ANNUAL PROGRESS REPORT, 1 JULY 1973--30 JUNE 1974

Robert W. Bailey

Army Aeromedical Research Laboratory
Fort Rucker, Alabama

July 1974

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Annual Progress Report FY 74
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 studies of Army aviation and airborne operation medical problems, provide consultative services as appropriate to other elements of the Army; and perform research on sensory physiology relating to the effects of visual [illegible] stimuli, acceleration and deceleration, and other physical [illegible] the soldiers' military performance.

(109)

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ANNUAL PROGRESS REPORT

Fiscal Year 1974

Reports Control Symbol MEDDH-288(R1)

ARMY AVIATION MEDICINE
3A762758A 819 00

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

30 June 1974

U. S. ARMY AEROMEDICAL RESEARCH LABORATORY
Fort Rucker, Alabama 36360

U. S. ARMY AEROMEDICAL RESEARCH LABORATORY

MISSION

Conducts studies of Army aviation and airborne operation medical problems; provides consultative services as appropriate to other elements of the Army; and performs research on sensory physiology relating to the effects of visual and auditory stimuli, acceleration and deceleration, and other physical forces on the soldiers' military performance.

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Disclaimer

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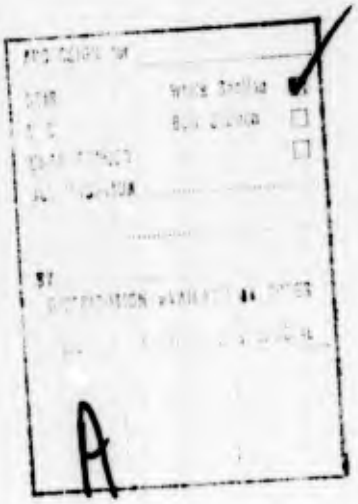

FOREWORD

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 accomplishments. A further opportunity is afforded by the cooperative research being accomplished by this activity and other laboratory groups such as the United States Army Aviation Test Board, US Army Agency for Aviation Safety (USAAAVS), Human Research Organizations 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 this 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.

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA OD 6737	74 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	8A. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
73 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	111
b. CONTRIBUTING				
c. [illegible]	CARDS 114(f)			

11. TITLE (Procede with Security Classification Code)

(U) Technical and Administrative Support to Army Aeromedical Research (01)

12. SCIENTIFIC AND TECHNOLOGICAL AREAS 050400 Administration and Management; 004600 Cost Effectiveness; 005100 Documentation and Information Technology

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
62 09	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 74	40	831
FISCAL YEAR — CURRENT 75	51	1,187

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Laboratory

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RESPONSIBLE INDIVIDUAL

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TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

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ADDRESS: Fort Rucker, Alabama 36360

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TELEPHONE: (205) 255-5107

SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS

NAME: Conselman, C. B., LTC

NAME: DA

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Procede 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. Procede 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.

25. (U) 73 07 - 74 06. An additional 14,830 square feet of floor space was acquired to be utilized by Aviation Medicine Research Division and Aviation Psychology Division. With the additional space, the laboratory has a total working area of 67,493 square feet.

*Available to contractors upon originator's approval

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE [illegible] AND 1498-1 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE [illegible]

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA OD 6734	74 07 01	DD DR&E(AN)636

3. DATE PREV SUMRY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8A. DISP'N INSTR'N	8B. SPECIFIC DATA - CONTRACTOR ACCESS	9. LEVEL OF SUM
73 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 11a(f)				

11. TITLE (Provide with Security Classification Code)

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

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001000 Aircraft; 006000 Escape Rescue and Survival; 013300 Protective Equipment

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

17. CONTRACT/GRANT

a. DATES/EFFECTIVE — EXPIRATION

b. NUMBER

c. TYPE: Not applicable — d. AMOUNT

e. KIND OF AWARD — f. CUM. AMT.

18. RESOURCES ESTIMATE

	PREVIOUS FY	a. PROFESSIONAL MAN-YRS	b. FUNDS (In Thousands)
FISCAL YEAR	74	5	35
	CURRENT FY		
	75	7	60

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Lab

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RESPONSIBLE INDIVIDUAL

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TELEPHONE: (205) 255-5107

GENERAL USE

20. PERFORMING ORGANIZATION

NAME: US Army Aeromedical Research Lab

ADDRESS: Bioengineering & Evaluation Div
Fort Rucker, AL 36360

PRINCIPAL INVESTIGATOR (Furnish SSAN of U.S. citizen investigator)

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SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS

NAME: Altekruse, E. B., LTC

NAME: Johnson, J. C. DA

21. KEYWORDS (Provide 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)

22. TECHNICAL OBJECTIVE 23. APPROACH 24. PROGRESS (Furnish individual paragraphs identified by number. Provide end 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) 73 07 - 74 06. Progress in this area is reflected by developments or reports in the following areas: dynamic electromyographic recordings, 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.

