helicopters produce intense noise which is predominantly low-frequency. Army personnel who are exposed to this noise may not be adequately protected by the current Army hearing conservation criterion.

Goals: This sub-task was designed to replicate previous findings and to provide a technological data base on hearing loss produced by low-frequency noise.

Progress: Two groups of four binaural chinchillas were exposed to an octave band of noise with a center frequency of 63 Hz. One group was exposed at 110 dB SPL (84 dBA) and the other group was exposed at 120 dB SPL (94 dBA). Both exposures lasted nine days. These results confirmed previous results in that permanent high-frequency hearing losses occurred in both groups.

TEMPORARY THRESHOLD SHIFT IN MAN RESULTING FROM FOUR-HOUR EXPOSURES TO OCTAVE BANDS OF NOISE CENTERED AT 63 HZ AND 1000 HZ

Background: In separate sub-tasks the effects of low-frequency noise on hearing have been investigated using animal subjects. In order to apply these findings to potential hazard to humans, it is necessary to obtain comparative data. Since humans cannot be given exposures which would result in permanent hearing loss, the necessary comparison between human and animal subjects is accomplished by examination of the early growth of temporary threshold shift. This sub-task is part of the mission related in-house research program.

Military Relevance: It has been found that many military vehicles, particularly armored vehicles and helicopters produce intense noise which is predominantly low-frequency. Army personnel who are exposed to this noise may not be adequately protected by the current Army hearing conservation criterion.

Goals: To contribute to establishment of valid hearing damage risk criteria for continuous noise by providing the necessary comparative data to permit the results of animals studies to be generalized to man.

Progress: Temporary threshold shifts for three human subjects exposed to an octave band of noise with a center frequency of 63 Hz have been obtained. The results indicate that in man, as in chinchilla, sizable temporary threshold shifts are induced at high frequencies by exposure to the 63 Hz octave band of noise.

INVESTIGATION OF THE RELATIONSHIP BETWEEN EYE PIGMENTATION AND SUSCEPTIBILITY TO NOISE-INDUCED HEARING LOSS

Background: For years it has been known that people display differential sensitivity to noise. This is reflected by differences in the amounts of hearing loss sustained by individuals having similar sound exposure histories. As yet we are unable to predict those individuals who are likely to suffer the most damage to a given noise exposure. The identification of a factor which could provide some predictive capability, which could be used to identify high-risk individuals would greatly enhance our protective capability. Research indicates that melanin may play a protective role in the ear as well as to the skin. This investigation concerns the ability to identify high-risk individuals on the basis of eye pigmentation. It is part of the mission related in-house program.

Military Relevance: All military combat personnel are exposed to potentially hazardous levels of noise throughout their careers. These exposures are costly both in the reduction of combat effectiveness and disability compensation upon separation from the service. New vehicles and weapons developments pose increasing hazards because of their increasing noise levels. In some cases these levels are so excessive that effective hearing conservation measures may require the selection of personnel who are less susceptible to noise-induced hearing loss.

Goals: To determine whether the presence or absence of pigmentation in the eye is correlated with differential amounts of noise-induced hearing loss.

Progress: Progress was halted after fabrication of the test apparatus because of insufficient personnel resources.

DEVELOPMENT OF AN ANIMAL MODEL FOR ASSESSING HEARING LOSS DUE TO HIGH-INTENSITY IMPULSE NOISE

Background: Recent weapons development (e.g., M198, M110) and operational requirements (e.g., firing DRAGON from enclosures) have raised serious questions concerning the adequacy of the current damage-risk criteria for impulse noise. Both the Surgeon General's hearing conservation criterion (TB-MED-251) and the limits on impulsive noise levels produced by Army Materiel (MIL-STD-1474A) are based on the CHABA criterion established in 1968. Because of the unique nature of the levels and pulse durations, these documents deal with them only on a basis of extrapolated data. A technological data base on auditory damage produced by high-intensity impulse noise is required for the derivation of a new, adequate damage-risk criterion for Army personnel. Existing animal models are inappropriate for many reasons. This is part of the mission related in-house research program.

Military Relevance: The hearing protection of firing crews and other Army personnel required to be proximate to the new generation of weapons depends on an adequate damage-risk criterion for impulse noise.

Goals: To identify an animal suitable for laboratory and field studies of hearing loss resulting from high-intensity impulse noise.

Progress: Progress was limited due to a lack of personnel and funding resources to the determination of a reinforcer and a mechanism for its delivery to be used with miniature swine.

**RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY**

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0C 6887 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA - CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| | H. TERMINATION | U | U | | NL | [X] YES [ ] NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.11.02.A | 3E161102BS07 | 00 | 027 |
| b. CONTRIBUTING | | | | |
| c. /////////// | CARDS 114 (f) (m) | | | |

11. TITLE (Precede with Security Classification Code)

(U) The Modification of the AN/PRC-70 Transceiver

12. SCIENTIFIC AND TECHNOLOGICAL AREAS 021000 Radio communications;000100 Acoustic detection; 007900 Industrial (occupational) medicine

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 76 10 | 77 09 | DA | C. In-House |

17. CONTRACT GRANT Not Applicable

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 0.1 | 43.0 |
| | CURRENT 78 | 0.0 | 0.0 |

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Laboratory

ADDRESS: Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL

NAME: Knapp, Stanley C., COL, Cdr

TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: US Army Aeromedical Research Laboratory Bioacoustics Division

ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME: Camp, Robert T., Jr.

TELEPHONE: (205) 255-4408

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: Mozo,. Ben T.

NAME: Marrow, Ronny

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Radio communications; (U) Acoustic detection; (U) Industrial (occupational) medicine; (U) Aircraft; (U) Acoustics; (U) Combat Vehicle

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) The acoustic environments associated with military training and operations in Army helicopters and tanks are usually hazardous and may cause interference with effective voice communications and the detection of warning signals. Most of the present aviation communication systems have characteristics that introduce both frequency and amplitude distortion of the speech signals. This research will be directed toward the development of an improved noise-cancelling microphone for use in Army aircraft. Improved radio communication systems will be developed for Army aircraft and armor vehicles (e.g., MICV).

24. (U) The approach is to modify a military type transceiver, the AN/PRC-70, to improve S/N ratio and eliminate the acoustic hazards of the present systems.

25. (U) Two AN/PRC-70 transceivers have been acquired and are currently being modified under contract by Cincinnati Electronics, Inc. The modified transceivers should be available early in FY 78. Evaluation of the modified transceivers will begin in conjunction with an on-going project on voice communication systems as soon as these modifications are complete. This project is being terminated due to funding termination.

NOTE: Reimbursement provided by Dir, Training Developments, Ft. Rucker, 6.57.06 21T 2040 T57-1077-675706-2572.

*Available to contractors upon originator's approval

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A 1 NOV 68 AND 1498.1 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE

* U.S. GPO: 1974-540-843/8691

GENERAL DETAIL SHEET

Title: The Modification of the AN/PRC-70 Transceiver

Objective:

The acoustic environments associated with military training and operations in Army helicopters and tanks are usually hazardous and may cause interference with effective voice communications and the detection of warning signals. Most of the present aviation communication systems have characteristics that introduce both frequency and amplitude distortion of the speech signals. This research will be directed toward the development of an improved noise-cancelling microphone for use in Army aircraft. Improved radio communication systems will be developed for Army aircraft and armor vehicles (e.g., MICV).

Background, Methodology, Status:

Statements concerning the above for this area of research can be found on the following page numbered 114.

Recommendation:

It is recommended that research in this area be funded on a continuing basis.

