JULY 1975

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ANNUAL PROGRESS REPORT

1 July 1974 - 30 June 1975

Reported by:
Robert W. Bailey, COL, MSC
Commander

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

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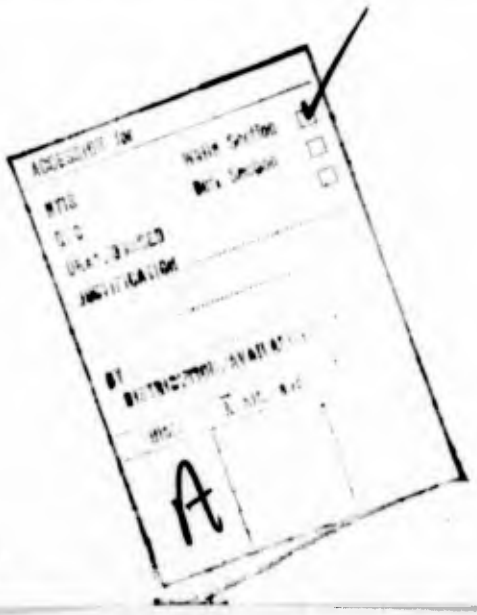

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US Army Aeromedical Research Laboratory

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

The mission of the US Army Aeromedical Research Laboratory is to 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 non-medical materiel; physiological/psychological responses to the operational environments; and military operational training impacts upon ecology.

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Reported by:
ROBERT W. BAILEY, COL, MSC
Commander

30 June 1975

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; performs medical research on visual/auditory functions; man/machine integration; the medical aspects of non-medical materiel; physiological/psychological responses to the operational environments; and military operational training impacts upon ecology.

FOREWORD

The US Army Aeromedical Research Laboratory (USAARL), a field service activity of the US Army Medical Research and Development Command, Office of The Surgeon General, was established in 1962 to perform medical research in Army aviation and airborne operations.

USAARL, along with several other research organizations, is a tenant activity at the Army Aviation Center, Fort Rucker, Alabama. The concentration of men and equipment at the Center provides assigned research personnel an ideal opportunity to maintain a current knowledge of the developments in Army aviation which affect mission accomplishment. A further opportunity is afforded by the cooperative research being accomplished by this activity and other laboratory groups such as the US Army Aviation Test Board, US Army Agency for Aviation Safety (USAAAVS), US Army Research Institute and our counterparts in the Navy, Air Force and Federal Aviation Agency.

The identification and investigation of problems in aviation medicine that are both soluble and important are the activity's goals. Problems presently being considered range from long-term fundamental research in the areas of vision, hearing loss, communications, and crash protection to the more immediate problems of the environmental characteristics of particular aircraft.

Considering the future, it is impossible to determine the problem areas which will be of most importance, but by maintaining a close relationship with the aviator and the active work of other research organizations, this laboratory will continue to work upon the problems it can identify and provide the service that aviation has requested.

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62 09	Cont	DA	C. In-House

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19. RESPONSIBLE DOD ORGANIZATION

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TELEPHONE: (205) 255-5107

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TELEPHONE: (205) 255-5107

SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS

NAME: CONSELMAN, C. B., LTC

NAME:

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Administration; (U) Management; (U) Cost Effectiveness; (U) Documentation; (U) Information Technology

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 technical, logistical and administrative support to those involved in Army aeromedical research at the US Army Aeromedical Research Laboratory.

24. (U) To evaluate and then supply, insofar as possible, that technical, logistical and administrative support required by research members of the laboratory in order that the laboratory can fulfill its mission. Among other things, this includes provision for scientific guidance and advice, technical support in development, construction, distribution and maintenance of research equipment and associated items, the attainment, distribution and cataloging of scientific literature, accounting, bookkeeping and clerical support. It also provides that these areas will be administered under an administration utilizing sound and accepted managerial practices.

*Available to contractors upon originator's approval

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
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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
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17. CONTRACT/GRANT

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PRECEDING	75	2	33
CURRENT	76	2	25

19. RESPONSIBLE DOD ORGANIZATION

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NAME: SAUERMILCH, P. W., GS-9

21. GENERAL USE

Foreign Intelligence Considered

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

25. (U) 74 07 - 75 06. Initial entry helicopter pilots were studied beginning in 1972. A controlled group of Army enlistees is being studied and each group has been evaluated on two occasions. The pilots have shown no significant bone mineral change after 30 months of flying but present subjective complaints. Enlistees demonstrated significant mineral loss after six weeks of basic training. The vibration table is 100 percent complete. Thirty-eight (38) of the aviator subjects have completed their last evaluation. Studies to determine effects of vibration on porcine joints using bone mineral analysis, x-ray mechanical transmissibility factors, tetracycline labeling, scanning electron microscopy of cartilage surfaces and joint fluid enzymes have begun. Pilot studies to correlate dynamic electromyographic (EMG) recordings to muscle work are 60 percent complete. FY 76 funds are earmarked for the last clinical follow-up of the control group and completion of EMG work.

*Available to contractors upon originator's approval

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 4 through 7.

RECOMMENDATIONS:

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

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. Seat-control configuration (angles and adjustments) will be analyzed and optimized to the extent that is possible in the current UH-1 helicopter.

BACKGROUND

Relationships between the seat back angle and the preferred lumbar and thoracic bend angles were assumptions based on limited human data, 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), etc. 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. However, accurate seated joint positional data are essential to the Cockpit Geometry Evaluation (CGE) Program as well as to many other man-machine interface studies states P. W. Ryan in the Joint Army-Navy Aircraft Instrumentation Research Final Report on Validation of Cockpit Geometry Evaluation, November 1971.

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. Design is such that the flying position 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 in five areas: (1) comfort, (2) egress time, (3) cushion evaluation, (4) anthropometry evaluation, (5) seat-control configuration evaluation.

STATUS

The reliability testing of the vibration table is complete. No test failures were experienced. Pilot in-flight vibratory dynamic electromyographic (EMG) studies have been conducted on the neck muscles. Refinements of the technique in the laboratory show correlation between frequency of mechanical exitation and muscle activity. Computer EMG analysis techniques are being developed. Man-rating of the table should be complete in October 1975 with experimentation on the musculoskeletal effects of helicopter vibration to begin soon after. Initial studies will be aimed at demonstrating neck and lumbar muscle activity using standard seats, restraint systems and helmets.

ARMY - AIR FORCE VIBRATION STUDY

OBJECTIVE

Determine the relatively short-term effect of helicopter flight training on bone mineral density.

Determine the time course of development of changes in the ratio of chondroitin four and six sulfate and keratin sulfate in the articular surfaces of miniature swine subjected to selected vibrations.

BACKGROUND

The effect of vibration as a work hazard effects 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 not known; however, recent studies on animals at Wright-Patterson Air Force Base indicate that musculoskeletal changes to the intervertebral disc to take place. Chronic vibration of various character and frequency effects the musculoskeletal system in a number of ways.

A recent study on 128 pilots disclosed that 87.5% suffered from back pain generally sometime after 300 hours of flying time. Pilots with slight pathologic condition 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 the threshold of appearance of "pain" occurs when one flies four to five hours per day, 40 to 50 hours per month.

METHODOLOGY

Forty Warrant Officer Candidates will be measured with the Norland Cameron Bone Mineral Analyzer and spinal x-rays prior to training. Forty basic trainees will be measured as a control group to compare the effects of muscular conditioning and vibration.

Twenty-two mature female miniature swine have been acquired. The diet is rigidly controlled and representative stool and food samples are being collected. USAARL Biochemistry Laboratory is developing a technique of measuring mucopolysaccharides with infrared spectrophotometry.

Articular surfaces will be sampled and the change in ratio of the mucopolysaccharides measured.

Scanning electromicroscopy and mass spectroscopy techniques will be used.

STATUS

Data collection continues. Helicopter pilots have shown no demineralization after 30 months. Basic trainees demonstrated significant mineral loss after six weeks of basic "boot camp" training. Thirty-eight of the aviator subjects have completed their last evaluation. Study to determine effects of vibration on porcine joint using bone mineral analysis, x-ray, mechanical transmissibility factors, tetracycline labeling, scanning electron microscopy of cartilage surfaces and joint fluid enzymes has begun.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
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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
74 07 01	D. Change	U	U	NA	NL	☒ YES ☐ NO	A. WORK UNIT

10. NO. CODES	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	62758A	3A762758A 819	00	055
b. CONTRIBUTING				
c. CARDS 114(f)				

11. TITLE (Precede with Security Classification Code)

(U) Direct Field Research Support to Immediate Army Aeromedical Problems (02)

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

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b. NUMBER:

c. TYPE: NA

d. AMOUNT:

e. END OF AWARD:

f. CUM. AMT.:

18. RESOURCES ESTIMATE

		a. PROFESSIONAL MAN YRS	b. FUNDS (In Thousands)
FISCAL YEAR	PRECEDING 75	3	70
	CURRENT 76	3	67

19. RESPONSIBLE DOD ORGANIZATION

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TELEPHONE: (205) 255-5107

22. GENERAL USE

20. PERFORMING ORGANIZATION

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ASSOCIATE INVESTIGATORS

NAME: ALTEKRUSE, E. B., LTC

NAME: JOHNSON, J. C. DA

23. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Protective Equipment; (U) Human Factors Engineering; (U) Stress Physiology; (U) Man-Machine Relations; (U) Drugs; (U) Safety; (U) Parachuting; (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) 74 07 - 75 06. Progress in this area is reflected by developments or reports in the following areas: dynamic electromyographic analysis techniques, injury and death costs in Army UH-1 aircraft, evaluation of a portable aviation oxygen system, head cooling devices, UH-1 lap belt installation failures, failure mode analysis of OV-1 ejection seat failures, effects of oral contraceptives on aviation performance, the history and epidemiology of acquired left bundle branch block, medical and human factors problems in transmeridian travel.

(*) Releasable 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.

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 a helicopter accident, 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 is to be compiled for FY 71-74. Personnel costs are 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

Definitive economic analyses have been accomplished for multiple cost parameters. Statistical computer programs have been written and debugged to facilitate continuing studies in this area. It has been demonstrated that the human economic loss in Army helicopter accidents often exceeds the hardware cost. The data from this study have been used by AVSCOM to justify the Crash Resistant Fuel System Retrofit Program, and by USAAAVS to justify the costs of crashworthiness features to be included in the UTTAS. The project has been inactive since July 1973 due to the departure of MAJ Bisgard, but is to be reopened by newly arrived personnel in July 1975.

Publication of the following:

Crash Injury Economics: The Costs of Training and Maintaining an Army Aviator, USAARL Laboratory Report 71-17, April 1971.

Crash Injury Economics: Injury and Death Costs in Army UH-1 Accidents in Fiscal Year 1969, USAARL Laboratory Report 71-18, December 1971.

Data base is continually being updated.

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) will be integrated as appropriate. Periodic statistical analysis of all data will be performed by USAAAVS.

STATUS

This was started as a combined USAARL-USAAAVS project. The project has suffered from insufficient personnel, but in early 1975 an Aviation Medical Officer and Naval Aerospace Physiologist were assigned. At USAAAVS, no personnel are assigned to the project although requests are filled and a good working rapport exists with the Applied Research Division of the Directorate for Technical Research and Applications. Identification of shortcomings of the Standard "A" SPH-4 helmet through

the LSERP and results from a one thousand aviator survey has been compiled and will be used in the formal IPR in the summer of 1975. Major shortcomings and problem areas of the LSERP exist, but continued education of flight surgeons, aviation safety officers and aircraft accident investigation boards should bring improvement in amount and types of equipment forwarded to USAARL. The major area of LSERP usefulness continues to be in survivable accidents which have injuries or fatalities secondary to shortcomings of life support equipment and/or basic crashworthy airframe design.

Publication of the following:

a. USAARL LR 74-2-3-1, Evaluation of the Head Cooling System, August 1973.

b. USAARL LR 74-25-3-4, Study of Lap Belt Installation in UH-1 Armored Seat, March 1974.

c. USAARL LR 74-29-3-6, Crash Injury Analysis of OV-1D, Number 17018, Fatal Accident East of Dothan, AL, 22 February 1974.

d. USAARL LR 75-33-3-3, Survey of SPH-4 Visor Housing Failures, March 1975.

ACQUIRED LEFT BUNDLE BRANCH BLOCK STUDY

OBJECTIVE

To study the natural history, epidemiology, and clinical nature of acquired left bundle branch block as it occurs in otherwise healthy flying personnel.

BACKGROUND

Left bundle branch block is currently disqualifying for flying duty. Many young and otherwise healtny aviation personnel develop this electrocardiographic finding without evidence of heart disease. Their loss from the flying environment is costly and reduces the effectiveness of the aviation program.

METHODOLOGY

The study has three phases. Phase I is a retroactive study of 65 patients seen over a 14 year period. Phase II is a clinical evaluation of patients with acquired left bundle branch block with thorough testing and selected coronary angiography. Phase III is a long term follow-up of all patients.

STATUS

Phase I - Preparation of report.
Phase II - Report complete, study ongoing.
Phase III - Ongoing.

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.

Presentation of: "Travel Stress", American Medical Association Scientific Session on Diseases of Travel for Category 1 Continuing Medical Education Credit, Atlantic City, NJ, 18 June 1975.

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

OBJECTIVE

To evaluate the potential compromise of aviation safety from the side effects associated with the use of oral contraceptives.

BACKGROUND

Regulations controlling the use of drugs by the aviation population require strict adherence to prescribed precautions and periods of grounding. The estrogens and progestins in oral contraceptives, included in these regulations, are "contraindicated only if adverse effects are present." A few women who use oral contraceptives may experience any of a wide range of undesirable side effects. Whether the side effects produced by oral contraceptives affect one's ability to perform flying duties is a question which has been largely ignored. The opening of the field of military aviation to women will bring into the services aviators who will be using oral contraceptives. It is assumed they will experience the same adverse reactions to their medications, and in the same proportions, as the general population at risk.

Pharmacutical houses admit and research studies have demonstrated evidence for the association of certain adverse side effects, some potentially severe, with the use of oral contraceptives. Such events are rare, occurring in about 0.002% of users. Most women experience no difficulties related to the use of oral contraceptives. The question arises as to whether any of the minor physiological changes associated with the use of oral contraceptives might affect task performance.

METHODOLOGY

This study will utilize eight basic psychomotor task and two psychological tests to measure mood and basic elements of performance. The investigators will extrapolate the findings to performance in the aviation environment.

STATUS

Data collection is one month from completion. Data analysis and report of findings, conclusions and recommendations are scheduled to be completed by late August 1975.

GENERAL BIOINSTRUMENTATION SUPPORT FUNCTION

OBJECTIVE

To develop, evaluate and recommend instrumentation and data trains for psychophysiological monitoring. To support and advise all investigators in data recovery and handling.

BACKGROUND

The day-to-day changes in technology regarding biomedical data systems make it almost impossible for the research investigator to keep abreast of the best tools and techniques available or to answer questions such as: What are the best (or the least costly) instruments to monitor parameter X? Who makes monitors for Y? What systems can be married to record Z and produce data D? There are often considerable delays in projects, especially when there is a lack of investigator continuity while these and other questions are solved. The vast array of sophisticated electrical data systems requires special skills for application.