*Available to contractors upon originator's approval

2

DD FORM 1498

U.S. GPO 1974-540 583/8041

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 number 4 through 12.

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 deatns to determine their contribution to the total aircraft accident cost.

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 UH-1 type helicopter accidents has been compiled for FY's 69-73. Personnel costs are determined using figures published by DCSPER in DA Circulars.

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 of 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.

Publication of the following:

a. Crash Injury Economics: The Costs of Training and Maintaining an Army Aviator, Report No. 71-17, April 1971.

b. Crash Injury Economics: Injury and Death Costs in Army UH-1 Accidents in Fiscal Year 1969, Report No. 71-18 December 1971

Data base is continually being updated.

LIFE SUPPORT EQUIPMENT RETRIEVAL AND ANALYSIS PROGRAM AND LIFE SUPPORT EQUIPMENT EXHIBIT

OBJECTIVE

To perform a bioengineering analysis, evaluation and injury correlation of life support equipment that has been subjected to the 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. Change 3, AR 95-5, March 1972 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 could never be safely duplicated with human subjects.

METHODOLOGY

Change 3 to 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 is a coordinated USAARL-USAAAVS project. An exhibit of particularly interesting material is being used to demonstrate the life support equipment role in accident prevention as an educational function to student flight surgeons, aviators, and safety personnel.

A system analysis approach has been devised and methods of collecting, interpreting, and integrating data in useful formats are being explored. A continuing record of damage to life support equipment will be kept to ascertain possible trends in equipment failure. This will assist in supplying information for future modifications. Attempts to identify trends are resulting in a thorough investigation of present systems and equipment.

Identification of shortcomings of the Standard A SPH-4 Helmet through LSERP. Research confirmation in progress. Formal IPR for product improvement to be called in the summer of 1974.

Publication of the following:

a. USAARL Laboratory Report 73-16, Preliminary Evaluation of Portable Aviation Oxygen Systems, Jul 73.

b. USAARL LR 74-2-3-1, Evaluation of the Head Cooling System, Aug 73.

c. USAARL LR 74-25-3-4, Study of Lap Belt Installation in UH-1 Armored Seat, Mar 74.

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

e. The report of results from a head-to-head bioassay evaluation of numerous thermal protective garments is in final draft form.

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 healthy 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 into 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 would indicate that large troop deployments of the future will be made by aerial means. 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 operation deployment was completed and staffed at AMRDC in 1973. Readiness Command has accepted and implemented recommendations for improved troop comfort and convenience during deployments.

Publication of the following:

a. "Travel Stress", Audio Digest, Vol 21, No. 30, Aug 73.

b. "When The Grand Tour is a Grind", Emergency Medicine, Vol 6, No. 6, Jun 74, pp 90-98.

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 affects 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 in process.

The number of personnel necessary to test and record data for study participants is one-third that originally planned. Therefore the number of participants in the study at the present time is one-third the number required for a statistically significant analysis and the program will require about two or three times the originally estimated five months for completion.

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 in regards to biomedical data systems makes it almost impossible for the research investigator to keep abreast of the best tools and techniques available to him or answer questions such as: What is 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 system require special skills for their application.

METHODOLOGY

Support and advice to 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 have special instrumentation requirements. Maintain computer index to 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 technique for the electronic acquisition and recording of dynamic electromyographic potentials of human and domestic swine muscle. Integration of a spectral dynamics impedance analyzer and shock spectrum analyzer for use in nondestructive life support equipment analysis in vibration experiments. Investigations of fundamental techniques to measure the mechanical impedance of anisometropic, viscoelastic structures, primarily in situ brain. Published USAARL LR 74-3-3-2, Shock Producing Device in Survival Training, Aug 73.

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	74 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. DISB'N INSTR'N	8a. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
73 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	107
b. CONTRIBUTING				
c. ~~CONTRIBUTING~~	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 74	16	529
	CURRENT 75	19	413

19. RESPONSIBLE DOD ORGANIZATION
NAME: US Army Aeromedical Research Laboratory
ADDRESS: Fort Rucker, Alabama 36360
RESPONSIBLE INDIVIDUAL
NAME: Bailey, Robert W., COL, CDR
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION
NAME: US Army Aeromedical Research Lab
Aviation Medicine Research Division
ADDRESS: Fort Rucker, Alabama 36360
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NAME: Schane, W. P., COL
TELEPHONE: (205) 255-5114
SOCIAL SECURITY ACCOUNT NUMBER
ASSOCIATE INVESTIGATORS
NAME: Pettyjohn, F., LTC
NAME: Anderson, D., CPT DA

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) 73 07 - 74 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 chromatograph/mass spectrometer was acquired to evaluate biological materials for stress-related biochemical changes; (6) Ortho-Hydroxyhippuric acid was evaluated as a biochemical indicator of chronic psychological stress.