## THE MODIFICATION OF THE AN/PRC-70 TRANSCEIVER

Background: The present voice communications systems used in military aircraft may be a source of insidious hearing loss that has been overlooked in most assessments of the acoustic hazards of military air crewmen. Since the introduction of the SPH-4 helmet the Aeromedical Research Laboratory has investigated the voice communication systems as a source of hazardous noise. This project to develop a modified transceiver is being funded by Dir, Training Developments, Ft. Rucker, 6.57.06 21T 2040 T57-1077-675706-2572.

Military Relevance: A large percent of military training and operations is dependent upon voice communication reliability. It has been found that Army aircraft communication systems are a potential hazard to the hearing of air crewmen.

Goals: To obtain high speech intelligibility, improved speech communication systems reliability, and to eliminate acoustic hazards which are characteristic of present military systems.

Progress: Two AN/PRC-70 transceivers have been acquired and are currently being modified under contract by Cincinnati Electronics, Inc. The modified transceivers should be available early in FY 78. Evaluation of the modified transceivers will be accomplished in conjunction with the ongoing project in medically signficant problems of voice communication systems as soon as the modifications are complete.

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0D 6738 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISB'N INSTR'N | 8b. SPECIFIC DATA - CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | D. Change | U (NO CH) | U | | NL | ☒ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E62773A819 | 00 | 009 |
| b. ~~XXXXXXXX~~ | 6.27.58.A | 3A76275SA819 | 00 | 118 |
| c. ~~XXXXXXXX~~ | CARDS 114 (f) | (m) | | |

11. TITLE (Precede with Security Classification Code)

(U) Research Psychology Applied to Medically Significant Problems in Army Aviation

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001300 Aircraft; 009400 Man-Machine Relations; 013400 Psychology

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 65 02 | Cont. | DA | C. In-House |

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: Not Applicable
d. AMOUNT:
e. KIND OF AWARD:
f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS. | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 7.6 | 271 |
| | CURRENT 78 | 3 | 95 |

19. RESPONSIBLE DOD ORGANIZATION

NAME: U.S. Army Aeromedical Research Laboratory
ADDRESS: Fort Rucker, Alabama 36362

RESPONSIBLE INDIVIDUAL
NAME: Knapp, Stanley C., COL, Cdr.
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: U.S. Army Aeromedical Research Laboratory
ADDRESS: Aviation Psychology Division
Fort Rucker, Alabama 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME: Kimball, K. A., Ph.D.
TELEPHONE: (205) 255-3211
SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS
NAME: Armstrong, R. N.
NAME: Krueger, G. P. CPT

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U)Man-Machine Relations; (U)Military Aircraft; (U)Human Factors Engineering; (U)Psychology; (U)Human Volunteers; (U) Recording Devices; (U)Stress; (U)Simulators; (U)Computers; (U) Aeronautics; (U) Safety Engineering

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Identify by number, each paragraph. Precede with Security Classification Code.)

23. (U) To provide U.S. Army aviation information that is medically important about the human factors in the aircraft man-machine system with special emphasis on the performance of this human factor and the variables that influence it.

24. (U) The approach will involve the application of current research techniques applicable to the objective as well as developing new techniques as required.

25. (U) 7610-7709. Progress under this work unit includes the completion of laboratory reports entitled "Comparison of Oculomotor Performance of Monocular and Binocular Aviators During VFR Helicopter Flight," "Human Factors Evaluation of AHIS Production Helicopter," "Human Factors Evaluation of 214A Helicopter," the acceptance of "Marijuana and Human Performance: an Annotated Bibliography (1970-1975)" as an open literature publication, and presentation of a paper to the Advisory Group for Aerospace Research and Development entitled "The Assessment of Rotary Wing Aviator Precision Performance During Extended Helicopter Flight." Findings of this research will also be presented at Human Factors Society Meeting in Oct 77. In addition to these accomplishments, research personnel have provided technical inputs to several aviation development programs, working panels and groups. Some of these include UTTAS, ASH, AAH, Technical Advisory Group for Human Factors Research; Concept Evaluation Program; CH-47 Mod Program; Tactical Instrument Steep Approach & Landing System; 2B31 (CH47 Synthetic Flight Simulator) and 2B33 (AH1 Synthetic Flight Simulator); Tri-Service Group on Helicopter Medicine, Human Resources, Human Factors Research; Joint Services Human Factors Workshop; and the Determination of Minimum Requirements for Army Aviators.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Research Psychology Applied to Medically Significant Problems in Army Aviation

OBJECTIVE:

To provide U.S. Army aviation information that is medically important about the human factors in the aircraft man-machine system, with special emphasis on the performance of this human factor and the variables that influence it.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 117 through 130.

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

# HOVERING PERFORMANCE OF AVIATORS DURING EXTENDED HELICOPTER FLIGHT

## OBJECTIVE

The purpose of this research is to determine the fatigue effects introduced by extended flight performance on the precision hovering performance of Army aviators. This investigation will determine at what point during the flight fatigue effects become apparent and will also describe the effect on the man-machine system performance.

## BACKGROUND

The effect of aviator fatigue on mission performance has long been a concern of the local flight commander. At the present time the Army is striving to develop a firm policy on crew rest and flight limitations. Previous research and experience have recognized that long hours of wakefulness and flight time degrade the skill level of the aviator. This skill degradation, in turn, impacts the potential utilization of aviator resources and substantially increases the risk of aircraft accidents. The current report will be developed from data obtained during a large-scale research investigation which examined a broad range of flight profiles. The hover maneuvers, which will be examined in this report, are particularly suitable for an investigation of the effects of fatigue on aviator performance. They are commonly required at some point in all missions, and the hover maneuver requires the aviator to maintain precise control of the aircraft along all translational axes. Previous research has indicated that precision skill is often affected by fatigue long before the more general mission required skills. Since the control of the aircraft is always the primary task of any rotary wing aviator, it is anticipated that the performance of precision hover maneuvers will demonstrate extensive fatigue effects.

## METHODOLOGY

Six recent graduates of the Army Rotary Wing Flight School will serve as subjects for an extensive investigation of extended flight performance. During the flight testing portion of this investigation, subjects will perform a standard set of 33 maneuvers each hour. Flight testing will be accomplished for 13 hours per day over a four and one-half day period for each subject. Subjects will have a controlled diet with no stimulants and be allowed approximately four hours of sleep per night. The performance of each subject on a selected maneuver will be assessed six times per day. The hover maneuvers examined in this report consist of a three-foot precision hover, a ten-foot, twenty-five foot, and a fifty-foot precision hover. Each hover will be maintained and recorded for one minute. Multivariate statistical techniques will be used to designate the primary performance dimensions and to describe significant changes in the man-helicopter system performance.

STATUS

The reduction of the available measures into an independent set of performance measures has been accomplished for data from the three-foot hover. The analysis of performance changes and the description of fatigue effects on performance have been completed for the three-foot hover maneuver. A final draft is being typed for publication as an USAARL technical report. A program for reduction and analysis of performance variables for the remaining hover maneuvers is being developed and standardized. The results of various facets of the three-foot hover maneuver have been presented at scientific conferences.

Presentation:

Lees, M. A., Kimball, K. A., and Stone, L. W. "The Assessment of Rotary Wing Aviator Precision Performance During Extended Helicopter Flights." Paper presented at the NATO/AGARD Aerospace Medical Panel Specialist Meeting, Cologne, Germany, April 1977.

# AVIATOR INCLINED LANDING PERFORMANCE DURING EXTENDED HELICOPTER FLIGHT

## OBJECTIVE

The objective of this internally generated research is to determine the fatigue effects introduced by extended rotary wing flight performance on the ability of aviators to perform inclined landings. This investigation will determine at what point during the extended flights the effects of fatigue become apparent and will also describe the effect on the man-machine system performance.