METHODOLOGY

Support and advise all investigators in data handling and recovery. Collaborate on or conduct those studies or sub-studies that require extensive electrical engineering expertise, closed loop simulation or special instrumentation. Maintain biomedical instrumentation equipment file. Conduct statistical data analysis in mathematical modeling of physiologic parameters and data. Troubleshoot and engage in conceptual design of data trains for implementation by the Electronics Branch.

STATUS

Development of a data acquisition system for electromyographic activity in the vibration environment. Documentation and development of specific mathematical techniques for processing EMG data. Determination of the relations which exist between electrical activity in muscles under static loading and vibratory dynamic loading. Coordination of activities to develop an on-line EMG processing system to be implemented by the USAARL ADP facility.

Design and development of an airborne telemetry system for monitoring acceleration, respiration, venous blood pressure, and ECG on a miniature swine to be used in a physiological factors evaluation of helicopter hoists by Aviation Medicine Research Division.

Conducted final acceptance evaluation for the USAARL multi-axis helicopter vibration simulator.

GENERAL LIFE SUPPORT EQUIPMENT FUNCTION

OBJECTIVE

To provide biomedical capability to managers charged with the development and procurement of life support equipment and to pursue the goal of better life support equipment for the Army aircrewman.

BACKGROUND

Approximately twenty (20) Army major command staff agencies are involved in development and support of the Army life support equipment effort. A formal biomedical input is not available to most of these agencies. This deficit has, in the past, resulted in acquisition of life support equipment with gross biomedical inadequacies.

METHODOLOGY

Remains abreast of current and planned developments in the life support field and incorporates biomedical concepts at all development stages from concept formulation through the engineering and service testing. Because of the limited manpower involved, the effort is implemented primarily through staff procedures.

STATUS

Continuing formal and informal contact is maintained with other Army agencies involved with life support equipment and with similar organizations in the other services and with industry. On request, represent The Surgeon General at IPR's, MN developments and program reviews. Provide representation to Navy, APSET, SAFE, and the Air Force Life Support Equipment Program. Consultant status to the Aerospace Medical Panel NATO-AGARD and Working Committees of the Aerospace Medical Association and the Survival and Flight Equipment Association.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA OD 6736	75 07 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
74 07 01	D. Change	U	U	NA	NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	62758A	3A762758A 819	00	107
b. CONTRIBUTING				
c. [illegible]	CARDS 114(F)			

11. TITLE (Precede with Security Classification Code)

(U) Medical Research Applied to the Problems in Army Aviation (03)

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001300 Aircraft; 016200 Stress Physiology; 016800 Toxicology

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: 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 75	12	491
FISCAL YEAR CURRENT 76	13	344

19. RESPONSIBLE DOD ORGANIZATION

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SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS
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NAME: McNeil, R. J., 1LT

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

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

(U) Recording Devices; (U) Telemetry; (U) Computers; (U) Human Volunteers; (U) Personnel Selection (Medical); (U) Aviation Safety

23. (U) To provide the US Army information about those variables found in Army aviation which influence the health of the aviator.

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

25. (U) 74 07 - 75 06. Progress is shown by: (1) Preparation for evaluation of a portable resuscitator/ventilator for use in helicopter aeromedical evaluation; (2) Portable oxygen systems for use in Army helicopters were evaluated. It was concluded that chlorate candles best met the requirements for Army use; (3) Chlorate candle generated breathing oxygen was evaluated by continuous mass spectrometer sampling; (4) Methods were developed to evaluate changes in plasma phospholipid in chronically fatigued subjects; (5) A computer-assisted gas chromotograph/mass spectrometer was acquired to evaluate biological materials for stress-related biochemical changes; (6) [illegible]tho-Hydroxyhippuric acid was evaluated as a biochemical indicator of chronic psychological stress.

[illegible]ailable to contractors upon originator's approval

DD FORM 1 MAR 66 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A 1 NOV 66 AND 1498-1 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE

GENERAL DETAIL SHEET

TITLE: Medical Research Applied to the Problems in Army Aviation

OBJECTIVE:

To provide the US Army information about those variables found in Army aviation in which the state of health of the aviator influences safety of flight or flight influences the state of health of the aviator.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 20 through 33.

RECOMMENDATIONS:

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

THE AIR AMBULANCE: A STUDY OF ITS USE AND UPGRADING OF EQUIPMENT AND CREWS - PHASE I, II & III

OBJECTIVE

The purpose of evaluation is to provide continuing review of the air ambulance helicopter and to update the available medical equipment and procedures to provide the most definitive medical care at the earliest possible time to the patient. Special emphasis will be 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.

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

METHODOLOGY

Evaluation of medical equipment, training of air ambulance aidman, and changing mission concepts of aeromedical evacuation is an ongoing process.

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

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

STATUS

Selected items of medical equipment have been procured. Specific utilization techniques and procedures are being evaluated in helicopter aeromedical evacuation. These items include a portable defibrillator/monitor, physiologic data telemetry, inflight oxygen analyzer, and portable ventilators.

Field evaluation is underway to determine applicability of the Western Gear high speed hoist to the U. S. Army Aeromedical Evaluation Mission.

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

OBJECTIVE

To develop a rapid, simple, and effective means of treating shock syndromes by paramedical personnel.

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 into the arterial circulation would benefit the patient and result in a reduction of mortality and increase survival time sufficiently so the patient could reach adequate medical treatment facilities. 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 decreasing venous pooling, control of abdominal hemorrhage (if present), and allow blood to recirculate and perfuse tissue. 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 heroic medications and blood transfusions.

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 80-100 mm Hg to the abdomen and lower extremities.

STATUS

Phases I and II, design and fabrication of basic prototypes, have been completed. The David Clark Company, Worcester, MA, has manufactured the trousers.

Operational evaluations are being conducted by military helicopter air ambulance units throughout the Continental U. S. This includes both USA and USAF operational units providing Military Assistance to Safety and Traffic.

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. A followup report is being prepared covering 66 patients for the JAMA.

Additional studies of the cardiovascular/hemodynamic effects of the Military Anti-Shock Trousers are ongoing. Changes in core blood volume, blood pressure, heart rate, and peripheral resistance will be quantitated. Further clinical applications are being evaluated. These areas include the treatment of cardiogenic shock, treatment of hypotension post-abdominal aortic surgery, and as an adjunct in cardiovascular physical examination.

EVALUATION OF OXYGEN SYSTEMS FOR USE IN ARMY AVIATION

OBJECTIVE

To test and compare various presently available oxygen systems for use in the helicopter operations.

BACKGROUND

At present, there are no oxygen systems tested for helicopter usage. Aircraft based at high altitude 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 in evacuation of wounded.

METHODOLOGY

Four major oxygen system types were tested: low pressure (450psig), high pressure (1800psig), 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.

STATUS

The initial investigation concerning selection of an oxygen system has been completed as USAARL Report 73-16, "Preliminary Evaluation of Portable Aviation Oxygen Systems." It was the conclusion of this report that the A2/23S-1 chlorate candle system best met the requirements for helicopter usage. Modifications were recommended. Seven systems will eventually be available for field test. Four systems are in hand, and being prepared for preliminary evaluation.

Future efforts are concentrated on reduction in operational costs by repackaging the candles with reusable housings and modularization to decrease space requirements. This effort includes procurement of improved design systems for operational test.

MASS SPECTROSCOPIC ANALYSIS OF A2/23S-1 CHLORATE CANDLE OXYGEN

OBJECTIVE

To identify and quartitate trace contaminants produced by A2/23S-1 chlorate candles.

BACKGROUND

The possibility of accumulator tank toxic residues due to trace gases in chlorate generated oxygen had not been previously evaluated through repetitive candle firing. Although military standards have been set for the system, only the manufacturer had performed quality testing. This study was undertaken to identify and quantitate trace contaminants in chlorate candle generated aviator and emergency medical oxygen supplier.

METHODOLOGY

Twelve chlorate candles were sampled at the candle outlet and at the accumulator outlet. Flow was set at 20/liters/min and the mass spectrometer was set for resolution of 5000, range 0-800 m/e initially, 0-300 m/e during tests and scan time of 2 sec for 500 scans. Sample was drawn into the MS directly on a continuous basis through a Teflon capillary sampling tube.

STATUS

The initial study project is complete. Complete results will be published as a USAARL Lab Report. Data summary on processed results is as follows:

a. Average ignition time 7.5 min, average output 257 liters.

b. At 800 ms - 2 sec into the burn there is a peak of chlorine and CO probably due to high rapid heats in the ignition zone.

Samples:

CO_2 (manifold) = 290ppm

CO (manifold) = 8.40ppm at 1 sec

Chlorine (Cl_2) (manifold) = 0.8ppm at 1 sec

CO_2 (accumulator) = 39ppm

CO (accumulator) = 27ppb max

Cl_2 (accumulator) = 7ppb max

c. Total hydrocarbons were very low, 1 X 10^{-9} M C_6 - C_7 maximum. Major constituent appears to be a C_6 fragment with a methyl or/and ethyl side chain at C_3 - C_4.

d. Solvents: acetone, probably used in cleaning metal containers, found in 7 of the 12 candles at the 7 X 10^{-10} M level max. Alcohol was present in 10 of 12 candles at the 6 X 10^{-8} M level max. Benzene present in one candle at 4.8 X 10^{-10} M level max. Tolulene present in three candles at the 3 X 10^{-9} M level max.

e. Accumulator washout after 12 candles (2 full banks) showed only trace amounts of contaminants. Monitoring of candles manufactured will be continued under a quality control project.

EFFECT OF OXYGEN ON RETINAL FUNCTION

OBJECTIVE

To study the effects of slight increases in ambient oxygen tensions on retinal lactate dehydrogenase.

METHODOLOGY

The experimental animals used in this study will be four month old female mice. The first part of the study will consist of *in vitro* exposures of retinal hemogenates to elevated oxygen tensions. In the second part of the study the animals will be exposed directly to high oxygen tensions. Retinal lactate dehydrogenase activity will be assayed according to the method of Worthington (Worthington Biochemical Corp., Freehold, NJ). The measurements will be made at a wavelength of 340 millimicrons by recording the change in absorbency produced by the conversion of $NADH_2$ to NAD.

BACKGROUND

The retina is the most sensitive tissue in the body to elevated oxygen tensions. 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 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 pressures 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. Complete reports are available as USAARL Reports numbered 75-8, 75-10, and 75-20.

CHANGES IN PLASMA PHOSPHOLIPID CONCENTRATIONS RESULTING FROM CUMULATIVE FATIGUE

OBJECTIVE

To determine if changes in specific plasma phospholipids can be used successfully on a routine basis to predict fatigue buildup in Army aviators.

BACKGROUND

Previous work by Polis, et. al., has shown that the level of specific plasma phospholipids (phosphatidyl glycerol, phosphatidyl ethanolamine, and phosphatidic acid) increases during the periods of physical and emotional stress. The phosphatidyl glycerol concentration increases independently of the type of stress, while changes in the other phospholipids are dependent on the type of stress to which the individual is exposed. In order for the measurement of plasma phospholipids to be a useful tool in Army aviation medicine, the technique of measurement must be simplified considerably and the changes in phospholipid concentration must be shown to correlate with pilot performance.

METHODOLOGY

The method of phospholipid analysis used by Polis, et. al., involved extraction, hydrolysis, separation by paper chromatography and electrophoresis followed by manual determination of phosphorus for phospholipid quantitation. The method that has been used in this laboratory eliminates the hydrolysis step, replaces paper chromatography and electrophoresis by thin layer chromatography (Silica Gel H), and automates the phosphorus determinations using the Technicon Autoanalyzer.

STATUS

The Technicon Autoanalyzer has been modified by the addition of a more sensitive colorimeter. It is now possible to measure on a routine basis phosphorus concentrations of less than 15 nanograms. Various types of TLC sorbents have been evaluated. A precoated Silica Gel H plate manufactured by Analtech, Inc., provides the best separation of the phospholipids present in blood plasma.

The use of TEAE cellulose column chromatography was necessary to separate the more abundant phosphatidyl choline and sphingomyelin from the more stress responsive acidic phospholipids. The time required for this added procedure, as well as the high degree of technical skill required for reproducible measurements makes this technique undesirable

for routine analysis. The possible use of high performance liquid chromatography (HPLC) will be examined. There is little doubt that HPLC has the capability of separating plasma phospholipids. Its greatest deficiency, however, is the sensitivity and stability of detection systems that are available for use in phospholipid detection.

COMPUTER ASSISTED MASS SPECTROMETRIC ANALYSIS FOR STRESS RELATED BIOCHEMICAL INDICATORS

OBJECTIVE

To evaluate a wide variety of compounds using computer assisted mass spectrometry to survey blood serum and urine for stress related biochemical changes.

BACKGROUND

Present studies of stress related metabolic changes have a serious drawback in only allowing 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 will allow identification and quantitation of all separable urinary components and direct comparisons with control urines or plasmas.

METHODOLOGY

Preliminary scans will be run directly by capillary GC-MS or thermal porization 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; a condition which greatly complicates mass spectral interpretation.

STATUS

USAARL has purchased JMSD100 double focusing, Matsuda geometry, high resolution mass spectrometer (demonstrated resolution >20,000) and a HP 5711A gas chromatograph capable of handling 100 meter 2mm capillary columns. Problems have been encountered with the GC itself due to faulty column packing. The thermal proble allows programming from -100° to 400°C at any rate. 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 (≥2 sec/0-800 amu) and high resolution low speed (≥60 sec/0-800 amu) scanning. Newly developed software will allow 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. Data reduction is underway.

CHANGES IN URINARY ORTHO-HYDROXY-HIPPURIC ACID (OHH) DURING CUMULATIVE STRESS

OBJECTIVE

To evaluate the usefulness of OHH as a possible indicator of cumulative stress.

BACKGROUND

There are no present means of objectively determining stress levels. In Army aviation the problem is acute as slight impairment of judgment due to physiological or psychological stress may result in loss of life. This testing is to evaluate a metabolite found in urine which has been shown by Naval investigators to increase during traumatic injury. OHH may provide an indicator of physiological, psychological, or cumulative fatigue.

METHODOLOGY

Preservation of urine specimens by vacuum drying has proven critical as an increase in temperature over 35°C during drying results in a fluorescence shift. (Drying is only necessary if analysis cannot be performed immediately.) 20 ml of acidified urine is extracted 3X with 2 vol of chloroform. The upper phase is re-extracted 3X with 3 vol of 2:1 heptane : isobutanol and the upper phase is taken to dryness by vacuum distillation below 35°C. The residue is extracted with methanol and analyzed with an Aminco Ratio Spectrophotoflorimeter at 428 nm emission and scanned excitation. A series of serial dilutions from 10:1 to 170:1 were used to prevent opacity interference

STATUS

The following problems were encountered in the extraction procedures:

(1) Vacuum distillation of the heptane extract at temperatures above 35°C results in a spectral shift from 306 nm excitation to a peak in the 310-360 nm region.