*Available to contractors upon originator's approval

DD FORM 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 D' TAIL 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 which influence the health of the aviator.

BACKGROUND, METHODOLOGY, STATUS:

Statements concerning the above for this area of research can be found on the following pages numbered 15 through 29.

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 Vietnam 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.

The first conference on US Army Aeromedical Evacuation was held at the US Army Aeromedical Research Laboratory January 15-16, 1974. This conference brought together the operational user with the research/developer in an open forum discussion. A USAARL report review of the conference will be available in the near future.

THE EVALUATION OF PORTABLE RESUSCITATOR/VENTILATOR FOR USE IN AEROMEDICAL EVACUATION

OBJECTIVE

The requirement for a fully portable resuscitator/ventilator remains a primary need in helicopter aeromedical evacuation. Simplicity of operation and reliability under the wide range of US Army operational commitments impose severe design requirements.

BACKGROUND

NATO nations are presently utilizing the Drager Portable Ventilator. No data is available on its functions at altitude and extreme environmental conditions.

Additional developments in portable hand-operated ventilators require evaluation under conditions of decreased pressure and temperature extremes prior to use in helicopter operations.

METHODOLOGY

Operational evaluation will be conducted in-flight and in the low pressure chamber facility. Evaluation of function will include pressure levels, inspiratory/expiratory valve function, flow, and oxygen percent delivered.

STATUS

Evaluation protocols are being prepared. In vitro measuring equipment is being assembled. Data collection will be initiated as measuring equipment becomes available.

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 irexpensive 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 chambers 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.

INDIRECT AND DIRECT MONITORING OF BLOOD PRESSURE DURING AEROMEDICAL EVACUATION

OBJECTIVE

Physiologic monitoring during aeromedical evacuation of critical patients is a primary requirement in providing intensive medical care. There is at present no satisfactory noninvasive technique of monitoring the parameter of blood pressure in the helicopter noise/vibration environment.

BACKGROUND

The routine use of Korotkoff sound determinations for blood pressure measurement in a helicopter has been proven to be unsatisfactory. Application of ultrasound principles to the measurement of flow/pressure appears to offer the most usable device.

METHODOLOGY

Development of updated ultrasound device fully compatible witn the helicopter environment is ongoing. Determination and monitoring of blood pressure by a sound, visual, or flow projection is to be evaluated. Accuracy of these determinations of blood pressure and/or flow parameters is to be assessed.

Helicopter/equipment interface as to electromagnetic radiation interference will be assessed.

STATUS

Available "off the shelf" ultrasound devices have been procured. In-flight testing of feasible models is ongoing. Attempts to improve an ultrasound device to simplify application to any portion of the vascular system is under evaluation. Improvements in electromagnetic interference shielding are under investigation.

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 are in procurement at present.

Future research efforts will concentrate 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 quantitate 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 at this time. Complete results will be published as a lab report FY 75. 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 (CL_2 and CO probably due to high rapid heats in the ignition cone. 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 homogenates 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 absorbancy 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. The results of this study will be published in the outside literature and in a USAARL report.

CHANGES IN PLASMA PHOSPHOLIPID CONCENTRATIONS RESULTING FROM CUMULATIVE FATIGUE

OBJECTIVE

To deterimine 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 vaporization programming with both urine and plasma. If the complexity of separation precludes direct analysis, only dialysis will be used initially to fractionate the specimen. This prevents molecular fracture prior to MS analysis; 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 probe 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 ($\geq$2 sec/0-800 amu) and high resolution low speed ($\geq$60 sec/0-800 amu) scanning. Software under development will allow elemental composition calculation with very low resolution (<2000) and short scan times (<20 sec/0-800 amu).

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 vacumn 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 vacumn 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) Vacumn 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 hospitals, 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^{0}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. Further evaluation of OHH with low level fliers and sleep deprivation studies in FY 75 will provide more background information on OHH metabolism and its relation to stress.