## BACKGROUND

The effect of aviator fatigue on mission performance has long been a concern of the local flight commander. At the present time the Army is striving to develop a firm policy on the realistic standardization of crew rest and flight limitations. Previous research and experience have demonstrated that long hours of wakefulness and flight time degrade the skill level of an aviator. This progressive but variable degradation of skill creates a major impact on the potential utilization of aviator resources and substantially increases the risk of aircraft accidents. The current work will be developed from a portion of the data obtained during a large-scale research investigation which examined a broad range of mission related flight maneuvers. The inclined landing of a rotary wing aircraft is unique among the many varied maneuvers which can be accomplished in a helicopter. Because of the critical attention, both in training and in tactical operations, and the potentially hazardous consequences of its unsuccessful accomplishment, this maneuver provides an outstanding operational indicator of the effect of fatigue on aviator performance. In addition, the acquisition and analysis of this data provide an essential quantity of information to the developing in-house data base regarding aviator performance.

## METHODOLOGY

Six recent graduates of the Army Rotary Wing Flight School will serve as subjects for an extensive investigation of extended flight performance. During the flight testing portion of this investigation, the subjects will perform a standard set of thirty-three maneuvers each hour. Flight testing for each subject will be accomplished for thirteen hours per day over a four and one-half day period. Subjects will have a controlled diet with no stimulants and be allowed approximately four hours of sleep per night. The performance of each subject will be assessed six times per day. The inclined landings examined in this report consist of two landings, one with the right skid up and one with left skid up, in a standard area with a slope differential of approximately five degrees.

STATUS

The data for these inclined landing maneuvers have been acquired and identified. At this time, the reduction of available measures into a set of independent performance measures has been initiated. Analysis of the data will be accomplished after the preliminary data reduction process has been completed. This project has not advanced beyond the data reduction phase because other maneuvers which were accomplished during this field investigation are presently being analyzed.

# AVIATOR PERFORMANCE DURING HOVER WITH A STABILITY AGUMENTATION SYSTEM

## OBJECTIVE

The objective of this research is to evaluate the effects of a stability augmentation system upon aviator and performance/workload during a high hover operation. Our goals were to determine if the device of concern could provide a more stable platform and enhance mission performance and reduce workload in critical MEDEVAC operations.

## BACKGROUND

Successful completion of the Army medical mission requires that the MEDEVAC aviator be capable of performing precise stabilized hovers during the extraction of injured personnel. The precision hover is one of the most difficult and taxing flight maneuvers. The potential severity of this mission-essential maneuver, when high altitudes, adverse weather, and immediate threat factors are considered, requires expedient execution. The current research examines a method of aiding the MEDEVAC pilot in the performance of a hover maneuver while perhaps reducing workload. Stability augmentation systems are purported to reduce pilot workload during hover, NOE, and IFR maneuvers. In 1975, an agreement was made such that the Fort Eustis Air Mobility Laboratory would provide this laboratory with the Kaiser Mini-Stab, which had been a candidate for UH-1H MEDEVAC missions. In return, the Air Mobility Lab could use the UH-1H helicopter for their subjective flight evaluation of the stability augmentation system. Our efforts were pointed toward an objective evaluation of the Mini-Stab with the Helicopter In-Flight Monitoring System.

## METHODOLOGY

Participating personnel for the project were nine U.S. Army aviators with an average age of 27.7 years and average total flight hours of 1172. A modular three-axes stability augmentation system (SAS), with integrated rate attitude and heading retention, was installed on the JUH-1H helicopter. The subject aviators hovered at 30 feet above ground level (AGL) for five minutes under each of the three following flight control conditions: (1) unaided "normal" hover conditions, (2) using force trim, and (3) using the SAS. The test vehicle was instrumented to measure and record pilot control inputs and aircraft status values. The subjects completed a biographical data form, a Cooper-Harper Handling Qualities Rating Scale (after each flight condition) and a questionnaire concerning aspects of the flight under the different experimental conditions.

## STATUS

Data have been collected and reduced in preparation for submission to multivariate analysis.

# AVIATOR OCULOMOTOR PERFORMANCE IN SIMUHIMS

## OBJECTIVE

The objective of this research is to enlarge the present data base of aviator oculomotor performance information during simulated IFR flight and to link this perceptaul data with aviator control and aircraft response parameters.

## BACKGROUND

The helicopter is an integral part of the tactical structure and is continuing to receive expanded missions. Although audio and tactile stimuli are utilized, the aviator still relies in large measure on visual information for aircraft control. This information, under visual flight rules (VFR), is obtained from sources within the cockpit as well as viewing outside the aircraft. However, when flying under instrument meteorological conditions (IMC) or restricted visibility such as night, more, if not all, cues required for appropriate aircraft control and management must be obtained from the aircraft instrument panel.

In the past, and also persistent in future helicopter design, is the concept that fixed wing instrument and instrument arrangements provide the rotary wing aviator with adequate visual information transfer. However, in light of pilot opinion, accident reports and limited objective data, it would appear that this concept should be challenged. This investigation will permit data collection with regard to visual cues necessary for IFR helicopter maneuvers, thus providing a partial data base useful for optimal panel design.

## METHODOLOGY

Visual and psychomotor performance will be measured in the USAARL helicopter simulator during basic IFR helicopter maneuvers. These data will be compared to similar data obtained in the 2B24 helicopter simulator and UH-1 helicopter. In additon to expanding the objective data base, this study will provide the above mentioned comparisons.

## STATUS

Preliminary design and equipment acquisition and integration have been accomplished. Data have been collected on five newly graduated pilots and five experienced pilots.

# COMPARISON OF OCULOMOTOR PERFORMANCE OF MONOCULAR AND BINOCULAR AVIATORS DURING VFR HELICOPTER FLIGHT

## OBJECTIVE

The objective of this investigation is to gain data concerning oculomotor performance during visual meteorological conditions (VMC) while executing a number of maneuvers in a UH-1 helicopter. For purposes of comparison, data will be acquired for one monocular aviator and six binocular aviators.

## BACKGROUND

There is little question that helicopters have become an integral part of the U.S. Army's tactical structure. Also, there is little question that mission accomplishment and safe flight of the helicopter are dependent in large measure on external visual information received by aircrew personnel. Evidence that minimum adequate visual information is currently afforded Army aviators is substantiated by the very fact they can and do fly the machines. However, little is known with regard to what areas of the windscreen aviators most often use, how long they dwell in these areas, what dynamic response patterns they utilize to transition from area to area, where and what they view external to the aircraft, or how these parameters change as a function of variables, such as aircraft flown, maneuvers flown, level of training, or physiological state. Knowledge concerning these parameters is perhaps a first step in gaining information concerning what visual cues are critical in helicopter flight control.

Though the visual sensory modality is considered, almost without exception, to be highly critical to helicopter flying, few research studies have been conducted measuring where the pilot looks during actual rotary wing flight.

Additionally, there may be information relative to visual flight rules to be gained from studying monocular visual performance during helicopter flight. Perhaps the major binocular cue which a monocular aviator loses is that of retinal disparity which perhaps can be useful to a distance of between 490 - 700 yards. This, however, does not appear necessary for the conduct of adequate flight control--a fact attested by a number of successful one-eyed helicopter pilots. However, there is little information available as to whether or not these monocular pilots tend to gain their flight control cues from the same areas which appear to be visually "rich" for binocular aviators.

## METHODOLOGY

Visual performance of all subjects will be measured via a modified NAC Eye Mark recorder used in conjunction with either a video recording

system or 16mm motion picture camera. All recording will be done in real time.

Each subject will perform a standardized set of eleven maneuvers common to helicopter operations. These are as follows: (1) lift-off to stabilized hover; (2) forward hover; (3) rearward hover; (4) hover turn left--90°; (5) hover sideward--left; (6) hover sideward--right; (7) hover turn left--360°; (8) hover turn right--360°; (9) hover turn right--90°; (10) normal takeoff and normal approach to a hover--left traffic pattern; and (11) normal takeoff and normal approach to touchdown--right traffic pattern.