(2) An interfering urine component recovered in the extraction produces a peak at 354-360 nm excitation. This fairly broad peak, as yet unidentified, masks or completely occludes any OHH peak which has moved due to urinary interference or thermal shifting.

(3) Subjects from high and low level navigation flights, as well as schizophrenic patients from VA hospital, have been tested and thus far only two individuals have demonstrated OHH production. Further, little correlation can be shown between their stressor activities and OHH levels.

(4) In the $>5x10^{-4}$M OHH concentration range, there is a pronounced spectral shift from 306 nm to 328 nm excitation indicating that OHH spectra are concentration dependent.

(5) The assay has proven accurate in the $1x10^{-3}$M to $1x10^{-6}$M OHH concentration range.

(6) Time dependent decomposition of OHH in methanol solution for standards is indicated by the increasing presence with time of a spectral peak at 276 nm excitation. Standards refrigerated at $4^{o}C$ last approximately two months.

Based on preliminary data and a review of Naval research, OHH may prove to be an indicator of chronic psychological stress. OHH determinations were performed upon the urine of sleep deprived helicopter pilots. Data reduction is underway. Further evaluation of OHH with low level fliers in FY 76 will provide more background information on OHH metabolism and its relation to stress.

BIOCHEMICAL CHANGES IN PLASMA RESULTING FROM CUMULATIVE FATIGUE

OBJECTIVE

To determine the usefulness of a number of plasma and urine chemical measurements for the prediction of excessive fatigue in Army aviators.

BACKGROUND

One of the most important areas of medical research in the Armed Forces is the effect of cumulative fatigue on a man's ability to perform his duty. In Army aviation we have a more specific problem of determining the time at which a pilot's coordination and judgment are impaired to the point of compromising safety. This laboratory is presently involved in a search for changes in body constituents that can be used as biochemical indicators of stress buildup, i.e., an objective indicator of stress.

METHODOLOGY

The creatinine phosphokinase (CPK), lactic dehydrogenase (LDH), cholesterol, and uric acid content of blood plasma is being measured by the use of the Biodynamics Unitest System. 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 sensitive protein binding procedure. Urinary catecholamines (epinephrine and norepinephrine) are determined by the trihydroxyindol reaction.

STATUS

The Biodynamics Unitest System was evaluated and found comparable in accuracy to other clinical procedures. The portion of the catecholamine procedure following the column separation has been automated.

Preliminary experimentation with human subjects and laboratory animals has given the following results. Stress-susceptible pigs had higher CPK, LDH, and lactic acid levels 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 recently been run on the plasma and urine sleep deprived helicopter pilots. Data reduction is underway.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA 0D 6733	75 07 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8. DISP'N INSTR'N	8b. SPECIFIC DATA - CONTRACTOR ACCESS	9. LEVEL OF SUM
74 07 01	D. Change	U	U	NA	NL	[X] YES [ ] NO	A. WORK UNIT

10. NO. CODES	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	62758A	3A762758A 819	00	50
b. CONTRIBUTING				
c. CARDS 114(f)				

11. TITLE (Provide with Security Classification Code)

(U) Research of Visual Problems Medically Significant to Army Aviation (04)

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001300 aircraft; 012000 optics; 012900 physiology

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
64 05	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 75	7	146
	CURRENT 76	7	196

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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Fort Rucker, Alabama 36362

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.F., CPT — DA

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Vision; (U) Human Factors; (U) Fatigue; (U) Protective Equipment; (U) Man-Machine Relations; (U) Optics; (U) Photometry; (U) Human Volunteers; (U) Stress Physiology; (U) Bioengineering; (U) Personnel Selection (Medical); (U) Weapon Effects

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 which has medical importance for US Army aviation.

24. (U) The approach will involve the employment of sound visual research practices in studying vision in its current and potential use in Army aviation.

25. (U) 74 07 - 75 06. Accomplishment has been shown by USAARL Report Nos. 75-9, Evaluation of Proposed Electroplated HGU-4/P Frames; 75-12, Development of a Prototype Experimental Plan to Evaluate Stabilized Optical Viewing Devices: I. Inflight Measure of Visual Acuity; 75-17, In-Flight Evaluation of Hand-Held Stabilized Optical Viewing Devices; 75-19, Enhancement of Visual Performance in Army Aviation: A Comparison of Two Commercial Products for Repairing Acrylic Aircraft Transparencies; 75-22, The Use of Opaque Louvres and Shields to Reduce Reflections Within the Cockpit: A Mathematical Treatment. Eleven USAARL Letter Reports were also published. In addition, three reports have been published in the open scientific literature and six papers have been presented at scientific meetings. Personnel have participated in numerous cockpit lighting, mockup-reviews, windscreen design and related workshops and standardization meetings. Projects at varying stages of completion include: Dynamic Visual Acuity; Depth Perception with the Night Vision Goggle; Scotopic Contrast Detection; AABSHIL Photometric Qualification; Clinical Techniques for Color Vision Testing.

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 which has medical importance for US Army aviation.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 36 through 57.

RECOMMENDATIONS:

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

EVALUATION OF PROPOSED ELECTROPLATED HGU-4/P FRAMES

OBJECTIVE

The purpose of this study was to determine if there were any medical contraindications to wearing an aviator ophthalmic frame which was finished in gold electroplating over a nickel-silver base metal.

BACKGROUND

A gold electroplated frame has been recommended to replace the standard gold-filled aviator frame. The bright gold finish is achieved by electroplating over a nickel-silver base metal. Since there have been numerous instances of individuals suffering a dermatitis after contact with nickel-containing objects cited in the literature, the Defense Personnel Support Center requested that the Aeromedical Research Laboratory determine if the proposed frames were medically safe for issue.

METHODOLOGY

Twenty test frames were received from the Defense Personnel Support Center of which eighteen pairs were used in the field study, one pair was retained for laboratory chemical analysis, and one pair was forwarded to the Medical Optical Laboratory, Fitzsimons Army Medical Center.

The eighteen subjects who volunteered to wear the test frames for the field study were selected as being reasonably representative of the potential user population. Before dispensing the test spectacles, each subject was individually briefed concerning the purposes of the study, the possible skin reactions to the frame, and what observations he or she should make periodically while wearing the test frame. Depending upon each subject's visual requirements, prescription lenses or plano tinted lenses were mounted into the frames. Each frame was adjusted to allow normal fitting characteristics, and the subjects were instructed to wear the test frames as they would normally wear their glasses.

After the subjects had worn the frames for approximately three months, they returned to the Laboratory to complete a questionnaire. Each subject was examined by a flight surgeon as required, and the frames were examined by an optometrist for wear and durability.

Several of the frames were tested for the presence of "free" nickel with a 1% alcohol solution of dimethylglyoxime (DMG) with ammonia. This precipitate test will detect the presence of "free" nickel in sufficient concentration (1:10,000) to produce dermatitis in nickel-sensitive individuals.

STATUS

This study is complete with the results reflected in USAARL Report No. 75-9, "Evaluation of Proposed Electroplated HGU-4/P Frames".

Of the 18 subjects who wore the test frames for three months, one subject developed a mild dermatitis along the frontal and supraorbital portion of the face. Chemical analysis indicated "free" nickle in sufficient quantity to cause a reaction from nickel sensitive individuals. This study has shown that some skin reaction can be expected from a small percentage of wearers if the gold electroplated frame replaces the gold-filled frame.

DEVELOPMENT OF A PROTOTYPE EXPERIMENTAL PLAN TO EVALUATE STABILIZED OPTICAL VIEWING DEVICES: 1. INFLIGHT MEASURES OF VISUAL ACUITY

OBJECTIVE

This was a joint Army-Navy study designed to develop a means of evaluating human performance in reference to the use of optically stabilized viewing devices. In addition, we wanted to investigate reports of motion sickness associated with use of the XM-76 viewing device.

BACKGROUND

The Army's scout helicopter scenario calls for increased stand-off distance for target acquisition. In order to acquire targets at this greater range, the human visual system must be optically assisted; but, due to the motion and vibration of the helicopter, the optics must be stabilized.

The Navy had received reports of nausea associated with the use of stabilized optics, specifically the XM-76 gyrostabilized viewing device. The XM-76 was also being considered for use by the Army scout helicopter crew and a determination was needed as to whether the scout crew might expect nausea problems.

A possible explanation for the nausea was the conflict of information received by the brain during flight usage of the devices. The visual system sees a very stable world through the device and this information is transmitted to the brain. At the same time, the vestibular system is sensing the motion and vibration of the helicopter and transmitting this, in conflict with the visual input to the brain.

METHODOLOGY

A nine kilometer flight course, with targets at each end, was used. A UH-1H helicopter flew a scout scenario including "pop-up", "S" turn, and straight passes to the targets. The observers flew three flights of five passes each. These flights were: first with the unaided eye, secondly with the XM-76 in a caged mode (as a control) and finally with the XM-76 stabilized. The latter two flights were counterbalanced across subjects to reduce learning effects.

The subject's task was to identify the orientation of Landolt C targets. His accuracy was measured using a radio-radio range system on board the helicopter. In addition, an in-flight experimenter recorded several motion sickness parameters.

Following the flight phase, the subjects were flown to Pensacola NAS for a day of visual and vestibular laboratory testing.

STATUS

Phase I: Inflight Measures of Visual Acuity has been published under USAARL Report No. 75-12 and NAMRL-1213 (Naval Aeromedical Research Laboratory), April 1975. Phase II: "Inflight Measures of Airsickness Potential" and Phase III: "Laboratory Evaluation of Individual Susceptibility" are in preparation at NAMRL.

The results of Phase I indicated that the incidence of airsickness symptoms rose when the subjects performed their assigned visual task with the device rather than the unaided eye. There was not a significant difference between the magnitude of the symptoms when the device was stabilized and the magnitude when caged, therefore the stabilization feature proper could not be identified as a problem source. Target acquisition performance was significantly correlated with the airsickness ratings of the on-board experimenter.

IN-FLIGHT EVALUATION OF HAND-HELD STABILIZED OPTICAL VIEWING DEVICES

OBJECTIVE

The purpose of this study was to compare several viewing devices by assessing visual performance using the devices in flight.

BACKGROUND

The Optics Branch of The Frankford Arsenal received several prototype visual devices for use in aerial target acquisition. They requested USAARL's assistance in evaluating visual performance with the devices.

METHODOLOGY

All observations were made from the front seats of a UH-1H helicopter flown at the USAARL instrumented range. The target consisted of a black Landolt C, 1.745 meters in diameter on a white 8 ft by 8 ft background (86% contrast). The subject was forced to guess the letter's orientation (eight alternative, forced choice) as soon as the target location was detected. He continued to respond until he positively confirmed the orientation of the target.

STATUS

The study was completed and the report published as USAARL Report No. 75-17, April 1975.

The results indicate that four of the five devices are promising from the acuity standpoint. However when cost and weight are also considered; one small, passive (non-electric) device definitely appears worthy of further military consideration.

ENHANCEMENT OF VISUAL PERFORMANCE IN ARMY AVIATION: A COMPARISON OF TWO COMMERCIAL PRODUCTS FOR REPAIRING ACRYLIC AIRCRAFT TRANSPARENCIES

OBJECTIVE

The purpose of this study was to enhance aviator visual performance by determining the best means of removing from acrylic transparencies the scratches and haze which can seriously degrade visibility.

METHODOLOGY

In this study, two products, CL Polish and Polysand[R], for removing abrasions from acrylic transparencies were compared. To do this, two sections on each of three UH-1 windscreens were abraded to various degrees. The first windscreen was abraded with 600 grade sandpaper which approximated moderate-to-light windshield-wiper abrasions. The second windscreen was abraded with 320 grade sandpaper which approximated moderate-to-heavy windshield-wiper abrasions. The third windshield was gouged deeply with a nail and chisel. The three windscreens were then polished using one of the products on one of the abraded sections and the other product on the other. Visual inspection and inspection by the Hazemeter and Glossmeter showed that for abrasions of a magnitude at least as great as moderate-to-heavy windshield-wiper abrasions (one of the most common types of abrasive failure) CL polish represents a faster and easier means of removing the abrasions. For deep scratches, however, a product such as Polysand or Micromesh must be used.

STATUS

The report on this work was published as USAARL Report NO. 75-19. The results of this study showed that for abrasions of a magnitude at least as great as moderate-to-heavy windshield-wiper abrasions (one of the most common types of abrasive failure) CL polish represents a faster and easier means of removing the abrasions. For deep scratches, however, a product such as Polysand and Micromesh must be used.

THE USE OF OPAQUE LOUVRES AND SHIELDS TO REDUCE REFLECTIONS WITHIN THE COCKPIT: A MATHEMATICAL TREATMENT

OBJECTIVE

The objective of this research was to develop a systematic means of determining the proper parameters for the opaque glare shields, baffles and mini-louvre sheets used in the cockpit to reduce reflections.

BACKGROUND

Reflections of the instrument panels and consoles from the windshields and canopies of Army aircraft are not only annoying but impair visual performance. One means of reducing these reflections is the placement of opaque glare shields, baffles, and mini-louvre sheets on and over the instrument panels and consoles. Heretofore, the proper width, spacing, and position have been determined on a trial-and-error basis. However, the determination of these parameters readily lends itself to analytic geometry and the development of such a system is described in this paper.

METHODOLOGY

A schematic of the cockpit was drawn and cartesian coordinates assigned. The abscissa was a line contained in the plane intersecting the bottom of the instrument panel and the ordinate was a line contained in the vertical plane through the design eye. A set of trigonometric coordinates was assigned to each of the relevant points. Since the mini-louvre material is available in six possible thicknesses of from .015 to .030 inch inclusive, a family of six curves, one for each possible thickness was plotted. In these graphs, the amount of reflection and visibility of instruments to the pilot was plotted as a function of distance on the ordinate.

STATUS

Work on this project has been completed and the report has been prepared for publication. This work showed a mathematical approach to the problem of determining the proper parameters for opaque louvres and shields when used as anti-reflection devices.

DYNAMIC VISUAL ACUITY IN FATIGUED PILOTS

OBJECTIVE

The dynamic visual acuity (DVA) task consists of the 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 air speeds 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. In the present study, an evaluation was made of dynamic visual resolution in the course of a flying induced fatigue regimen which extended for five days.

BACKGROUND

The early evaluation of DVA and its significance for aviation was established by Drs. Ludvigh and Miller, under Navy sponsorship. Their research elaborated the effects of a number of experimental parameters and although they did not test the susceptibility of DVA thresholds to the effects of fatigue, they postulated such a relationship. This expectation is quite reasonable since good DVA performance depends not only upon the resolution ability of the eye, but also upon the integrity of the oculomotor system in providing (a) the prompt saccade to "catch up" to the moving target, and (b) the smooth pursuit movement to minimize eccentric fixation and smearing of the retinal image. Furthermore, because of the brevity of target presentations, DVA depends upon efficient central processing of briefly presented visual targets.

METHODOLOGY

Six rotary wing aviators participated in a "continuous operation" study involving some 14 flying hours daily and severe sleep loss (3 1/2 hours per night) for five days. In addition to DVA thresholds, flying performance, laboratory tests of psychomotor function, and biochemical levels were all measured. DVA varied during the course of fatigue buildup and was related to performance measures.

STATUS

A preliminary report of this study was presented at the Sixty-seventh annual meeting of the Southern Society for Philosophy and Psychology, March 27-29, 1975. A detailed report is in preparation. Further studies of DVA are underway or in preparation.

REDUCTION OF UNDESIRABLE LIGHT REFLECTIONS WITHIN THE CREWSTATIONS OF ARMY AIRCRAFT

OBJECTIVE

The objective of this study was to reduce the amount of light reflected internally from the windscreens of Army aircraft. These reflections are, at best, annoying and under certain conditions can considerably impair a pilot's performance.

BACKGROUND

Light reflected internally from the windscreen comes from external sources as well as from functional and non-functional portions of the crewstation itself. For example, in the LOH-58 light from external sources below the aircraft comes through the chinbubble and is reflected internally from the windscreen. Unwanted illumination from the top of the instrument panel onto the windscreen is especially annoying in this model of aircraft and is an example of unwanted illumination from a non-functional part of the crewstation. Previous work in this area performed by the Land Warfare Laboratory as well as USAARL has indicated the efficacy of Nextel® Velvet Coating, black, 101-C10 as a means of reducing illumination of the windscreen. Also, work at the Land Warfare Laboratory has indicated the non-efficacy of anti-reflections, at least when dealing with external reflections.

METHODOLOGY

This study progressed in the following order:

1. A laboratory evaluation was made of the reflectance of several paints and/or coating products including that presently used on the non-functional surfaces of most aircrew stations. Reflectance was measured at angles of 0, 15, 30, 45, 60, and 75 degrees.

2. Small portions of the aircraft interior were coated with a low reflectance substance and any reduction in reflection from the part of the windscreen was measured. This was accomplished by photometry on the relevant portion of the windscreen before and after the application of the low reflectance material.

3. The entire crewstation of the LOH-58 was changed to the low-reflectance configuration and the amount of reduction of unwanted reflection will be established by photometry . Consideration was given to both daytime and nighttime aspects of this problem.

STATUS

This report has been published as USAARL-LR-75-21-7-4. This work showed that the glare in the cockpit can be greatly reduced by the use of black Nextel^{R} Velvet Coating rather than the standard grey lacquer.

MODIFICATIONS TO THE COCKPIT FOR NIGHT VISION GOGGLE COMPATIBILITY

OBJECTIVE

The objective of this work was to arrive at a detailed, consolidated list of the cockpit modifications necessary for flying with night vision goggles.

METHODOLOGY

A list of five recommended modifications was compiled: (1) Install the NVG-compatible cockpit illuminator developed by the Avionics Lab. This is essentially a modified map light which is mounted behind the overhead console. (2) Install an emergency switch to return the cockpit lighting to a normal level in the event of a NVG failure. (3) Install clip-on filters over the master caution, fire warning, and RPM warning lights. (4) Paint the cockpit with black Nextel Velvet Coating. (5) In some cases, extend the glare shield. Designs, diagrams, etc were obtained from the developers of the cockpit illuminator, emergency switch, and filters and a detailed set of fabrication and installation procedures was prepared.

STATUS

The report of this work will be published in the Proceedings of the Staying Power Symposium held at Fort Rucker, Alabama, 1975. This work showed just what modifications to the cockpit must be performed in order to fly with the night vision goggles.

A VISUAL COMPARISON OF STANDARD AND EXPERIMENTAL MAPS USING THE AN/PVS-5 NIGHT VISION GOGGLE

OBJECTIVE

The objective of this study was to compare the information available to a night vision goggle (NVG) user from a standard, white background, 1:50,000 transverse mercator map and the same map printed with a black background.

BACKGROUND

The built-in light source on the night vision goggles is a red, light emitting diode. As a result, when it shines on a map the only information seen is that which reflects the red light. In addition, the output of the goggles is a green light so the only visible information is that which contrasts with green.

METHODOLOGY

The Defense Mapping Agency, Topographical Center provided the laboratory with a black background (70% of a map is background) to assist us in a NVG study. Since the identical map was available in the white background we were able to make a color by color comparsion using both the night vision goggles and the standard red cockpit map light.

STATUS

The report was published as USAARL-LR-75-26-7-6.

The results indicate that the information lost on the white map (brown contour lines, blue water and green woods) are readily visible on the black map and the good colors on the white map are equally good on the black. A recommendation is needed in reference to a good drawing material (pen or pencil) for use on the map.

DARK ADAPTATION CHANGES ASSOCIATED WITH USE OF THE AN/PVS-5 NIGHT VISION GOGGLES

OBJECTIVE

The purpose of the study was to determine and describe to the night vision goggle (NVG) user, what changes in dark adaptation could be expected following NVG use.

BACKGROUND

The Low Light Level Night Operations Steering Committee was interested in the visual problems which an Army aviator might encounter if he had to suddenly remove the goggles. This laboratory volunteered to measure the dark adaptation changes and submit these findings to the committee.

METHODOLOGY

Dark adaptation curves were developed on six male subjects using the Goldmann/Weekers-Adaptometer. The subjects were allowed to fully dark adapt for thirty minutes followed by NVG use for five minutes. Five minutes of goggle wear was adequate because the goggle luminance level is approximately four foot-lamberts which is well into the photopic range where adaptation is completed within two minutes.

STATUS

The report is complete and was published in USAARL-LR-75-2-7-2.

The results show that the average recovery time to the thirty minute level of dark adaptation was two minutes (range 1.5 to 3 min). The average loss of sensitivity was from the thirty minute sensitivity level to the ten minute sensitivity level.

AFTERIMAGES ASSOCIATED WITH USING THE AN/PVS-5, NIGHT VISION GOGGLES

OBJECTIVE

The purpose of this report was to show the night vision goggle (NVG) user that the afterimages associated with NVG use are very temporary and will not affect his color vision.

BACKGROUND

This laboratory received a call from the Fort Knox flight surgeon advising that two aviators had reported visual problems following use of the night vision goggle. The phenomenon had been previously called "The Brown Eye Syndrome". This name is misleading in that a syndrome is defined as a pattern of symptoms in a disease. There is no disease involved here and since the eye does not become brown, it is best to call it simply an afterimage which, in fact, is what it is.

METHODOLOGY

Five subjects were given three separate color vision tests before they wore the NVG and then immediately after wearing it. The goggles were worn, in the operating mode, for a period of at least thirty minutes.

STATUS

The report was published as USAARL-LR-75-1-7-1, August 1974. The results showed no change in the subjects' color vision following use of the goggle. The report further explained why the aviators were having color perception difficulties and it described the visual effects of afterimages.

FIELD OF VISION STUDY WITH SIERRA CVC HELMET

OBJECTIVE

The objective was to determine whether or not the combat vehicle crewman's (CVC) helmet, manufactured by Sierra Engineering Company, produced any restriction to the wearer's normal field of view.

BACKGROUND

The U S Army Aeromedical Research Laboratory is tasked to evaluate protective equipment, specifically to address the extent to which the equipment may affect the user's normal operation. The Bio-Optics Division is interested in all visual aspects of equipment designed for use by the soldier. Restrictions to field-of-view can be hazardous and must be evaluated on any new item.

METHODOLOGY

All visual fields were determined using the Aimark Mark IV Projection Perimeter. Five subjects' fields of vision were measured with and without the helmet. Each subject was tested with both a medium and a large size helmet.

STATUS

The study was published as USAARL-LR-75-17-7-3. The results indicated no differences in the field of vision with either of the two helmet sizes, when compared to the field without the helmet.

QUANTITATIVE METHOD OF WAVEFORM CHARACTERISTICS OF PUPILLARY REFLEX RESPONSE TO LIGHT IN FATIGUE RESEARCH

OBJECTIVE

The purpose of this study was to derive a quantitative method for characterizing the pupillary reflex response to light of fatiqued aviators.

BACKGROUND

Ferree and Rand have shown the relation between the shape of the pupil size and various light stimulus intensity levels. Lowenstein and Lowenfeld have studied and characterized various shapes of pupillary reflex to light in the cat, monkey, rabbit and human under stresses. They believed that the waveform characteristics were an objective evaluation of fatigue. Nevertheless, they onlv utilized qualitative methods to classify the waveforms associated with the fatigue.

METHODOLOGY

A differential method was developed to characterize the shapes of the waveform relating to the degree of the pilot's fatigue. The initial data was collected from a combined research project of Aviation Medicine Division, USAARL Highfall Fatigue Research Program. Portions of the total data were then used for the present study.

STATUS

Results of this study have been published in USAARL-LR-75-28-7-7, entitled "Quantitative Analysis of Waveform Characteristics of Pupillary Reflex Response to Light in Fatigue Research".

SIMULTANEOUS COLOR CONTRAST OF HERMANN PATTERN FOR COLOR DEFICIENCY TESTING

OBJECTIVE

This study extends the experimental collection of the chromatic Hermann grid to be used as a possible color deficiency test.

BACKGROUND

Hermann grid consists of an array of white stripes and dark squares. When one perceives this pattern, he will detect an induced darkened spot at the intersection of the two white stripes. When this pattern is made in various chroma instead of just black and white, an induced color spot can be observed. Furthermore, color deficient patients perceive differently from those of the normals. An application of this chromatic induction may be used to detect color deficient persons when other testing devices are not available and for mass screening.

METHODOLOGY

One hundred subjects will be needed in this study to determine the reliability of the test. The test stimuli will be selected from various combinations of chromatic pattern slides. Three primary chroma which will be used are: red, green and blue. The white will serve as another chroma. The pattern will be projected against a white background and the subject will be allowed two minutes of free viewing. Then the subject has to determine what color he (or she) observes. Various statistical analyses will be used to decide the validity of the test.

STATUS

The initial screening process has been underway to select the various patterns of stimuli. Various color deficient, as well as normal, subjects will be arranged at various stages of testing. An optical arrangement of creating the stimulus patterns is under construction to substitute the slide presentation. The latter enables the experimenter to alter the ratio of the luminance, hue and the saturation of the stripes with respect to the squares. Data collection will be underway as soon as the apparatus is ready.

COMPARATIVE STUDIES OF COHERENT VERSUS INCOHERENT POLARIZATION

OBJECTIVE

The objective of this study was to investigate the effect of coherent versus incoherent polarization for military application.

BACKGROUND

Ever since Malus discovered polarization at the turn of the nineteenth century, scientists have applied the principle not only to advance the understanding of the physics of electromagnetic radiation, but also to assist the advancement of technologies with various industrial applications. The increasing usages of coherent radiation sources for military application, especially night vision devices, require an advanced knowledge of the nature of the coherent and incoherent polarizations. It provided valuable information for visual psychophysical studies and objective evaluations of the night vision devices.

METHODOLOGY

Light source (He-Ne laser for coherent and tungsten for incoherent) was entered into a photovoltaic detector through a linear polarizer, a Brewster angular reflective surface, an analyzer and a collecting lens. A digital ammeter served as a photo-response output.

STATUS

This study has been reported in USAARL-LR-75-38-7-11 under the title, "An experimental observation on coherent versus incoherent polarization". An interesting experimental observation was obtained, i.e., the reversal polarization of coherent versus incoherent sources. The physics of the reversal process is presently unknown.

THE ATTENUATION OF LIGHT TRANSMISSION IN ARMY AIRCRAFT WINDSCREENS DUE TO SLANTING

OBJECTIVE

This study was undertaken in response to the need for readily accessible reference data concerning the light transmission characteristics of windscreens in Army aircraft. More specifically, this study attempted to focus on the overall attenuation of white light transmission due to slanting of these windscreens in the aircraft.

BACKGROUND

Since the transmission characteristics affected the optical quality of the windscreen, they affected the visibility of crew members in a flight mission. There existed no central documentation of windscreen transmission characteristics data in Army aircraft.

METHODOLOGY

Samples, 2" by 2" in dimension, were obtained from various manufacturers. The samples used were: (1) T41 flat/uniformed Cessna, (2) T41 formed edge Cessna, (3) T42, (4) TH55/OH6A, (5) OH58, (6) CH47, (7) UH1, and (8) U6. Data was gathered by the Pritchard Photometer (manufactured by Photo Research, Model 1980). The light source was a Spectra Regulated Brightness Source of 100 Ft L (also manufactured by Photo Research Inc., Burbank, California). Samples were mounted in a supporting device which was calibrated in one degree increments in both horizontal and vertical positions. They were also rotated through an angular range of 0° to 90°.

STATUS

This study has been written in USAARL-LR-75-24-7-5, entitled, "The Attenuation of Light Transmission in Army Aircraft Windscreens Due to Slanting". Results were compatible to those of Air Force Reports.

COMPARATIVE SPECTRAL STUDIES OF SCRATCHED AND POLISHED UH-1 AIRCRAFT WINDSCREENS

OBJECTIVE

This study was undertaken to furnish spectral analyses for scratched and polished UH-1 windscreen samples.

BACKGROUND

A scratched windscreen sometimes hampers the vital visibility of the pilot in a flight mission. To replace a scratched windscreen is costly. It is desirable to find an economical technique such as a polishing method to repair the scratched windscreen. The optical quality may change after the application of the polishing agents. The spectral transmission characterisitcs may also alter thereafter. No documented information was available at the time of this study.

METHODOLOGY

A UH-1 windscreen was used in this study. The dimension of the samples was two inches by two inches. The polishing grades were (1) 320 polysand, (2) 600 polysand, (3) DS polysand, (4) 320 CL, and (5) DS CL. The 320 polysand was rougher than that of 600 polysand. DS stands for deep scratch and CL for a commercial polishing agent containing rare earth element Cerium-Lantherium. There was an automatic data acquisition system to obtain the spectral transmission analyses. The light source was incoherent tungsten light of 75 watts.

STATUS

This study has been published in USAARL-LR-75-36-7-10, entitled "Comparative spectral studies of scratched (untreated) and polished (treated) UH-1 aircraft windscreens".

VISIBLE SPECTRAL TRANSMISSION CHARACTERISTICS OF WINDSCREENS IN ARMY AIRCRAFT

OBJECTIVE

The purpose of this research was to provide readily accessible reference data of visible spectral transmission characteristics of windscreens in Army aircraft.

BACKGROUND

Transmission characteristics were expressed in terms of spectral transmittances from 400 to 800 nanometers. It was approximately the same spectral range as those of the 1931 and 1964 CIE (Commission Internationale de l' Eclairage) chromaticity coordinates and color-matching functions. These reference data enabled potential users to compute the light stimulus presented to the aviator after transmission through the windscreen.

METHODOLOGY

Tektronix rapid scan spectrometer (RSS) and digital processing oscilloscope (DPO) with PDP 11/05 minicomputer were used as an automatic data acquisition unit. Samples of windscreens were (1) T41 flat/uniformed Cessna, (2) T41 formed edge Cessna, (3) T42, (4) TH55/OH6A, (5) OH58, (6) CH47, (7) UH1, and (8) U6. Power energy spectra, corresponding transmission, and CIE chromaticity diagrams were obtained.

STATUS

Results of this study have been published in USAARL-LR-75-29-7-8, entitled "Visible spectral transmission characteristics of windscreens in Army Aircraft".