All data will be recorded and scored to determine time spent in each area of the windscreen, as well as percentages of flight time for each visual cue will be obtained. Comparisons between monocular and binocular visual performance will be made.

STATUS

Project completed.

Publications:

Frezell, T. L. and Hofmann, M. A. Comparison of Oculomotor Performance of Monocular and Binocular Aviators During VFR Helicopter Flights. USAARL Report 77-11, March 1977.

# PILOT VISUAL PERFORMANCE DURING SIMULATED INSTRUMENT FLIGHT

## OJBECTIVE

This is the first of a series of studies designed to extend our present data base, compare the fidelity of the 2B24 simulator to the real world, and compare that of simulation in general. The current project concentrates on visual performance during instrument flight in a helicopter simulator.

## BACKGROUND

The helicopter has become an integral part of the tactical structure and is continuing to receive expanding missions. Mission accomplishment in a safe and efficient manner is dependent in large measure on visual information. This information under visual flight rules (VFR) can be gained from sources within the cockpit as well as viewing the outside world. On the other hand, when flying under instrument meteorological conditions (IMC), all cues required for appropriate aircraft control and management must be gained from inside the cockpit. This study will provide data with regard to the critical visual cues used during simulated instrument flight. Such data are vital for optimal design and information transfer in the helicopter environment.

## METHODOLOGY

Ten rotary wing aviators of varying experience will participate in simulated aerial flights in the 2B24 Synthetic Flight Trainer. Visual performance will be recorded via a modified NAC Eye Mark recorder in conjunction with a 16mm motion picture camera with time code capability.

## STATUS

Eye movement data have been acquired from aviators of varying experience levels. Preliminary results indicate that aviators spend 68% to 70% of their total visual time, during IFR flight, monitoring two of the twenty-three instruments. Final statistical analyses have been completed and the report is being finalized and typed for publication. A report was developed that emphasized the methodological and technical development of the visual performance measurement system.

Publications and Presentations:

Simmons, R. R., Kimball, K. A., and Diaz, J. J. "Methodological Considerations of Visual Workload of Helicopter Pilots." Paper presented at the NATO/AGARD Aerospace Medical Panel Specialists' Meeting, Cologne, Germany, April 1977.

Simmons, R. R., Kimball, K. A. and Diaz, J. J. Measurement of Aviator Workload During Helicopter Operations. USAARL Report 77-4, December 1976.

# DRUGS IN AVIATION MEDICINE: AN INVESTIGATION OF THE EFFECTS OF ORAL CONTRACEPTIVES ON PERFORMANCE

## OBJECTIVE

The objective of this investigation is to measure changes indicative of mood and psychomotor performance, if any, associated with oral contraceptive therapy.

## BACKGROUND

The assignment of women to aviation occupations in the military promises to rapidly augment the number of women active in the field. This innovation may bring many benefits such as increasing the size of the pool from which qualified aviators can be drawn. However, it will require certain adjustments relating to aviation medicine, such as the management of aviators who are using oral contraceptive medication. Women in military aviation are in the 18 to 50 year age group which corresponds closely to the childbearing years of 13 to 44. Contraceptive practice patterns among women aviators will probably be similar to those of women of similar age in the general population. In the United States, the use of oral contraceptives is reported in 22% of women currently married and 23% of the age specific population. Common usage of any drug warrants investigation of the side effects of its use, especially where speculation has suggested that the particular generic group might affect performance and thus could influence safety.

## METHODOLOGY

Participating personnel for the study will be 47 women volunteers from the Fort Rucker, Alabama, area. Subjects will be placed in one of four groups according to their contraceptive practices: (1) those using no oral contraceptives throughout the study; (2) those using oral contraceptives throughout the study; (3) those entering the study not taking oral contraceptives who volunteered to take them for the last month of the study; and (4) those entering using oral contraceptives who will volunteer to discontinue such usage for the last month of the study. The last two groups will function as their own controls. Psychomotor performance will be evaluated through the use of the following tasks: Minnesota Rate of Manipulation--Placing and Turning; Purdue Pegboard--Dominant Hand, Nondominant Hand, and Both Hands; Groove Type Steadiness; Visual and Auditory Reaction Times; Rotary Pursuit tracking and Rotary Pursuit Tracking with Visual Digit Span.

Additionally, a mood checklist scale measuring anger, happiness, fear, depression, lethargy and psychological well-being will be administered at each testing session. Subjects will be tested twice monthly--mid-cycle and premenstrually/menstrually on the psychomotor tasks and mood scale.

STATUS

Project is completed.

# AVIATOR PERFORMANCE DURING HOVER USING RADAR ALTITUDE AND AUDITORY AUGMENTATION AIDS

## OBJECTIVE

The purpose of this investigation is to determine the improvement in hover performance of Army aviators that is provided by the introduction of altitude maintenance information. Aviator hover performance using a radar altitude visual display and auditory display is to be compared with hover performance obtained using current flight instruments.

## BACKGROUND

In the helicopter medical evacuation mission and other Army aviation missions, there exists the requirement to perform hover maneuvers. This maneuver requires the aviator to control his aircraft along and about all three axes. This control must often be established within a narrow tolerance band if the mission is to be efficiently accomplished. With regard to medical evacuation missions by hoist extraction, reasonable tolerances must be maintained to preclude adversely affecting the patient. Previous investigations have indicated that the precise simultaneous control of the helicopter along the three axes is difficult even for the most experienced pilots. It is anticipated that unburdening the aviator by stabilizing one axis may improve the overall quality of precision hover performance.

## METHODOLOGY

Approximately 20 experienced Army aviators will be used as subjects for this investigation. These pilots will be required to perform a thirty-foot precision hover for 120 seconds. Each subject will be tested under conditions of normal flight instruments, flight instruments plus information from the radar altimeter, and flight instruments plus information from the auditory altimeter display. All subjects will fly the USAARL test aircraft for each of these maneuvers with the test location being at the Highfalls stagefield. The Helicopter In-Flight Monitoring System will be utilized to acquire data on the man-helicopter system performance.

## STATUS

At the present time further progress in this investigation requires the completion of other current projects and the subsequent allocation of personnel and equipment resources. Preliminary flight checks of the equipment and experimental design have been conducted and the required test program has been drafted. Priority in this area has been shifted to the stability augmentation system evaluation.

# FLIGHT TIME AND CREW REST REQUIREMENTS FOR INITIAL ENTRY ROTARY WING (IERW) TRAINING AND SELECTED COMBAT MISSIONS

## OBJECTIVE

The objective of this study is to provide data in the form of subjective estimates of the appropriate flight time and crew rest requirements for the different phases of IERW training and selected combat missions.

## BACKGROUND

Studies of flight time/crew rest related to rotary wing flight are few in number and inconclusive in their results. The amount of crew rest necessary is directly related to the degree of fatigue encountered during crew duty time. In a recent NATO AGARD report, "for the 50 accidents on which a full report was available, it was concluded that in some 20 percent, aviator fatigue was a major cause of the accident." USAAAVS data indicate that for the FY 1969-73 period fatigue was cited as a factor in six percent of the rotary wing accidents and four percent of the fixed wing accidents. The question remains, how many other Army aircraft accidents were in part due to fatigue but were attributed to other factors such as: (1) failure to use accepted procedures, (2) selected wrong courses of action, (3) inadvertent operation self-induced, (4) poor crew coordination, (5) inadequate coordination or timing, (6) misjudged speed or distance, (7) delay in taking necessary action, (8) distraction, (9) channelized attention, (10) task oversaturation, (11) inattention, and (12) confusion of controls, and others.

U.S. Army Aviation Regulation, AR 95-1, indicates that flight time limitations and crew rest requirements are established by local commanders. AR 95-1 provides the commanders with very few guidelines as to what might be appropriate. The proposed project will provide additional information concerning flight time and crew rest during IERW training and selected combat missions.