SPECTRAL TRANSMISSION EFFICIENCY OF QUARTZ FIBER OPTICS

OBJECTIVE

The objective of this study was to investigate the spectral transmission characteristics and its chromatic efficiency of UV quartz optical fibers at various geometrical configurations.

BACKGROUND

During the past few years, the use of optical fibers has been widely applied in military electro-optical devices. Its unique transmission processes have also been utilized in the theoretical modeling of human visual information processing. One of the prime features of optical fiber is that it is flexible and bendable. The question arises as to whether the curving or the bending of the fiber will change the spectral transmission characteristics and the nature of the transmitted chromaticities.

METHODLOGY

The 500 mm optical fiber manufactured by Schott Inc. (Duryea, Pennsylvania) was used in this study. Light sources were tungsten (incoherent) and He-Ne laser (coherent). Tektronix RSS (rapid scan spectrometer) and DPO (digital processing oscilloscope) were used as an automatic data acquisition unit (with PDP 11/05 minicomputer of 24 k memory capacity). Seven geometrical forms used were: straight, 90°, 45° bending, S-shape, one loop, two loops and three loops. Spectral transmission characteristics and transmitted power spectra incorporated with its CIE chromaticity diagrams were obtained from the automat data acquisition unit.

STATUS

This project has been published in USAARL-LR-75-34-7-9, entitled "Effect of geometrical configurations of quartz fiber optic bundles upon spectral transmission efficiency of coherent and incoherent radiation sources. A portion of this study, entitled "Spectral transmission characteristics and chromatic dispersion of UV optical fibers", has also been accepted for publication in Applied Optics.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA 0D 6739	75 07 16	DD-DRAE(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
74 07 01	D Change	U	U	NA	NL	☒ YES ☐ NO	A WORK UNIT

10. NO. CODES	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	62758A	3A762758A 819	00	119
b. CONTRIBUTING				
c. CONTRIBUTING	CARDS 114(f)			

11. TITLE (Precede with Security Classification Code)
Research of Psychoacoustical Problems Medically Significant to Army Aviation (05)

12. SCIENTIFIC AND TECHNOLOGICAL AREAS
1300 Aircraft, 021000 Radio Communications; 000200 Acoustics

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
70 07	Cont	DA	C. In-Hours

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: 75	6	185
FISCAL YEAR CURRENT: 76	8	458

19. RESPONSIBLE DOD ORGANIZATION
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SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS
NAME: MOZO, Ben T.
NAME: PATTERSON, James H., CPT, MSC DA

21. GENERAL USE
Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Conversion Techniques; (U) Man-Machine Relations; (U) Human Volunteers; (U) Protective Equipment; (U) Recording Devices;

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)
(U) Weapon Effects; (U) Acoustic Detection; (U) Electronic Engineering; (U) Communications; (U) Information Theory; (U) Radio Communications.

23. (U) To provide information about sound which has medical import to US Army aviation.

24. (U) The approach will be twofold. One will entail the physical description of the critical sound stimuli found in US Army aviation. This will involve descriptions at the generators or sources as well as descriptions of subsequent changes that may be precipitated by various propogating media. The second approach will involve studying the effects of these sounds on human receivers. Both approaches will employ valid research practices.

25. (U) 74 07 - 75 06. Progress in this area is reflected by the following reports: Foreign Materiel Exploitation Report, AST-1100X-131-75, "Real-Ear Sound Attenuation and 'Bump' Protection Characteristics, Tank Crewmen Helmet, Soviet (U)," and USAARL Report No. 75-18, "Word Intelligibility of Two Types of Synthesized Voice Warning Systems; USAARL Letter Reports - "Investigation of a Nonhardening Seal for the DH-132 Helmet", "Investigation of the Effects of Three Types of Eyeglass Temples on Attenuation of the SPH-4 Helmet", "Investigation of a Nonhardening Ear Pad for the SPH-4 Helmet", and six USAARL Letter Reports on Quality Assurance Tests of Real-Ear Sound Attenuation Characteristics of DH-132 Helmets. In progress are: eight Armored Vehicle Crewmen Helmet reports; and four Aviator Helmet reports.

Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Research of Psychoacoustical Problems Medically Significant to Army Aviation

OBJECTIVE:

To provide information about sound which has medical importance to US Army aviation.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 60 through 71.

RECOMMENDATIONS:

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

EFFECTS OF DISTORTION IN MILITARY COMMUNICATION SYSTEMS

OBJECTIVE

The purpose of this investigation is to study the effects of the following three important variables:

a. Type of microphone

b. Environmental noise level

c. Distortion on the intelligibility of military communication systems.

Objectively, an attempt will be made to show the theoretical limits communicating in noise with idealized systems, to estimate the relative efficiency of present systems and to make recommendations on methods to improve the present systems. The hypothesis of this project is that systems with low distortion are the most suitable for communicating in thick noise levels.

BACKGROUND

During the early development of telephone communication systems, Bell Laboratories did extensive basic research concerned with the investigation of speech intelligibility parameters. The results of this research have shown that the process of communicating with speech is complex. Volumes have been published on the analyses of speech. The complex analyses have not yielded simple basic constitutents that a layman may easily synthesize for practical application. It was only through close coordination of scientists in the field of psychophysics and engineers who designed the communication systems that the Bell Telephone achieved its successful application of the results of their basic research. The present networks of the telephone cables which transmit reliable messages around the world is a manifestation of the success.

The development of radio and intercommunication systems in military and commercial aircraft has not had the same degree of success. It is difficult to state the precise reasons for the arrested progress of the military applications. This project is proposed as an attempt to probe some of the causes of the present inefficient systems.

The principal investigator has had training and research experience in the field of speech communication. From 1952 to 1957 he was associated with the Ohio State Research Foundation conducting research concerned with investigating parameters of speech communication in noise. The most significant contribution was the publication entitled, "Perception of Multiple-Choice Intelligibility Items in the Presence of Simulated Propeller-Type Aircraft

Noise." This was a long-term empirical study of multiple-choice words as a tool for expedient measurements in research applications. Close approximation of the functions was determined to be a system of Poisson equations.

Articulation indices have been computed by Bell Laboratories. Most of the basic research of the analysis of speech may be found in Speech and Hearing, 1929, by Harvey Fletcher.

METHODOLOGY

Three types of microphones will be used. An omnidirectional condenser microphone, a military type noise cancelling dynamic lip microphone, and an inertial contact transducer, to be placed on the head of the speakers, will serve as transducers for picking up speech of talkers. Each of these microphones will be fed into systems of low distortion and recorded.

Each talker will be fitted with the three microphones for simultaneous recording of lists of phonetically balanced (PB) words. A list of words will be spoken under four environmental conditions. The talkers will speak under a condition of quiet and three levels of ambient white noise. The sound pressure levels of the noise will be 100 dB, 110 dB and 120 dB (re 0.0002 dyne/cm^2). Recordings of simultaneous pickups from each of the three microphones will be presented to listeners who will be instructed to write down the words. Samples of listeners will be divided into six groups. Each of three groups will listen to one of the three microphones with amplification conditions of frequency and amplitude distortion. The frequency distortion will be a filtered bandpass of 200 Hz - 6,000 Hz. Scores of each group of listeners will be the measure of the intelligibility of the experimental conditions.

Type of Microphones: The three types of microphones chosen for the experiment are various types usually discussed in most controversies about selection of proper transducers for transmitting speech in noise. The omnidirectional condenser microphone is extremely linear throughout the speech frequencies. The noise cancelling dynamic microphone is a type presently used with military helmets. The contact microphone receives the vocal signal via bone conduction. It represents a type of transducer that is frequently suggested by laymen to replace the conventional lip microphone. The simultaneous recording of the same speech signal with the three types of microphones will serve to make a direct comparison of the relative efficiencies of the three.

Environmental Noise Levels: The ambient sound pressure level of environments in which the speech is picked up by the microphone is a very important variable of the communication situation. A range of ambient SPL quiet, 100 dB, 110 dB and 120 dB (re 0.0002 dyne/cm^2) is chosen because it is an approximation of the dynamic range of most aircraft noise. The variable will furnish valuable information about the relative performance of the three microphones in a wide dynamic range.

Frequency and Amplitude Distortion: Most aviation communication systems have characteristics that introduce amplitude and frequency distortion. The width of the passed band of frequencies is usually less than the width of the speech spectrum. Also, often the dynamic range of the speech signal is distorted by peak clipping. The 200 - 6,000 Hz bandpass filtering and the 20 dB clipping are considered to be a conservative estimate of the two types of distortion.

An experiment of this design will provide the necessary supplement to the existing knowledge of the speech communication process of subsequent application to the military communication systems in Army aircraft.

STATUS

Further tests of noise cancelling microphones have been completed. An AGARD report of the results of these tests was completed. This report, entitled: "Characteristics of New Generation Military Noise Cancelling Microphones," was presented by Mr. Robert T. Camp, Jr. in Naples, Italy, at the 31st Aerospace Medical Panel Meeting, 16-20 September 1974. The new generation noise cancelling microphones have improved frequency response that would provide high quality voice communications and would eliminate the 4 KHz peaks of the present standard M-87 microphone.

A pilot study of the effects of peak clipping distortion, with and without added noise on the level adjusted by aviators, was undertaken. Preliminary results indicate that in the presence of noise and clipping higher levels were set when the aviators used a criterion of best understanding to adjust the level. These data were included in a presentation by Mr. Robert T. Camp, Jr., at the AGARD Aerospace Medical Panel Specialists Meeting, 5-9 May 1975, Toronto, Canada, entitled: " An Investigation of Aircraft Voice Communication Systems as Sources of Insidious Long-Term Acoustic Hazards."

ACOUSTICAL ENVIRONMENT OF US ARMY AVIATION PERSONNEL

OBJECTIVE

The objectives of this work are to determine noise spectra of the various environments in which US Army aviation personnel are required to perform their duties. These data will be used not only as a basis for the design and supply of protective equipment, but also as a means for improvement of future equipment designs.

BACKGROUND

Due to the wide variety of acoustic problems in the US Army and the need for effective solutions, it is necessary to have a knowledge of the characteristics of the acoustic environments of Army personnel.

Octave-band analyses have been useful for damage risk criteria and noise survey problems. The human ear response, on the other hand, is more analogous to third-octave spectra information. Also, for certain engineering purposes it is required to obtain narrow-band analyses. Therefore, three types of analyses will be desirable for adequate descriptions and treatment of acoustic problems.

For the above-stated reasons, it is desirable that three types of analyses be applied to noise data. This complete investigation of the characteristics of various acoustic environments will furnish valuable information not only for damage risk criterion applications, but also engineering applications of noise abatement programs.

METHODOLOGY

Samples of noise data will be recorded with a precision magnetic tape recorder with a 70 dB signal-to-noise ratio. The analyses of the recordings will be done in the laboratory with octave-band and third-octave band filters and real-time narrow-band instruments. Statistical descriptions of the mean sound pressure levels and standard deviations of the third-octave and octave-band data will be provided. For certain outdoor measurements, a precision fourteen-channel tape recorder will record data from multi-positions simultaneously.

STATUS

Evaluation of helicopter noise data collected during flyby test in April 1974 is presently being conducted. Programs for complete evaluation of the flyby data are approximately 60 percent complete.

Noise measurements of a high performance hoist developed by Lockheed Corporation, installed on a UH-1H helicopter, were made. Analysis of the data is in progress and is about 80 percent complete.

Noise measurements were made in two CH-47C helicopters under normal training conditions. The measurements were made at the pilot's ear using a 5333C electret microphone. The data show the sound pressure levels of the helicopter and communications system noise at the ear of the aviator. These data were presented by Mr. Robert T. Camp, Jr. in a report entitled, "An Investigation of Aircraft Voice Communication Systems as Sources of Insidious Long-Term Acoustic Hazards," at the AGARD Aerospace Medical Panel Specialists Meeting, 5-9 May 1975, at Toronto, Canada.

Octave-band, third-band and narrow-band analyses have been completed and reported on. Further analyses are presently being performed.

HEARING PROTECTION DEVICES EVALUATION

OBJECTIVE

The objectives are to: 1) maintain readily available data, recorded under ANSI Z24.22 (1957) standardized procedures, of the attenuation offered by standard helmets, earmuffs and earplugs used by Army aviation personnel; and 2) estimate the protective properties of prototype equipment that will be considered for use by Army aviation personnel.

BACKGROUND

Since World War II, there has been an increase in the interest and effort to perfect devices for the protection of personnel from harmful high sound pressure levels. The effort has resulted in the development of earplugs, earmuffs and helmets designed for sound attenuation.

Although the present prototype ear protection devices seem to reflect an asymptote in the rise of efficiency realized in the 1950's and early 1960's, there is still a need to properly evaluate the attenuation characteristics of all prototypes and standard equipment worn by Army aviation personnel. The real-ear method of psychophysically testing the effective attenuation at the human ear is the method presently preferred.

It is important to maintain available data about the attenuation characteristics of all standard and proposed equipment. These data are necessary for ascertaining noise levels in which personnel can safely operate. This information is invaluable to medical personnel who prescribe devices for the adequate protection against noise. Such information, therefore, is in constant demand by laboratories concerned with noise problems, Army agencies responsible for design of helmets, medical personnel and private manufacturers of Army aircraft.

METHODOLOGY

Psychophysical measurements of attenuation will be made. The procedure will be in line with the ANSI Z24.22 (1957) standards. In addition to this standard ANSI test, other methods are being investigated. The physical-ear attenuation test developed by this Laboratory uses noise spectra and Fast Fourier Transform instrumentation.

STATUS

Evaluation of nonhardening seal for DH-132 helmet has been completed and report issued. The single layer 15 mil thickness yields attenuation characteristics equal to or greater than the mininum requirements of the DH-132 helmet.

Quality assurance testing of Lots 69 and 74 of tne Gentex DH-132 helmet has been completed. All lots passed in accordance with the Combat Vehicle Crewmen attenuation criteria. Written reports have been completed on these lots.

Three sizes of the E-A-R disposable earplug were evaluated by the real-ear attenuation test method. This device shows superior attenuation at the low frequencies. The .54 inch diameter plug was considered optimum with respect to fit and comfort and therefore was recommended as the standard size to be procured.

Quality assurance testing for the American Safety SPH-4 helmet, Lot 8, has been completed. Report is in progress.

Tests of the attenuation characteristics of the DH-132 helmet, with and without chinstrap, have been completed. A report is in progress.

Test of the H-161 C/U communications headset, using the real-ear attenuation test method, has been completed. Report is in progress.

Attenuation testing of a nonhardening seal for the SPH-4 helmet and subsequent report have been completed.

Real-ear and physical-ear sound tests have been completed on the following electrical or communications headsets available through Federal Supply Channels: 1) H-157/AIC; 2) H-173A/AIC, 3) H-140; 4) H-158; 5) David Clark 10673294-1; 6) David Clark Prototype; and 7) H-251. Report for these communications headsets is in progress.

Test of a Soviet tank crewmen helmet was conducted with the real-ear and physical-ear sound attenuation methods. Report has been completed.

Real-ear and physical-ear sound attenuation characteristics of the modified Sierra P/N 791 AVC helmet were acquired. The medium size helmet passed attenuation requirements at all test frequencies. The large size helmet yielded lower than minimum acceptable required values at some test frequencies. An investigation of the effective head size and hair length in relation to sound attenuation was conducted. It was concluded that the failing attenuation characteristics of the large helmets could not be linked to the head size or hair length of the subjects being tested. Report has been completed.

Real-Ear tests and physical-ear tests of the modified Sierra Engineering P/N 791 AVC helmet (second submission), large size, are complete. Results of these tests show that this large size helmet yielded lower than the minimum acceptable attenuation values at 500 Hz. Data analysis has been completed. Report is in progress.

The Gentex BPH-2, in combination with the E-A-R Disposable Earplug, was tested for real-ear sound attenuation characteristics. Unusually high attenuation values were obtained with this combination.

Quality assurance real-ear and physical-ear sound attenuation tests for Lots 1 and 2 of the Gentex SPH-4 helmet were completed. Passing attenuation values were acquired, and subsequent reports of these findings have been completed.

Quality assurance real-ear and physical-ear sound attenuation tests for Lots 79 and 84 of the Gentex DH-132 helmet were completed. Passing attenuation values were obtained. Written reports have been completed.

An investigation of the effects of three types of eyeglass temples obtainable through the Federal Supply system on attenuation of the SPH-4 helmet was conducted. It was concluded that the wearing of glasses with the SPH-4 will degrade the hearing protection afforded by the helmet. Of the three types of glasses tested, the two metal frames provide the least reduction in attenuation and are essentially equivalent in this respect. The S-10 plastic frame is significantly worse and would constitute a serious degradation of the hearing protective capability of the helmet. Report has been completed.

Investigations were undertaken to evaluate the effects on attenuation of a number of possible modifications to the SPH-4 flying helmet in preparation for an IPR on this helmet. The modifications investigated included: 1) Shortening of the SPH-4 shell in the cup area; 2) Change of the double cross tension earcup retention system to a single strap tension system to accommodate the shortened shell; 3) Modifications of the earcup and earcup flange; 4) Nonhardening seals to fit the various cup/flange configurations; 5) Foam filler of shell cavities in the region of the earcup; and 6) Change of shell material from standard fiber glass to Kevlar material. The change of shell material and the shortening of the shell in the earcup region appear to have no effect on attenuation properties of the helmet. The single cross strap tension system appears to function adequately in the shortened shell. Various earcup modifications and nonhardening seals are still under investigation. The use of foam filler in the earcup region appears to improve attenuation in the low frequency region. However, final field worthy configuration of the padding has not been established. This project is 85 percent completed.

Quality assurance testing of Lot 1 of the Gentex DH-132 helmets, Contract No. DSA100-75-C-0111, has been completed. Even though these helmets passed attenuation performance tests, there were defects noted with Lot 1 in the following areas: 1) The earcups were excessively loose within the earcup retainer assembly; 2) The Nomex webbing in the area of the earcup showed tears and snags; and 3) Air leaks were noted in the microphone plug cavity of the right earcup. USAARL recommended to Natick and DPSC that appropriate repairs of affected areas be made in the affected lot.

Quality assurance real-ear and physical-ear sound attenuation tests of Lots 3 and 4, Contract No. DSA100-75C-0480, of the Gentex SPH-4 helmets were completed. Both lots passed in accordance with SPH-4 standard attenuation criteria. Written reports on these lots have been completed.

Completed real-ear attenuation tests of a modified design of a nonhardening ear pad, part number 75C 2990, for the SPH-4 helmet. Results indicate attenuation values of the nonhardening pad to be equivalent to the standard pad. Report is in progress.

Four David Clark circumaural hearing protective devices have been tested for real-ear sound attenuation characteristics, which are as follows: 1) David Clark 9AN; 2) David Clark E-195; 3) David Clark E-305; and 4) David Clark E-310.

Randomly selected test samples from Lots 7 and 8 of the E-A-R disposable earplugs were evaluated with real-ear sound attenuation tests. The real-ear attenuation values were commensurate with earlier lots of this device.

A polyvinyl chloride earcup seal manufactured by Astrocom (NSN-5330-00-143-8577) was evaluated as a possible replacement for the standard seal of the SPH-4 helmets. Real-ear attenuation values of these Astrocom seals were shown to be essentially equivalent to real-ear attenuation characteristics of the standard seal.

Real-ear sound attenuation tests of the Bilsom Propp Circumaural muff with foam-filled cushions attached to a Jackson Safety hardhat have been completed. Report is in progress.

Real-ear sound attenuation tests of the Gentex DH-175 with a lead lined cup and nonhardening seals have been completed. Report is in progress.

Four David Clark communication headsets are under test for real-ear sound attenuation characteristics. Progress on these devices is as follows: 1) David Clark 800 SBA - 80 percent complete; 2) David Clark 15 SMA - 25 percent complete; and 3) David Clark 800 SMA - 25 percent complete.

Quality assurance real-ear and physical-ear sound attenuation tests of Lot 6 of the Gentex SPH-4 helmets have been completed. Report is in progress.

Quality assurance real-ear and physical-ear sound attenuation tests of Lot 9 of the American Safety SPH-4 have been completed. Report is in progress.

Quality assurance real-ear and physical-ear sound attenuation tests of the Gentex DH-132 helmets, Lots 6, 6A, 7, 8, 9, 10 and 11, have been conducted. Reports are in progress.

ARMY AVIATION AUDIOMETRY PROGRAM

OBJECTIVE

The purpose of this program is to perform precision audiometric tests of a large sample of Army aviation personnel. The results of these tests will serve not only as valuable information about the status of hearing among Army aviation personnel, but also will serve as a basis for the amelioriza-tion of the automatic audiometric testing conditions in US Army aviation. This will be accomplished by the establishment of a more reliable audiometer calibration program and the introduction of trained personnel with an MOS for operating audiometers.

BACKGROUND

A survey of audiograms of US Army aviation personnel has revealed that a large percentage of young Army aviation personnel have hearing losses. The reliability of these data must be tested with a program of rigidly controlled instrumentation and testing procedures that will yield dependable data about the magnitude of hearing losses among US Army aviation personnel. If the results of such tests show a significant difference between the health records data and the experimental data, there will be a recommendation for an amelioration of audiometer calibration and audiometry in the US Army.

METHODOLOGY

The first task will be to determine the proper audiometer for the making of precision audiograms. The audiometer may be chosen from several sources. Presently, the possibilities are the Rudmose ARJ-4, the Rudmose ARJ-5 or some of the new models of automatic audiometers developed by Grason-Stadler Company, Inc. After a suitable audiometer has been chosen, the testing program will proceed. The next task will be a treatment of the data to determine whether or not the differences between the health records data and the experimental data are of significance. If the differences are sig-nificant, then recommendations will be made as to how an improvement of audiometry may be accomplished. The requirement for having trained personnel with an MOS for audiometry and requirement for improved audiometer maintenance and calibration will be the primary recommendations. The acoustical environ-ments of audiometric testing facilities in the Army will be investigated.

STATUS

A study is in progress designed to determine the prevalence of hearing loss among air traffic control personnel stationed at Fort Rucker. Hearing

assessment is being measured by pure tone and speech techniques. Also, background information regarding history of exposure to noise is being accumulated. Thirty-five personnel have been measured to date.

The Bioacoustics Division designed and fabricated a control system for audiometric and real-ear attenuation measurements. The system utilizes a programmable logic system with arithmetic instructions. This approach to logic design yields maximum flexibility for hardware utilization.

USAARL Report Number 75-18, "Word Intelligibility of Two Types of Synthesized Voice Warning Systems," was completed in April 1975.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA OD 6738	75 07 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
74 07 01	D. Change	U	U	NA	NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	62758A	3A762758A 819	00	118
b. CONTRIBUTING				
c. CONTRIBUTING	CARD (114F)			

11. TITLE (Precede with Security Classification Code)

(U) Research Psychology Applied to Medically Significant Problems in Army Aviation (06)

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: Not Applicable

c. TYPE — d. AMOUNT

e. KIND OF AWARD — f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
PRECEDING FISCAL YEAR 75	8.8	273
CURRENT FISCAL YEAR 76	13	469

19. RESPONSIBLE DOD ORGANIZATION

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SOCIAL SECURITY ACCOUNT NUMBER

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NAME: Kimball, K. A., CPT

NAME: Sanders, M. G., CPT DA

22. GENERAL USE

Foreign Intelligence Considered

23. KEYWORDS (Precede EACH with Security Classification Code)

(U) Military Aircraft; (U) Human Factors Engineering; (U) Man-Machine Relations; (U) Psychology; (U) Bioengineering; (U) Pharmacology;

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

(U) Computers; (U) Safety Engineering; (U) Human Volunteers; (U) Recording Devices; (U) Stress Physiology; (U) Aeronautics

23. (U) To provide US 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) 7407 - 7506. Progress under this work unit is reflected by the following: publication of 5 USAARL Laboratory Reports; 2 USAARL Letter Reports; 8 presentations at scientific meetings; input to a number of aviation related working groups or projects. Working groups and/or projects which received input included SEEKVAL, ICAS, NOE Communications, Night Vision Goggles, SATAN, UTTAS, TAWG, AH-1Q, ACE, Radar Altimeters, and DOD Topical Review. Presentations of research funding were presented to Aerospace Medical Association, Joint Army/Navy Scientific Conference, DOD Topical Review and AMEDD Conference. Two letter reports were published - USAARL Letter Reports 75-19-4-1, and 75-20-4-2 entitled "Evaluation of the System Interface Characteristics of the Synthetic Flight Training System (2B24)" and "Night Vision Performance Criteria". Five USAARL Reports were published numbered 75-1, 75-3, 75-11, 75-13 and 75-15. These reports were entitled "Personality Aspects of Pilot-Error Accident Involvement", "Aviator Performance During Local Area, Low-Level and Nap-of-the-earth Flight", "Aviator Visual Performance in UH-1, Study II," "Communication During Terrain Flight," and "A Cross-Validation Study of the Personality Aspects of Involvement in Pilot Error Accidents."

* 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

GENERAL DETAIL SHEET

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

OBJECTIVE:

To provide US Army aviation information that is medically important about the human factor 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 74 through 90.

RECOMMENDATIONS:

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

PERSONALITY CHARACTERISTICS AND PILOT ERROR ACCIDENTS

OBJECTIVE

The purpose of this study was to attempt to reduce the high number of pilot error accidents by examining the relationship between pilot error accidents and personality characteristics.

BACKGROUND

Pilot-error accidents have plagued military aviation programs since they evolved into large scale operations. The human element in complex aviation man-machine systems has been a disproportionate contributor to aviation accidents.

The United States Army Agency for Aviation Safety (USAAAVNS) recently reviewed the aircraft accidents which occurred between 1958 and 1972. The results of their study indicates that pilot error was a factor in 80% of the accidents occurring during that fifteen year period. A striking sum of $58,000,000 per year was attributed to pilot error in terms of injuries, fatalities and aircraft damage.

A total examination of the pilot error problem would not be complete without examining the personalities of pilots involved in pilot-error accidents. Haddon concluded that "...studies indicate that accident proneness is a psychological abstraction based upon a statistical frequency. As often happens when a statistical distribution is given theoretical significance, the concept quickly assumed much more meaning than was originally intended. The unacceptability of the concept of accident proneness in a technical sense should not, however, be taken to mean that personal factors do not play an important role in accidents. In fact, rejecting the concept of accident proneness, with its implication of a global personality trait forces one to search for many different psychological factors and their significance in given environmental circumstances." Thus, personal factors in accidents cannot be ignored, especially in light of the high rate of pilot error accidents occurring in the military and civilian communities.

METHODOLOGY

The subjects were 50 rated Army aviators who volunteered for the project. Fourteen of the subjects had been listed as a cause factor in an aviation accident, as determined by USAAAVS accident data.

The Cattell Sixteen Personality Factor Questionnaire was administered to each subject along with the Mehrabian Need Achievement Scale.

The 16 PF scores were corrected for age differences and used as predictor variables with the need achievement score in a biomedical computer program for stepwise discriminant analyses.

STATUS

Two USAARL Reports have been published numbered 75-1 and 75-15. These reports are entitled "Personality Aspects of Pilot Error Accident Involvement" and "A Cross-Validation Study of the Personality Aspects of Involvement in Pilot Error Accidents."

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 inflight 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 aircraft, weather conditions, 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 a precis has been submitted to perform the research.

VISUAL PERFORMANCE DURING NIGHT NOE AND LOW LEVEL FLIGHT

OBJECTIVE

The objective of this investigation is to gain information concerning the areas of the windscreen most often utilized by aviators while performing night NOE and low level flight.

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 video 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 in a riverbed negating the navigation task.) The video 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.

STATUS

Equipment to modify the corneal reflection device has been ordered. The system, when complete, will consist of the Eye Mark Recorder, a COHU Silicon Diode Vidicon LLLTV Camera and video recorder and an infrared light augmentation system. Modifications are also being designed for the Eye Mark Face Mask to increase comfort and ensure compatibility with the LLLTV. Data acquisition will take place in the coming year.

AVIATOR MISSION PREFERENCE AS RELATED TO DECISION MAKING AND PERSONALITY CHARACTERISTICS

OBJECTIVE

The purpose of this study is to explore the possible relationship between preference for CONUS and Vietnam mission assignments and personality characteristics. Also, it is designed to investigate the performance of aviators under simulated conditions involving decision making and risk taking.

BACKGROUND

Data indicate that some individuals tend to actively seek out sensational or stimulating experiences and are willing to accept greater risks than others. Therefore, it is assumed that some aviators are willing to accept the high risk activities associated with assignments calling for close enemy contact while other aviators would prefer assignments which involved a more homeostatic environment typically found near established friendly positions. With job satisfaction, retention, and performance optimization being of concern to the military, a study comparing personality traits to assignment preferences could perhaps help provide useful information in these areas of concern.

METHODOLOGY

Cattell's Sixteen Personality Factor Questionnaire and Mehrabian's Need Achievement Scale were given in order to determine stable personality characteristics of the aviators. These personality factors were used in stepwise discriminant function analyses in an attempt to predict both CONUS and Vietnam mission assignment preferences. In addition, subjects performed on dynamic decision making tasks yielding data which was compared to personality and assignment results.

STATUS

Data has been collected and reduced, and the majority of the analyses have been performed. The 16 PF scores for the aviators tested were compared to a sample of airline pilots and the profile for males in the general population.

Currently, final analyses are being performed and a report is in the final stages of completion.

VISUAL PERFORMANCE DURING DAY TERRAIN FLIGHT

OBJECTIVE

The objective of this work is to gain information concerning visual performance during terrain flight.

BACKGROUND

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 precis to perform this research has been submitted.

TEMPERATURE EFFECTS ON ACCIDENT RATES

OBJECTIVE

To determine the effect of cockpit ambient temperatures on accident rates in Army aviation.