## METHODOLOGY

Subjects will consist of IP's and student pilots. The flight time/crew rest questionnaire was developed in two forms--one dealing specifically with IERW training, the other with combat missions. Both versions contain: (1) biographical information, (2) questions relating to flight time/crew rest limits for various periods of time across each training phase or combat mission, (3) rank ordering of phases or missions in terms of fatigue, (4) applicable factors contributing to fatigue for each phase or mission, and (5) a general comments section in which subjects could address any problems related to the project in detail.

STATUS

The data have been collected and analyzed and initial drafts of the methodology and results section have been completed. The project is currently in the interpretation and write-up phase. Very little progress has been made on this project because of: (1) personnel departures without replacements, and (2) the priority of this project relative to other ongoing projects.

**RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY**

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0B 6899 | 77 10 01 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8A. DISB'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | D. Change | U (NO CH) | U | | NL | ☒ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E762773A819 | 00 | 010 |
| b. [illegible] | 6.11.01.A | 3A161101A91C | 00 | 284 |
| c. [illegible] | CARDS 114(f)(m) | | | |

11. TITLE (Precede with Security Classification Code)

(U) Operational Measures of In-Flight Performance

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

009400 Man-Machine Relations; 013400 Psychology; 001300 Aircraft

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| 74 07 01 | Cont | DA | C. In-House |

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER: Not Applicable

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 77 | 8.3 | 284 |
| | CURRENT 78 | 2.5 | 55 |

19. RESPONSIBLE DOD ORGANIZATION

NAME: U.S. Army Aeromedical Research Laboratory

ADDRESS: Fort Rucker, Alabama 36362

RESPONSIBLE INDIVIDUAL

NAME: Knapp, Stanley C., COL, Cdr.

TELEPHONE: (205) 255-5107

21. GENERAL USE

Foreign Intelligence Considered

20. PERFORMING ORGANIZATION

NAME: U.S. Army Aeromedical Research Laboratory

ADDRESS: Aviation Psychology Division
Fort Rucker, Alabama 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME: Kimball, K. A., Ph.D.

TELEPHONE: (205) 255-3211

SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS

NAME: Sanders, M. G., Ph.D.

NAME: Lees, M. A., CPT

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Military Aircraft, (U) Man-Machine Relations, (U) Human Factors Engineering, (U) Psychology, (U) Human Volunteers, (U) Recording Devices, (U) Aeronautics

23. TECHNICAL OBJECTIVE. 24. APPROACH. 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To explore, in the operational environment, variables which affect aviator performance.

24. (U) The approach will involve the utilization of an in-flight monitoring and recording system capable of sampling and recording nineteen channels of continuous analog and digital information, and an oculomotor monitoring device for eye movement recording during flight. Areas of research to be addressed will include: Aviator Oculomotor Performance during Conditions of VFR, IFR, Low Level and Terrain Flight, Assessments of Workload of Pilot and Copilot/Navigator during Terrain Flight, and Navigation Performance during Terrain Flight Day and Night Conditions.

25. (U) 7610-7709. Progress under this work unit has been reflected by the following laboratory accomplishments. The completion of two laboratory reports entitled "Aviator Performance During Day and Night Terrain Flight" (USAARL Rpt. No. 77-3), and "Measurement of Aviator Visual Performance and Workload During Helicopter Operations" (USAARL Rpt. No. 77-4). Research findings have have been presented to AGARD entitled "Methodological Considerations of Visual Workload of Helicopter Pilots," and "Visual Workload of the Copilot/Navigator During Rotary Wing Terrain Flight." These papers were also accepted for presentation at the Annual Meeting of Human Factors Society, October 1977. Additionally, the paper "Methodological Considerations of Visual Workload of Helicopter Pilots" has been accepted for open literature publication in Human Factors Journal. Significant progress has also been made in the area of assessing helicopter pilot workload. This work has been reflected by staff members of this division being named to participate in AGARD/ASMP Working Group 08, Methods to Assess Workload, and a paper presented at Aerospace Medicine Association, Las Vegas, May 1977, entitled "Aviator Workload Measurement in Rotary Wing Aircraft."

GENERAL DETAIL SHEET

TITLE: Operational Measures of In-Flight Performance

OBJECTIVE:

To explore, in the operational environment, variables which affect aviator performance.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 133 through 142

RECOMMENDATIONS:

It is recommended that research in this area be funded on a continuing basis.

# VISUAL PERFORMANCE DURING NIGHT NOE AND LOW LEVEL FLIGHT

## OBJECTIVE

The objective of this investigation is to examine the visual information requirements (scan patterns, dwell times, viewing range, etc.) of Army aviators while performing night NOE and low level flights.

## BACKGROUND

In contrast to day NOE flight, where the aviator is constantly flooded with many perceptual cues, night NOE work places the aviator in an environment where normal cues are degraded or deteriorated to such an extent that they possibly lose their normal value. For example, it has been demonstrated through classic laboratory research that as luminance levels deteriorate, it becomes increasingly difficult for the human eye to perceive detail, delineate texture, or retain good depth perception. These cues are of extreme importance for NOE-low level flight and a deterioration in efficient aviator performance may well be evident as such cues are more difficult to perceive. This work will seek to determine if changes in visual scanning techniques result as a function of decreased luminance levels. If performance is maintained at a satisfactory level for NOE flight with less visual information, and visual scanning patterns are similar for both day and night operations, this information will be of value in determining just what the critical perceptual cues are for optimally performing this type of flight profile.

## METHODOLOGY

This study will utilize six Army aviators. Visual performance will be measured using a corneal reflection technique in conjunction with a 16mm motion picture recording system. The windscreen will be divided into eight sectors and there will also be marked two chin bubble sectors, two side door sectors and one inside cockpit sector. The six aviators will fly both low level and NOE runs and will be required to make two flights. (NOE flights will be a riverbed negating the navigation task.) The motion picture data will be analyzed with regard to time spent in each sector, transitions in and out of each sector, and percentage of time spent in each sector's viewing ranges, etc.

## STATUS

Investigation of formerly proposed techniques, including low light level TV and video recordings, have been assessed and determined to be inadequate. Further modifications to the equipment have been accomplished. The present approach will include the utilization of the Eye Mark recorder, LOCAM motion picture cameras, high speed film and a light intensifier system. The project is delayed awaiting the delivery of the light intensifier system.

# AVIATOR PERFORMANCE DURING DAY AND NIGHT TERRAIN FLIGHT

## OBJECTIVE

The objective of this research is to determine what effects on aviator performance during terrain flight are introduced by the application of the night vision goggles (NVG) as a primary viewing device. Performance of aviators during low level (LL) and nap-of-the-earth (NOE) flight profiles using NVG's will be compared to similar profiles flown during the day and night using only the unaided eye.

## BACKGROUND

Previous experience with Army aviation has emphasized the tactical requirement for around-the-clock operations. A primary requirement in achieving 24-hour capability is the development of the aviator's ability to perform terrain flight profiles during both day and night operations. One device developed to aid in the accomplishment of this requirement is the AN/PVS-5 Night Vision Goggles (NVG's). The night vision goggles were originally developed for ground use but are now considered to be an interim solution to aid the pilot's night vision. Currently, little information is available which describes the effect of night vision goggles on aviator performance during the mission essential terrain flight profiles. The investigation will assess the influence of night vision goggles on aviator performance and improve the in-house data base being developed as a result of an ongoing research program designed to evaluate the effects of night vision goggles on rotary wing aviator performance.