BACKGROUND

Data currently do not exist on the effect of temperatures on accident rates in Army aviation. The lack of such data has resulted in cockpit environmental conditioning requirements in new aircraft developments being subjectively determined. Comfort of the crew is generally regarded as too costly in terms of the weight/power penalties involved for cooling; the design concern is the temperature that can be tolerated without serious performance consequences. Laboratory data do not translate easily into the serious consequence tolerance limits that are needed, other than physiological collapse limits. Data are available indicating a substantial increase in industrial accidents during high temperatures in comparison to moderate temperatures. It is reasonable to expect that this temperature-accident relationship may also exist for Army aviation accidents. If so, it would seem to be the most valid basis for determining cockpit environmental conditioning requirements.

METHODOLOGY

The accident record ADP files of USAAAVS (US Army Agency for Aviation Safety) will be searched and sorted by relevant data items on their accident reporting form. These items will include temperature, aircraft type, mission profile, humidity related items, geographic, density altitudes, and possibly others. Statistical techniques will be used to separate temperature-humidity effects from other co-varying factors to the extent the data permits. It is anticipated that accident rates, per se, may not be directly obtainable as a function of temperature, but that comparisons of the relative numbers of accidents at various temperatures should be possible. A comparison of temperature distributions for accidents in relation to average temperature distributions should also be possible. An attempt will be made to determine accident rates as a function of temperature directly if adequate data for this purpose can be obtained.

STATUS

This study is in the preliminary planning stage. The USAAAVS accident recording forms have been reviewed to determine the feasibility of the study, the record items likely to be relevant, and the general approach that will be required. Relevant data has been acquired from USAAAVS and is now being reviewed in detail.

AEROMEDICAL EXPLORATION OF HELICOPTER FLIGHT CONTROL CUEING CONCEPT FOR CONTACT TRAINING

OBJECTIVE

To gain a full understanding of a cueing concept that has been developed to assist students in developing helicopter contact flying skills, and to explore the potential application of the concept in resolving aeromedical problems in helicopter flight operations and training.

BACKGROUND

A senior flight instructor has developed a cueing technique that appears to assist in acquisition of higher than usual skills in contact flying. This cueing is highly similar to the attitude cues used in instrument flight, and students trained with the technique in contact training seem to do quite well in instrument training. The technique seems likely to have potential for resolving some of the disorientation and control problems that exist when attempting to fly helicopters using imaging devices.

METHODOLOGY

A thorough indoctrination was conducted in the application of the cueing technique in student flight training, with emphasis on essential aspects, advantages, and drawbacks. A tape recording is being obtained of classroom and flight training and discussions, and film recordings illustrating the application of the cue in flight are being obtained. A non-rigorous assessment will be made of the effect of the technique on learning of contact and instrument flying skills, and of the potential of applying the technique with a minimum of time and effort. After a full understanding of the cueing technique and its potential is obtained, the potential of the technique for resolving various aeromedical problems in current and future Army helicopter systems will be assessed. More definitive research on applications of the concept will be defined should they be considered appropriate.

STATUS

A manuscript has been completed and will be published shortly.

AVIATOR PERFORMANCE DURING NIGHT NOE AND LOW LEVEL FLIGHT WITH AN/PVS-5 NIGHT VISION GOGGLES (40 DEGREES, 60 DEGREES AND 40 DEGREES BIFOCAL)

OBJECTIVE

The purpose of this investigation is to assess differences in aviator performance (flight and physiological) during NOE and low level flight utilizing various AN/PVS-5 night vision goggle configurations and the unaided eye.

BACKGROUND

The increased utilization of helicopters in night tactical operations and the particular flight profiles required for their projected mission effectiveness have necessitated the development of night vision aids for rotary wing aircrews. One device of this type is the AN/PVS-5 Night Vision Goggle developed by the US Army Night Vision Laboratory. This system allows the aviator to operate the aircraft at night with natural illumination. Although various agencies have utilized the goggles during night flight operations, little quantifiable data is available with regard to the relative impact of 40^{o} FOV, 40^{o} FOV bifocal and 60^{o} FOV when worn by aircrews for various flight profiles. Of particular interest is their effect on aviator performance during NOE flight. This investigation will obtain and assess performance data from aviators wearing the NVG and performing NOE and low level flight. An attempt will be made to determine what differences in performance are present between three goggle configurations and the unaided eye.

METHODOLOGY

The subjects for this study will be six rotary wing aviators with extensive NOE flight experience. Each aviator will be required to fly five consecutive low level and NOE flights. (NOE flights will be in a riverbed, thus negating the navigation task.) The first flight will be flown with the unaided eye. This run will be followed by three flights utilizing each of the three configurations of goggles (40^{o} FOV, 60^{o} FOV, 40^{o} FOV bifocal). The last flight will again be performed with the unaided eye. Aviator and aircraft performance measures will be continuously recorded for all flights through the use of the Helicopter Inflight Monitoring System (HIMS). Physiological measurements such as heart rate and EKG will also be recorded and a urinalysis of pre- and post-flight specimens will be conducted.

STATUS

A report is now being written.

AVIATOR PERFORMANCE DURING DAY NOE, LOW LEVEL AND LOCAL AREA FLIGHT

OBJECTIVE

The first objective of this investigation is to provide data concerning aviator performance and aircraft state variables derived from inflight measures collected during local area, low level and NOE flights. The second objective is to provide information concerning physical workload and stress differences for the three types of flight profiles under investigation. These physiological parameters will include muscle activity, heart rate and changes in body chemistry.

BACKGROUND

Because of the projected tactical environment in which helicopters will be required to operate, there exists a necessity to fly close to the earth. Of the three recognized tactical flight profiles (i.e., contour, low level and NOE), the most demanding is nap-of-the-earth (NOE). The aviator who flies NOE must maintain a high level of alertness to detect and avoid obstacles while maintaining maximum concealment and the desired flight path. Though research has been conducted to demonstrate the capability of aviators to perform such flights (Ref. CDEC work) and the US Army Aviation School provides low level and NOE flight training, much remains to be known about aviator performance during these different flight profiles and their physiological impact.

METHODOLOGY

Subjects will be six rotary wing aviators with extensive NOE experience. For design purposes, subjects will be divided into two groups of three aviators each. Each group will participate in flights over a two day period, with each day representing a different test condition. One condition calls for a low level and NOE flight and the other a normal local area flight. Twenty channels of continuous information on pilot performance and aircraft states will be collected for all NOE, low level, and local area flights utilizing the helicopter inflight monitoring system (HIMS). These data will be submitted to statistical analysis.

STATUS

Data for the six aviators has been collected and analyzed. A report on portions of this data has been published in USAARL Report number 75-11 entitled "Aviator Performance during Local Area, Low Level and Nap-of-the-Earth Flight."

PERCEIVED VELOCITY AS A FUNCTION OF ALTITUDE AND VISUAL ENVIRONMENT

OBJECTIVE

The investigation of aviator ability to estimate aircraft velocity as a function of altitude under normal daylight and low light level night conditions.

BACKGROUND

The perception of velocity is believed by some to be a linear function of altitude; however, there does not appear to be any empirical evidence in this regard. Velocity perception has become increasingly important with the new tactical profiles and night vision devices.

METHODOLOGY

Eight subjects will be flown at 12 altitude/aircraft speed combinations (4 altitudes, 3 aircraft speeds) under each of 4 visual conditions: unaided eye in daylight and both the aided and unaided eye in night light (simulated and equivalent to quarter to half moon). Visual aids are 2 pairs of night vision goggles, one with a 60^{o} field of view, the other with a 40^{o} field of view.

The subjects will estimate aircraft speed and altitude, utilizing normal visual cues, for each of the above conditions.

The experiment design consists of a counterbalanced Latin-square with subjects randomly assigned to visual conditions and altitude/aircraft speed combinations.

Criterion measure will be the difference between aviator estimates and the actual altitude/aircraft speed measured by the radar altimeter and a helicopter in flight monitoring system.

Analysis of variance will be used to examine the data with respect to altitudes, aircraft speed and visual conditions.

STATUS

Data on six aviators has been acquired and analyzed. A report on the results of this investigation is nearing completion.

COMMUNICATIONS AT LOW LEVELS

OBJECTIVE

The primary objective of this project is to facilitate navigation and improve flight performance by standardizing navigation terminology and instructions from the navigator (or co-pilot) to the pilot so that uncertainty and misunderstanding will be reduced and head in cockpit time is minimized.

BACKGROUND

The unique characteristics of nap-of-the-earth (NOE) flight have brought many new demands and requirements upon helicopter aircrews. Among the most important of these requirements is the need for a communication system which allows the navigator and pilot to operate efficiently (in terms of the amount of communication) and effectively (keeping the pilot's head outside the cockpit and on the immediate terrain features). It has been noted that one problem related to NOE flight is the head-in-the-cockpit time demands made by conventional navigation techniques. Safe NOE flight requires that the pilot keep his head outside the cockpit and rely on terrain features and directions from the navigator as the primary means of controlling the direction of his flight. Navigation in this manner is a most difficult task which calls for a great deal of teamwork between the pilot and co-pilot. A standardization of terminology to describe the terrain has been suggested but no emphasis has been placed on the standardization of those terms by which the navigator guides the pilot over the terrain. Too often the navigator gives a direction which either requires the pilot to focus inside on the instrument panel for reference or produces some uncertainty in the pilot as to the exact meaning of the instructions. Either case results in a slower reaction time by the pilot and could result in a degradation in his efficiency in handling the helicopter.

A recent review of Army aviation accident reports for the 15-year period from 1958 to 1972 indicated that 80% of the helicopter and fixed wing accidents were due to pilot error. An analysis of the task errors, listed in the USAAAVS accident report, which contributed to the overall human error that resulted in the mishaps revealed that: (1) processing and using information, (2) communicating, and (3) following procedures, were three of the five task errors listed.

The accident data indicate that communication and the effective utilization of transferred information is currently a problem and will continue to be one unless remedial actions are taken.

METHODOLOGY

Tape recordings of two groups of initial entry flight students during the NOE phase of their training have been obtained and scored.

STATUS

Basic comparisons have been made between the types of navigation terms used inflight.

Frequency counts of favored terms have been obtained along with communication time in comparison to total NOE route time.

Currently a questionnaire is being constructed which will be given to NOE IPs and students. The results of the questionnaire should provide alternative approaches for the standardization of inflight navigation terminology.

The result of this investigation can be found in USAARL Report number 75-13 entitled "Communication during Terrain Flight."

GEOGRAPHIC FEATURE VISIBILITY IN LOW LEVEL FLIGHT

OBJECTIVE

To provide preliminary definition of the relative orientation and time in view of geographic features during low level flight.

BACKGROUND

Masking by vegetation and terrain during low level and nap-of-the-earth flight greatly restricts visibility to features used for geographic orientation. The time in view of features and their relative orientation when in view is determined largely by vegetation and terrain characteristics, but has not been quantified. As a result, the characteristics needed in systems for navigation at low level have not been well defined in regard to the orientation and duration that potential navigation features are in view. Preliminary analysis has suggested that little information for navigation is likely to exist directly ahead of the aircraft.

METHODOLOGY

Existing extreme wide angle low level motion picture imagery obtained in the Fort Rucker vicinity will be used to define quantitatively the relative orientation of features potentially usable for geographic orientation, and to define the time these features are in view. The azimuth and elevation angles at feature appearance and disappearance will be recorded, as well as intermediate orientations if in view for an extended period of time. Angular orientation of linear features such as roads will also be defined at crossing. The data will be summarized with regard to relative expectations of lines of sight which exist for various types of features at various orientations and durations.

STATUS

Data analyses are nearing completion. The results of this effort will be reported in two phases. The first phase will yield information concerning object visibility as a function of line of sight viewing angles and detection probabilities. The second phase will primarily be concerned with line of sight viewing time as a function of range and angle.

VISUAL PERFORMANCE DURING INCLINE (SLOPE) OPERATIONS

OBJECTIVE

The purpose of this research is to provide data on the eye movements of aviators performing incline landings. Comparative evaluation of the visual performance of pilots on these landings and other flight maneuvers will be possible when these data are available.

BACKGROUND

The incline landing in a rotary wing aircraft is unique among the many maneuvers which helicopters can perform. Unlike most helicopter operations where the aviator is constantly scanning his environment, searching for visual information about terrain, aircraft status and relying heavily on the visual modality for receiving such information, after the judgment has been made as to whether an incline is an acceptable landing site, this maneuver could be categorized as one in which more importance is then placed on feedback from other sense modalities. Indeed, subjective information obtained from accomplished aviators concerning this maneuver indicates that visual information is primarily used for assuring a precise and stationary heading during touchdown. Because of this maneuver's singular characteristics, its frequent practice both in training and in tactical operations, and the potentially hazardous consequences of its unsuccessful accomplishment, objective information on the visual processing aspect of this task is important. Further, the acquisition of these data will allow the integration of a complete record of both perceptual and motor aviator performance for this unique maneuver.

METHODOLOGY

Subjects for this project will be six Army aviators. Visual performance, i.e., eye movements measured by corneal reflection, will be monitored and recorded on a video recording system. The windscreen, doors, chin bubbles and instrument panels of the test aircraft will be partitioned into sections. This will permit scoring of the video tapes to provide information concerning dwell time in each section, total transitions in and out of each section, and the percentage of time spent in each section.

STATUS

Data has been obtained and analyzed. A report on this effort entitled "Aviator Visual Performance in UH-1, Study II," (USAARL Report 75-13) has been published.

PERCEPTUAL-MOTOR FACTORS IN STRESS RESISTANT HELICOPTER DISPLAY-CONTROL SYSTEMS

OBJECTIVE

The objective of this research area is the definition of helicopter display control formats which will significantly reduce pilot errors, workload and training; minimize the adverse consequences of stress; and provide for the orderly introduction into the cockpit on an integrated basis of the advanced avionics capabilities that Army aviation will require in the future.

BACKGROUND

Conventional helicopter instrumentation is conducive to high rates of pilot error and stressful situations greatly increase these pilot error tendencies. Future Army aviation operations will be considerably more stressful than in the past, due to enemy weapon improvements and consequent requirements for nap-of-the-earth flight. This future environment will frequently result in accidents from pilot errors that would have been correctable at high altitudes. The fixed wing instrumentation now used in helicopters also does not provide the higher control bandwidths that are required, particularly during hovering flight. Instrument flight skills in helicopters are difficult to acquire and maintain.

Addition of complex avionics systems that are necessary for future operations seem certain to exceed workload capacity by wide margins if conventional unintegrated instrumentation is retained. Displays proposed for a number of advanced avionics systems each presume nearly full-time pilot attention, the display formats frequently are inefficient in transmitting information, and no common integration constructs are evident for reducing the information interpretation load to manageable proportions.

Helicopter display concepts have been proposed which seem to have potential for reducing pilot errors through integration to improve stress resistance, information transmission capacity, and control bandwidth. These concepts need to be assessed in regard to their potential for reducing pilot errors and improving performance.

METHODOLOGY

A series of individual studies will be performed initially to assess critical individual aspects of the integrated display concepts. If favorable, these will be followed by studies to assess display element combinations that partially implement the integrated display concepts, which would, in turn, be followed by studies to assess and optimize the fully integrated display concept. Assessment will focus on pilot error reduction information transmission capacity/control bandwidth, stress resistance, and pilot workload stress involved in performance.