## METHODOLOGY

Performance data obtained from two earlier investigations of terrain flight, one using the night vision goggles and one using the unaided eye during the day and night, will be utilized for this investigation. Appropriate flight profiles will be identified and standardized across the two studies. Multivariate analysis techniques will be used to test for significant differences between NVG's flight and flights using the unaided eye for both LL and NOE flight profiles. In addition, the analysis will designate those measures of man-helicopter system performance that demonstrated changes between visual conditions.

## STATUS

Data selection, processing and analysis have been completed.

Publication and Presentations:

Lees, M. A., Kimball, K. A., Stone, L. W., and Hofmann, M. A. Aviator Performance During Day and Night Terrain Flight. USAARL Report 77-3, December 1976.

Lees, M. A., Kimball, K. A., Stone, L. W., and Hofmann, M. A. "Aviator Performance During Day and Night Terrain Flight." Paper presented at the 20th Annual Meeting of the Human Factors Society, Dallas, Texas, December 1976.

# VISUAL PERFORMANCE DURING DAY TERRAIN FLIGHT

## OBJECTIVE

The objective of this research is to examine the visual performance/workload of pilots with varying experience levels during terrain flight. Some of the goals were to determine: (1) how does the visual workload during terrain flight compare to that during IFR flight, (2) where do aviators look for visual cues during this type of flight, and (3) what are the minimum cues necessary to successfully complete the mission?

## BACKGROUND

During the Vietnam experience, the Army very rarely had to contend with surface-to-air weapons. With small arms being the main threat, helicopters were flown at a high altitude until they reached their objective, completed their mission, and returned home at the same high altitude. It is felt that we may no longer have that same luxury. With the threat of some of the Russian surface-to-air weapons, the Army now has developed a tactical flight called nap-of-the-earth or NOE which basically utilizes the terrain for concealment to approach and leave their objective. This type of flight requires aviators to maneuver their aircraft at slow airspeeds and very close to trees or other objects of concealment. When executing terrain flight profiles in an Army helicopter, the aviator traverses through a constantly changing perceptual environment. Unlike normal flight profiles, NOE work is conducted at very low altitudes and variable airspeeds with the primary objective being concealment of the aircraft enroute to an assigned mission objective. The necessity of avoiding obstacles, assuring adequate height above all potentially hazardous terrain features, navigating to an objective while maintaining concealment as well as performing normal flight duties, places a formidable workload on the aviator. Much of the information necessary to perform these various functions is processed through the visual modality. Indeed, this sensory modality could be considered the most critical for helicopter flight. However, to date, little research has been accomplished to determine where a pilot looks with his eyes during flight. Recent work by this laboratory has monitored visual performance of aviators while flying standard maneuvers. This work will provide similar information for terrain flight.

## METHODOLOGY

Subjects will be six Army aviators. Visual performance will be measured using an Eye Mark recorder linked to a film camera. The windscreen will be divided into eight sections. There will also be two chin bubble sectors, two side door sectors, and one inside cockpit sector. All pilots

will perform two NOE-low level flights, each approximately twelve minutes in duration. All film will be scored in the laboratory. Time measurements in each sector will be obtained as well as the number of transitions into and out of each sector. A percentage of time spent in each sector will also be computed.

STATUS

A protocol to perform this research has been reviewed and accepted. Data has been collected and data reduction has been initiated.

# VISUAL WORKLOAD OF THE COPILOT/NAVIGATOR DURING TERRAIN FLIGHT

## OBJECTIVE

The objective of the proposed research project is to examine the existing visual workload of the navigator/copilot and navigation performance of the aircrew during terrain flight. The project will be divided into three phases. Phase I will examine the visual workload of the navigator/copilot. Phase II will incorporate information obtained in Phase I and will examine experimental navigation devices. Phase III will also incorporate information obtained in Phases I and II and examine NOE navigation at night with and without the use of the AN/PVS-5 night vision goggles.

## BACKGROUND

The emphasis on aviator workload has been of primary concern to the U.S. Army aviation community since the incorporation of low altitude terrain flight techniques into the helicopter tactics repertory. Navigation has been a particularly acute problem at low altitudes due to the relative perceptual speeds at which the terrain is traversed and the subsequent short periods of time that navigational cues remain in the visual field.

The division of duties between the primary aircrew currently requires that the navigator/copilot perform duties which entail, among other things, monitoring the map and navigation instruments as well as the terrain in an attempt to locate the significant navigational cues needed for maintaining the correct flight path; monitoring the helicopter engine instruments and other flight instruments; tuning the radios; orally providing navigational information to the pilot that will allow him to maintain the appropriate flight path; and helping the pilot locate and avoid potentially hazardous terrain obstacles. Thus, the navigator/copilot also encounters a large visual workload during low altitude flight.

## METHODOLOGY

Visual performance will be measured via a modified NAC Eye Mark recorder used in conjunction with a LOCAM high speed camera. Each subject will be fitted with the NAC recorder in the laboratory and checked for accuracy. The subject will then be taken to the aircraft for hook-up with the LOCAM camera. Stability of the Eye NAC recorder will be checked after the mission to insure that the device has not shifted, thus introducing error into the measurements. The scoring methodology to be utilized in the analysis of the eye movement data can be found in previous USAARL reports.

Altitude, airspeed and georgraphical location and other flight performance measures will be recorded via HIMS. Visual free time will be determined

through performance of a nonflight related task (reading task of random words). Nap-of-the-earth flight will be required and successful location of the checkpoints will be noted along with the other flight performance measures.

STATUS

Data on Phase I have been collected, analyzed, and discussed. The final draft for a technical report is being typed.

Publications and Presentations:

Sanders, M. G., Hofmann, M. A., Simmons, R. R., and DeBonis, J. N. "Visual Workload of the Copilot/Navigator During Rotary Wing Terrain Flight." Paper presented at the NATO/AGARD Aerospace Medical Panel Specialists' Meeting Cologne, Germany, April 1977.

# AVIATOR VISUAL PERFORMANCE IN JUH-1H HELICOPTER UNDER VISUAL FLIGHT RULES (VFR)

## OBJECTIVE

The objective of this internally generated and funded project is to provide information concerning visual performance/workload during helicopter flight under visual flight rules (VFR).

## BACKGROUND

Evolving from the Army's modern air mobility concept, the helicopter has become a strategic element of the tactical structure. The pilot's ability to manipulate his aircraft in the tactical setting is directly related to the inputs or cues he receives from the flight environment. Of the perceptual inputs required to fly the aircraft, visual cues are considered vital. Visual data obtained during the conduct of basic VFR helicopter maneuvers will be compared with similar data obtained in the 2B24 helicopter simulator and IFR helicopter flights. These performance data and their subsequent comparisons will provide an objective data base which will be useful in understanding pilot workload on different subtasks and pilot scan techniques as well as demonstrating potential cockpit panel design deficiencies.

## METHODOLOGY

Subjects will consist of ten Army aviators of varying experience levels. Visual performance during each of the actual JUH-1 flights will be recorded via a modified NAC Eye Mark recorder in conjunction with a 16mm motion picture camera with time code capability. A technique for assessing visual free time will be applied during the testing sequence. This technique will require the subjects to read from a free time monosyllable word chart during periods of low visual activity.

## STATUS

Two groups of subjects have been selected. The recently graduated pilots have been flown and their visual performance recorded. Data are still needed from the more experienced pilots before analyses can be completed.

# VISUAL PERFORMANCE DURING NIGHT HELICOPTER FLIGHT

## OBJECTIVE

The primary objective of this project is to obtain data of pilot's visual performance/workload during night helicopter flight.

## BACKGROUND

Evolving from the Army's modern air mobility concept, the helicopter has become a strategic element of the tactical structure. Although audio and tactical stimuli are utilized, the pilot still relies in large measure on visual information to maintain aircraft stability and safe flight. This information, under visual flight rules (VFR), is obtained from sources within the cockpit as well as outside the aircraft. However, when flying under instrument meteorological conditions (IMC) or restricted visibility such as night, more if not all, cues required for appropriate aircraft control and management must be gained from the information provided on the aircraft instrument panel.