STATUS

The experimental approach and test conditions have been defined. Equipment for stimulus programming and driving have been acquired. Logic requirements for display driving and response recording have been defined as have the data analyses to be used.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1 AGENCY ACCESSION	2 DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA OD 6735	75 07 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
74 07 01	D. Change	U	U	NA	NL	☒ YES ☐ NO	A. WORK UNIT

10 NO CODES	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	62758A	3A762758A 819	00	100
b. CONTRIBUTING				
c. ///////////	CARDS 114(f)			

11 TITLE (Precede with Security Classification Code)

(U) Research of Bioengineering Problems Medically Significant to Army Aviation (07)

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: NA

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: 75	4	124
FISCAL YEAR — CURRENT: 76	6	120

19 RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Lab

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RESPONSIBLE INDIVIDUAL

NAME: BAILEY, R. W., COL, Cdr

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20 PERFORMING ORGANIZATION

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Bioengineering & Evaluation Division

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SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS

NAME: HALEY, J. L.

NAME: SAUERMILCH, P. W. DA

21 GENERAL USE

Foreign Intelligence Considered

22 KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Man-Machine Relations; (U) Bioengineering; (U) Escape, Rescue and Survival; (U) Human Volunteers; (U) Protective Equipment;

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

(U) Stress Physiology; (U) Thermodynamics; (U) Safety Engineering; (U) Anthropometry; (U) Electronic and Electrical Engineering

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) 74 07 - 75 06. Progress in this area is reflected in developments or reports dealing with the following areas: Impact evaluations of CVC helmets, crashworthiness of light fixed and rotary wing aircraft, musculoskeletal effects of long term helicopter vibration, aircrew station geometry, mathematical model of thermal transfer through skin, analysis of helicopter impact injury problems, VSTOL aircrewmember seat design, appointment to the NATO-AGARD-AMP Biodynamic Committee, National Academy of Science Committee on Flammability, ASTM Committee on Head-Neck Injuries, helmet test and performance evaluation methods, helmet design philosophy quality assurance evaluations of P/N 791, DH-132, SPH-4 helmets, crashworthy troop seat development, validation of a man rated three axes helicopter vibration table.

* 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 93 through 103.

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, Triservice 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 Crash worthiness Contract Review Boards, Eustis Directorate, Air Mobility Laboratory

NATO-AGARD/PEP-SMP-ASMP Working Group on Aircraft Firt 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 School, 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
Triservice Life Support Equipment Panel

BIODYNAMIC EVALUATION OF PROTECTIVE HEADGEAR

OBJECTIVE

Design, develop, validate and keep abreast of current evaluation methodologies specifically as they fulfill the needs of Army aviation in regard to head protection.

To determine the potential bump and impact protection provided to the wearer by protective helmets. To evaluate the degree to which various helmet protective systems meet the technical performance criteria outlined in Z90.1 safety standards, appropriate MN's and to evaluate the adequacy of the existing standards.

BACKGROUND

The development, evaluation, quality control, and investigative techniques used in the study of the impact protective aspects of aircrew protective headgear is currently being accomplished under contract with civilian organizations. Standard test methods currently employed use Z90.1 methodology. This methodology is designed for helmets for civilian use, i.e., motorcyclist, etc. Until recently there was no responsive military operationally oriented helmet evaluation facility capable of making biodynamic physiologic judgments about design, construction, or development of aircrew protective headgear. There was no facility charged with evaluating biodynamic aspects of head injury causation or injury prevention during aircraft crashes. USAARL now has mission authority for the Quality Assurance Evaluation of all Army helmets in relation to medical and protective performance criteria.

METHODOLOGY

Evaluations are conducted to compare all helmets, available standards, and alternate protective systems. The helmet systems are subjected to various tests to include bump and impact protection, weight and center of gravity determinations, effects of POL products and temperature extremes, and retention characteristics in order to make a judgment of the relative protective merits of various systems. Coordination and liaison have been established with all interested or responsible federal and civilian agencies. New designs, fabrication techniques, and standards of test are developed and validated.

STATUS

Methodologies for helmet retention and impact testing are continually being developed. Coordination and liaison have been established with all interested or responsible federal and civilian agencies.

USAARL end item verification evaluation of Standard "A" CVC helmets continues for DA. Improved design and construction have resulted from USAARL's input.

Publication of USAARL Letter Report 75-16-3-2, Second (Bump) Test Evaluation of P/N 791 as Combat Vehicle Crewman's Helmet, November 1974.

Publication of:

Knapp, S. C., "Review of Operational Statistics on Army Aircrew Head Injury and Helmet Function in Crash and Ejection", published in Proceedings of ASCC Working Party 61, Auckland, New Zealand, September 1974.

Knapp, S. C., "Overall Design Philosophy and Trends in Army Helmet Head Protection Design", published in Proceedings of ASCC Working Party 61, Auckland, New Zealand, September 1974.

Haley, J. L., "Research on Helmet Test Methods, published in Proceedings of ASCC Working Party 61, Auckland, New Zealand, September 1974.

Item by item evaluation of ANSI Z90.1 helmet standard is demonstrating that current test and design criteria are in need of change. Frictional forces, which occur during deformation of the helmet, are receiving particular attention.

Contractual work has been completed with the Engineering School at Auburn University to develop a math model of the head-neck combination. A report is to be published on this completed work within this calendar year.

Criteria and design concepts are being validated for an ultra lightweight aviator's helmet with superior retention and crash attenuating characteristics. The standard "A" SPH-4 helmet has been reduced one-half pound in weight. These improvements are currently being detailed in a USAARL report.

A new data retrieval system, designed to eliminate laborious hand calculations and potential errors, is under development. Raw data from approximately 2,000 helmet drops has been translated for computer usage. Future plans are to record and store helmet drop test data in the computer at the time of the test. Computer output will include: peak G; time duration at specified G load; area under acceleration-time curve (velocity change), and two different human injury severity indices.

A new, more convenient, and advanced drop tower is under construction. It is planned for operation on or before December 1975. Data from the new tower is to be translated directly to computer storage.

At the request of the Defense Procurement Service Coordination Agency (DPSC), an additional evaluation of a new SPH-4 helmet producer was done. The results of this evaluation are currently being recorded in a USAARL report.

A helmet center-of-gravity device was borrowed from the US Navy and utilized to compare various helmet c.g. locations. Current plans are to construct an improved c.g. device.

Form-fit helmets, procured for use by cobra pilots with helmet mounted gunsights, were evaluated and improvements were recommended.

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 mathematical model developed by Takata for USAARL would not predict with reliable accuracy the known results of experimental burns. The reasons for this failure have been investigated and identified. The Takata model was based on the earliest USAARL experimental data available and subject to the greatest error. No correction was made for tissue distortion during long or severe thermal exposure. No attempt was made to correlate heat flux data to experimental biologic data. The model was not optimized or tuned using all the USAARL data. The computer codes suffer from internal errors and need extensive revamping.

All data collection is complete and represents the largest single repository of controlled porcine flame burn data available. In order

that the maximum utility is achieved from these data, a research effort at Louisiana State University entitled Predictability of Burn Depth. Data Analysis and Mathematical Modeling Based on USAARL's Experimental Porcine Burn Data has been funded.

EVALUATION OF THERMAL PROTECTIVE CLOTHING TESTING METHODS

OBJECTIVE

Development of a military standard method utilizing state-of-the-art data collection and evaluation procedures for the evaluation of thermal protective clothing systems.

BACKGROUND

Current textile and clothing flammability testing methodologies do not adequately test the completed clothing ensemble. While a number of test methods for small pieces of fabric are available and while ensembles have been "tested" by dragging them through a fire pit, no standard method has adequately integrated the principles of textile testing with known biological effects of burns.

METHODOLOGY

Phase I, a feasibility study of fire simulation in a furnace-like container has been completed and a letter report prepared and accepted. In Phase II a study to establish the correlation between physical thermal sensors and tissue damage (burns) has been prepared and accepted. In Phase II the pig was used as a bioassay substrate against which to calibrate the performance of the sensors. A mathematical burn model will be developed to quantitatively predict the severity of burns from sensor output. Based on the analysis report in Phase I and laboratory constraints a thermal source will be designed, built and evaluated. The final burn model will be used to evaluate the temperature and heat flux data from an instrumented helicopter fire. Predicted escape times associated with specific degrees of skin damage will be calculated.

STATUS

Phase I is complete although refinements and some redesign in the thermal source and shutter system are being explored to increase reproducibility of the burns. Phase II data collection and analysis is complete. Modeling of the biologic data continues.

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 bio-dynamically 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 crash-worthy 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 proto-type 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

Dynamic tests at the FAA's aeronautical center at Oklahoma City, OK in July and August, 1974 uncovered weak points in the floor attachment joints and the energy-absorbing cables; however, the basic concept appeared to be sound. Decelerative G force in the dummy torso was in most cases less than the floor input decelerative G, while existing unyielding seats always give higher torso G than floor input G due to "dynamic over-shoot" effects.

Due to a severe shortage of people in the laboratory it has not been possible to accomplish needed rework of the seat floor fittings to the present time; however, new components for the seats are currently being constructed. Additional dynamic tests are expected to be continued at the FAA's Oklahoma facility in the September - December 1975 time frame.

After completion of the FAA dynamic tests, an evaluation report will be prepared.

GENERAL AEROMEDICAL ENGINEERING AND SAFETY SUPPORT FUNCTION

OBJECTIVE

To provide a liaison, consultative, review and investigatory capacity to USAARL and other government agencies requesting bioengineering input into safety design. To provide direct aeronautical support, and to investigate, evaluate, monitor and advise on the dynamics of Army aircraft and related systems during flight and crash sequences as they relate to morbidity and mortality.

BACKGROUND

This branch is often asked to review material specifications for medical/physiological acceptance and to act in a consultative role to Army agencies (USAAAVS, TECOM, Test Board, AvLABS, etc.) These projects do not necessarily carry formal precis and are of short duration but of great importance to the total Army aviation program. Effective accident investigation, understanding of the medical and human factors aspects of accident injuries and fatalities and the in-flight evaluation of prototype aircraft sub-systems that have a physiologic man-machine interface is predicated on a knowledge of aeronautical engineering and extensive aviation experience.

METHODOLOGY

Investigation, evaluation and advice on man's physiologic response to his mechanical environment, e.g., impact, vibration and crash injury sequence. Conduct research and development programs; provide medical, physiological, and bioengineering evaluation and testing of Army aircraft systems and sub-systems. Conduct fundamental and applied research, development and evaluation of protective headgear. Investigate, evaluate and advise on the aerodynamics of fixed and rotary wing aircraft during flight and the crash sequence.

STATUS

USAARL's helmet evaluation facility is operational and has been designated a DOD helmet test facility. Evaluation of a prototype competitive CVC helmet for impact protection, comfort, center of mass and construction was accomplished. USAARL was designated lead laboratory for the military potential evaluation of the Yankee extraction system for the OV-1 aircraft. A test program is underway. Provides on call consultation to various accident investigation boards and safety schools.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA OE 6730	75 07 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
74 07 01	H Terminate	U	U	NA	NL	[X] YES [ ] NO	A. WORK UNIT

10. NO. CODES	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	61101A	3A161101A91C	00	284
b. CONTRIBUTING				
c. [illegible]	None			

11. TITLE (Precede with Security Classification Code)

(U) Operational Measures of In-Flight Performance (22)

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	75 06 30	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: NA 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 75	2.0	77
FISCAL YEAR CURRENT 76	0	0

19. RESPONSIBLE DOD ORGANIZATION

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SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

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21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Human Factors Engineering; (U) Military Aircraft; (U) Man-Machine Relations; (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 device capable of sampling and recording nineteen channels of continuous analog and digital information. This system will interface with existing field equipment to provide continuous acquisition of data on pilot and aircraft performance during flight. Projected areas of investigation include the determination of the effect of sleep deprivation induced fatigue on pilot performance, the effect of flight induced fatigue on aviator performance and the isolation of physiological indications of this degradation after prolonged flight. Investigations to determine the work load stress of various flight profiles currently employed by Army aviation will also be conducted and data pertaining to physiological and psychological limitations of efficient aviator performance will be obtained.

25. (U) 7407 - 7506. Progress has been reflected by completing data acquisition in two field research efforts. These efforts are entitled "Correlation of Biochemical, Physiological, and Psychological Parameters with In-Flight Performance During Extended Helicopter Flight" and "Aviator Performance During Low Light Levels." Currently, data analysis is underway, and some initial findings should be reported in the near future. The project will continue and is considered terminated only as a funding change.

[illegible] to contractors upon originator's approval

OPERATIONAL MEASURES OF IN-FLIGHT PERFORMANCE

OBJECTIVE

The objective of this project is the utilization of a system capable of simultaneously measuring and recording pilot and aircraft performance in the operational environment.

BACKGROUND

The simultaneous objective quantification of operational pilot and aircraft performance in rotary wing flying has seldom been done. An ability to do such quantification, however, would provide an efficient and effective means of assessing a wide range of variables which may affect aircraft performance and mission accomplishment. The range of variables which could be systematically studied with such quantification could include the various physiological and psychological states which the pilot brings with him to the flying situation, various aircraft configurations which affect involved aerodynamics, various display and control man-machine interfaces, a host of environmental factors which influence both man and machine, and the interactions of these variables. Very limited quantified information with regard to this range of variables is currently available. A few studies have investigated pilot performance for a given aircraft in a limited number of maneuvers, but lack data relating the measured performance to resultant aircraft performance. It is possible that relatively wide individual differences in operator performance in certain areas might be tolerated providing the aircraft does not exceed the limits of determined flight envelopes which must be maintained for safe and successful mission accomplishment. A small number of studies, for the most part, have been concerned with performance differences with a modified aircraft, for some limited number of maneuvers or the assessment of flight capabilities and limitations of aircraft performing given maneuvers. These represent the systematic study of only a few of the many variables which must be explored if maximum utilization of pilot and aircraft are to be realized. These studies have also relied on photographic techniques which inherently reduce flexibility and create certain problems in data reduction and analysis.

METHODOLOGY

The helicopter inflight monitoring system (HIMS) was used in two efforts under this work unit number. The first effort was entitled "Correlation of Biochemical, Physiological and Psychological Parameters with In-Flight Performance During Extended Helicopter Flight". In this effort six instructor pilots flew various missions for a five day period while sleeping only 4 hours per day. In addition to the performance measures provided by the HIMS system a number of biochemical, physiological and

psychological measures were acquired. These included catecholamines, blood components related to muscular fatigue, cholestrol, uric acid, EKGs, pupilometry, reaction time, rotary pursuit tracking, etc.

The second research effort in which the HIMS system was applied, involved a study entitled "Aviator Performance During Low Light Levels". In this study aviators performed a hover maneuver while levels of illumination were systematically decreased via neutral density filters. The results of this effort should indicate at what level of illumination the S/N ratio for the goggle becomes too small to provide adequate visual cues for flight control. Additionally, information will be gained concerning performance with the unaided eye at low levels of light.

STATUS

The analysis of data from both research efforts is underway. Some initial findings will be reported in the near future.

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