The purpose of this project is to provide information relative to the visual performance and workload of pilots during helicopter flight under night conditions.

## METHODOLOGY

Ten Army aviators of varying experience will participate in helicopter flights under night conditions. Visual performance will be measured with a modified NAC Eye Mark recorder used in conjunction with a LOCAM high speed camera. Visual free time will be measured with a free time monosyllable chart. Altitude will vary from ground hover to cruise flight at five thousand feet.

## STATUS

Techniques utilizing video low light level cameras and infrared photograph film have proven inadequate to record visual performance during night helicopter flights. Additional tests are being performed employing a light intensifier system. Project is delayed awaiting delivery of the light intensifier system.

# OPERATIONAL MEASURES OF PILOT PERFORMANCE DURING AUTOROTATIONS

## OBJECTIVE

The objective of this study is to investigate pilot and aircraft performance as related to autorotational maneuvers.

## BACKGROUND

Currently, autorotation is the only in-flight escape system available to the helicopter pilot. For this reason, research into mechanisms which affect this maneuver is very important. Preliminary investigations into accident data records show that a significant number of problematic landings associated with this maneuver could be attributed to human factor errors, leaving the question of what factors are associated with such pilot performance.

## METHODOLOGY

This study is being conducted in two phases.

Phase I involves a review of autorotational accidents. Information derived from these reports will provide cost figures and should yield information as to variables common to various types of aricraft, weather conditions, and time of day which may be contributory factors to these accidents.

Phase II will involve measuring both pilot and aircraft performance during autorotation. Initial variables to be studied relative to performance during autorotation will include environmental conditions and individual differences.

## STATUS

Autorotational accidents for FY 70-72 have been analyzed. A technical report detailing these accidents has been written (USAARL Report No. 74-2 entitled, "Army Autorotational Accidents FY 70-72"). Necessary equipment for measuring autorotational performance has been developed, and preliminary flight tests have been performed. A protocol to accomplish this research is being prepared.

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| AD 0B 6903 | 77 01 15 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | K. Completion | U | U | | NL | [X] YES [ ] NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E62773A819 | 00 | 013 |
| b. CONTRIBUTING | | | | |
| c. [illegible] | CARDS 114 (f) (m) | | | |

11. TITLE (Precede with Security Classification Code)

(U) Evaluation of Low Cost Navigation System

12. SCIENTIFIC AND TECHNOLOGICAL AREAS 019300 Passive Sensors, Trackers and References; 019700 Computers and related programming; 009400 Man-Machine Relations; 001300 Aircraft

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| Jan 76 | Dec 76 | | In-House |

17. CONTRACT GRANT

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER: Not Applicable
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING: 76 & 7T | .8 | 65 |
| | CURRENT: 77 | .2 | 3 |

19. RESPONSIBLE DOD ORGANIZATION

NAME: U.S. Army Aeromedical Research Laboratory
ADDRESS: Fort Rucker, Alabama 36362

RESPONSIBLE INDIVIDUAL
NAME: Bailey, Robert W., COL, Cdr.
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: U.S. Army Aeromedical Research Laboratory
ADDRESS: Aviation Psychology Division
Fort Rucker, Alabama 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME: Kimball, K. A., Ph.D.
TELEPHONE: (205) 255-3211
SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Armstrong, R. N.
NAME: Krueger, G. P., CPT

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Psychology; (U) Recording Devices; (U) Aircraft; (U) Navigation; (U) Electronics Engineering

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede last of each with Security Classification Code.)

23. (U) To evaluate the potential for application of low cost sensors and data processors as navigation aids during NOE and tactical instrument flight missions.

24. (U) The approach in evaluating these devices will be to conduct in-flight testing. Flights will be conducted at NOE and low level to determine the accuracy and navigation aid this system affords.

25. (U) Project has been completed and results are found in a final report submitted to USAAVNC, ATTN: ATZQ-D-MT.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Evaluation of Low Cost Navigation System

OBJECTIVE:

To evaluate the potential for application of low cost sensors and data processors as navigation aids during NOE and tactical instrument flight missions.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 145 through 146.

RECOMMENDATIONS:

Project has been completed and results are found in a final report submitted to USAAVNC, ATTN: ATZQ-D-MT.

# EVALUATION OF LOW COST NAVIGATION SYSTEM

## OBJECTIVE

The purpose of this project was to evaluate a concept for an inexpensive self-contained navigation system designed from off-the-shelf hardware for use during low altitude, terrain-following helicopter flight. The system developed was designed to ease the navigation workload by presenting the piloting crew with continuously updated aircraft position information, course ground track, and command "fly-to" information to get from one identifiable ground reference point to another.

## BACKGROUND

Accurate and timely navigation makes up an important part of many types of tactical flight missions. It is particularly important in the conduct of such missions as air assault, reconnaissance, aeromedical evacuation and medical support. Navigation at relatively high altitudes is a complex task in itself; however, with the Army's recent emphasis on the tactical use of low level and NOE helicopter flight, aviators are presented with a relatively new navigation problem. NOE flight places the aircraft below tree top level much of the time. At such low altitudes, the overall visual perspective of the ground below is narrowed considerably. The crew can no longer make continuous use of the "big picture" scene of the significant landmarks and terrain features by which they normally navigate when flying at higher altitudes. In effect, some of the map-depicted information is more difficult to use because the aircraft is not high enough for crew members to see distinct terrain features. As a result, the navigation workload is significantly increased making it much more difficult to maintain a desired course. Therefore, a considerable portion of NOE/low level mission time is spent in verifying aircraft position with respect to the desired course.

## METHODOLOGY

The procedures followed during the project consisted of five steps: (1) determination of the mathematical equations required to transform velocity sensor information and helicopter instrumentation data into appropriate geographical map reference information; (2) testing of individual hardware components to determine their potential usefulness in the aircraft navigation system; (3) integration of the most promising components into a prototype microcomputer-controlled navigation system; (4) development of computer programs for the navigation system; and (5) calibration and testing of the breadboard navigation system in-flight under operation conditions.

STATUS

Project complete. Funding was provided by the TRADOC Concept Evaluation Program. A final report was prepared in January 1977, entitled "A Low Cost Navigation System for Terrain-Following Helicopter Flight."

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA 0B 6900 | 77 01 15 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISP'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | K. Completion | U | U | | NL | [X] YES [ ] NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E62773A819 | 00 | 011 |
| b. CONTRIBUTING | | | | |
| c. (blank) | CARDS 114 (f) | (m) | | |

11. TITLE (Precede with Security Classification Code)

(U) Evaluation of Mini-Huds

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001400 Aircraft Flight Instrumentation; 012000 Optics; 009400 Man-Machine Relations

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| Jan 76 | Dec 76 | | In-House |

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: Not Applicable
d. AMOUNT:
e. KIND OF AWARD:
f. CUM. AMT.

| 18. RESOURCES ESTIMATE | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|
| FISCAL YEAR PRECEDING: 76 & 7T | .6 | 65 |
| FISCAL YEAR CURRENT: 77 | .3 | 3 |

19. RESPONSIBLE DOD ORGANIZATION

NAME: U.S. Army Aeromedical Research Laboratory
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RESPONSIBLE INDIVIDUAL
NAME: Bailey, Robert W., COL, Cdr
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: U.S. Army Aeromedical Research Laboratory
ADDRESS: Aviation Psychology Division
Fort Rucker, Alabama 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
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TELEPHONE: (205) 255-3211
SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Lees, M. A., CPT
NAME: Burden, R. T., Jr., CPT

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Displays; (U) Night Vision Goggles; (U) Aircraft; (U) Terrain Flight.

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide information as to whether or not numeric and/or analog LED displays focused at infinity can be effectively utilized as displays during flight with night vision goggles.

24. (U) The approach will be to fabricate working prototypes of displays which can be evaluated during helicopter flight.

25. (U) Project has been completed and results are found in a final report submitted to USAAVNC, ATTN: ATZQ-D-MT.

*Available to contractors upon originator's approval

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A 1 NOV 65 AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE

* U.S. GPO: 1974-540-843/8691

GENERAL DETAIL SHEET

TITLE: Evaluation of Mini-Huds

OBJECTIVE:

To provide information as to whether or not numberic and/or analog LEO displays focused at infinity can be effectively utilized as displays during flight with night vision goggles.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following page numbered 149.

RECOMMENDATIONS:

Project has been completed and results are found in a final report submitted to USAAVNC, ATTN: ATZQ-D-MT.

# EVALUATION OF MINI-HUDS

## OBJECTIVE

This test was conducted to determine if an experimental information display concept could be effectively utilized to provide Army aviators with important flight information during the day, night, and particularly during flights using the night vision goggles (NVG) focused at the maximum viewing distance. At the present time, cockpit instruments provide only day and night capability and require manual refocusing of the NVG's to assess the displayed information. The experimental displays (ED) consisted of a numeric light emitting diode, and a gas discharge light column display, both collimated to provide direct view capability for the unaided eye and the night vision goggles.

## BACKGROUND

As a function of battlefield threat conditions, tactical helicopter operations will require NOE flight. As such, aviators will be required to maintain a maximum of head-out time to avoid obstacles and maintain concealment. Consequently, finding time available to come into the cockpit and adjust to near vision for flight and aircraft status information is a problem. This problem is further compounded when wearing night vision goggles because they require a manual refocus in order to achieve near vision when coming into the cockpit. This, of course, not only increases the required time to come in but also means removing one or both hands from the controls. Because of these time considerations, the aviator must often go without the information he desires at the time he desires it, or he must ask the copilot to provide it or risk obstacle collision by coming inside. A potential solution for alleviating this problem resides in mounting LED numeric displays focused at infinity on the glare shield. Such displays have the potential for quickly relaying certain parameters of key interest to the pilot at a low dollar cost.

## METHODOLOGY

Subjects for the investigation were four rotary wing Army aviators. Each subject flew two test maneuvers: (1) a 30-foot AGL hover for two minutes and (2) a flight profile lasting approximately six minutes which included one standard rate turn and two straight segments of approximately 3.8 nautical miles per segment at constant airspeed and heading.

## STATUS

Project completed. Funding was provided by the TRADOC Concept Evaluation Program. A final report was prepared on 15 December 1976, entitled "Increased Night Flight Capabilities."

# RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

| 1. AGENCY ACCESSION | 2. DATE OF SUMMARY | REPORT CONTROL SYMBOL |
|---|---|---|
| DA OB 6901 | 77 01 15 | DD-DR&E(AR)636 |

| 3. DATE PREV SUM'RY | 4. KIND OF SUMMARY | 5. SUMMARY SCTY | 6. WORK SECURITY | 7. REGRADING | 8a. DISB'N INSTR'N | 8b. SPECIFIC DATA-CONTRACTOR ACCESS | 9. LEVEL OF SUM |
|---|---|---|---|---|---|---|---|
| 76 10 01 | K.Completion | U | U | | NL | ☒ YES ☐ NO | A. WORK UNIT |

| 10. NO. CODES | PROGRAM ELEMENT | PROJECT NUMBER | TASK AREA NUMBER | WORK UNIT NUMBER |
|---|---|---|---|---|
| a. PRIMARY | 6.27.73.A | 3E62773A819 | 00 | 012 |
| b. CONTRIBUTING | | | | |
| c. [illegible] | CARDS 114 (f) | (m) | | |

11. TITLE (Precede with Security Classification Code)

(U) Evaluation of Scan Converters for Airborne Application

12. SCIENTIFIC AND TECHNOLOGICAL AREAS 009400 Man-Machine Relations; 011900 Optical Detection; 005700 Electronics and Electrical Engineering

| 13. START DATE | 14. ESTIMATED COMPLETION DATE | 15. FUNDING AGENCY | 16. PERFORMANCE METHOD |
|---|---|---|---|
| Jan 76 | Dec 76 | | In-House |

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER: Not Applicable

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

| 18. RESOURCES ESTIMATE | | a. PROFESSIONAL MAN YRS | b. FUNDS (In thousands) |
|---|---|---|---|
| FISCAL YEAR | PRECEDING 76 & 7T | .6 | 50 |
| | CURRENT 77 | .2 | 3 |

19. RESPONSIBLE DOD ORGANIZATION

NAME: U.S. Army Aeromedical Research Laboratory

ADDRESS: Fort Rucker, Alabama 36362

RESPONSIBLE INDIVIDUAL

NAME: Bailey, Robert W., COL, Cdr.

TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: U.S. Army Aeromedical Research Laboratory

ADDRESS: Aviation Psychology Division
Fort Rucker, Alabama 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME: Kimball, K. A., Ph.D.

TELEPHONE: (205) 255-3211

SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS

NAME: Sanders, M. G., Ph.D.

NAME: Simmons, Ronald R.

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Video Cameras; (U) CRT: (U) Psychology; (U) Optics; (U) Target Acquisition

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To evaluate the potential of imagery scan converter processing techniques for application to a target acquisition task.

24. (U) The approach will be to integrate the necessary visual and electrical components to provide low cost target acquisition prototype device and determine the feasibility of this type of device for field application.

25. (U) Project has been completed and results are found in a final report submitted to USAAVNC, ATTN: ATZQ-D-MT.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Evaluation of Scan Converters for Airborne Application

OBJECTIVE:

To evaluate the potential of imagery scan converter processing techniques for application to a target acquisition task.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following page numbered 152.

RECOMMENDATIONS:

Project has been completed and results are found in a final report submitted to USAAVNC, ATTN: ATZQ-D-MT.

# EVALUATION OF SCAN CONVERTERS FOR AIRBORNE APPLICATION

## OBJECTIVE

The objective of this research was to determine if two scan converter television signal processing techniques, used in conjunction with low light level and daytime television cameras, could be used to improve military vehicle detection in the field, thereby reducing a helicopter's exposure time by a "pop-up" maneuver.

## BACKGROUND

Based on current tactical doctrine there exists the requirement for certain Army aircraft to execute "pop-up" type maneuvers for the purpose of gaining information. Such maneuvers have threats associated with them which increase as a function of exposure time. Therefore, time reduction in gaining required information will lead to a decrease in vulnerability and subsequent aircraft losses. However, the ability to extract the essential information from available images is a function of human perceptual limits and the amount of "noise" in the imagery. A potential solution for reducing image "noise" and related time for information extraction is the application of scan converter image processing techniques.

## METHODOLOGY

Documentation of each of the techniques evaluated was accomplished by taking a series of photographs of the CONRAC monitor with the camera of concern focused on one or more of the targets. Ambient light levels were recorded and direct view photographs taken for comparison purposes.

## STATUS

Project completed. Funding was provided by the TRADOC Concept Evaluation Program. A final report was prepared on 15 December 1976, entitled "Increased Aircraft Survivability and the Capability of Target Acquisition and Surveillance."

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Washington, DC 20314

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ATTN: AHS-COM
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Office of Naval Research
800 N. Quincy Street
Arlington, VA 22217

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Commanding Officer
Naval Medical R&D Command
National Naval Medical Center
Bethesda, MD 20014

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Office of The Surgeon General
Department of the Air Force
Washington, DC 20314

1 copy to:

Director of Defense Research and Engineering
ATTN: Assistant Director (Environmental & Life Sciences)
Washington, DC 20301