BIOCHEMICAL CHANGES IN PLASMA RESULTING FROM CUMULATIVE FATIQUE

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 judgement 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.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA 0D 6733	74 07 01	DD-DRA&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY S TY	6. WORK SECURITY	7. REGRADING	8a. INSTR INSTRN	8b. SPECIFIC DATA FOR CONTRACTOR ACCESS	9. LEVEL OF SUM
73 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 (Use 00 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. NUMBER: Not applicable
b. TYPE:
c. KIND OF AWARD:
d. EFFECTIVE:
e. EXPIRATION:
f. AMOUNT:
g. CUM AMT:

18. RESOURCES ESTIMATE	FISCAL YEAR	A. PROFESSIONAL MAN YRS	B. MANDAYS
	74	3	68
	75	9	271

19. RESPONSIBLE DOD ORGANIZATION

a. NAME: US Army Aeromedical Research Laboratory
b. ADDRESS: Fort Rucker, Alabama 36360

RESPONSIBLE INDIVIDUAL
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TELEPHONE: (205) 255-5107

21. GENERAL USE

Foreign Intelligence Considered

20. PERFORMING ORGANIZATION

a. NAME: US Army Aeromedical Research Lab
Bio-Optics Division
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PRINCIPAL INVESTIGATOR
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SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS
NAME: Glick, D.D., MAJ
NAME: Wiley, R.W., MAJ DA

22. KEYWORDS (Include P.A. Nbr with Security Classification Code)

(U) Aircraft; (U) Pharmacology; (U) Human Factors Engineering; (U) Protective Equipment; (U) Man-Machine Relations; (U) Human Volunteers; (U) Psycho; (U) Optics; (U) Stress Physiology; (U) Bioengineering; (U) Personnel Selection (Medical); (U) Weapon Effects

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) 73 07 - 74 06. Accomplishment has been shown by USAARL Report No. 74-10 describing the feasibility of soft (hydrophilic) contact lenses worn in an aviation environment. Progress in this area is reflected in the acquisition of visual performance data from aviator subjects while using a stabilized viewing device for aerial observation. Data have been acquired on the effect of the AN/PVS-5 night vision goggles on selected visual parameters, and several modifications (yoked focusing, astigmatic outsert correction, bifocal addition) have been designed for the goggles. Instrumentation has been constructed to examine stereopsis and depth perception with restricted viewing conditions. Data have been acquired on color vision deficient aviator correlating laboratory and field testing techniques. A study directed toward the elimination of interfering reflections in the aircrew station has been initiated. Several in-flight studies on main rotor, tail rotor, and propeller blade paint schemes to enhance blade and aircraft conspicuity have been completed. A high visibility marking scheme for the SPH-4 helmet has been developed. Light transmission characteristics through a helicopter windscreen at various angle of inclination have been determined. Personnel have participated in numerous cockpit lighting, windscreen design, and related workshops. A major contribution has been provided in developing the final performance specification for the Aircraft Anti-collision Beacon System, High Intensity Light.

*Available from contributing organizations upon justification received.

DD FORM 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. U.S. GPO 1973 540-841-8091

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 32 through 44.

RECOMMENDATIONS:

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

COLOR VISION TESTING

OBJECTIVE

The objective of this joint investigation with the Fort Rucker Aeromedical Activity is to correlate the results of laboratory color vision tests with in-flight color vision testing.

BACKGROUND

There has always been a small percentage of aviator trainee applicants, deficient in color vision, who complete their pre-flight physicals undetected. The defect is then found, usually on an annual physical, but only after extensive flight training has been completed. The Aeromedical Activity personnel must then decide if the deficiency is severe enough to ground the individual or if he may be granted a waiver. The aviator is currently required to pass a field test consisting of colored smoke and colored light signals. If he passes, he is granted a waiver and continues flying.

METHODOLOGY

The patients are given six color vision tests including: the American Optical, Hardy, Rand and Rittler (AO/HRR); Dvorine pseudoisochromatic plates; Nagel anomaloscope; color threshold tester (CTT); the Farnsworth lantern (FALANT); and the new Lovibond Colour Vision Analyzer. The results of each test are correlated with the individual's performance during the field study.

STATUS

A preliminary report was given at the Aerospace Medical Association Meeting. A final report will be published when a sufficient number of subjects have been seen.

VISION SURVEYS

OBJECTIVES

The first objective is to obtain cross sectional data of several visual parameters of U.S. Army personnel. A second objective is to develop a data bank of longitudinal visual changes on Army aviators.

BACKGROUND

The laboratory has been asked to provide refractive, ocular motility, and other limitations for use in designing Army optical equipment. To date, there are no data available on the Army population's refractive errors and heterophorias.

We are also interested in determining if the aviation environment produces unusual effects on the visual system. Since aviators take annual physical exams, these data can be extracted on the same individual year after year and the changes noted.

METHODOLOGY

For the cross sectional study, a questionnaire will be sent to all Army optometry clinics. It has been designed for ease and rapidity of completion at the clinic level and also for direct entry into the computer upon return to this laboratory.

The longitudinal study currently consists of extracting data from the aviator physical examination forms. However, with the computer interfacing capabilities of examining equipment soon becoming available, the data will be incorporated on line.

STATUS

Coordination with the Army Optometric Consultant to the Surgeon General has been completed and requests for the clinics are being prepared.

NOCTURNAL MYOPIA AMONG AVIATORS

OBJECTIVE

The objective of this study is to determine the prevalence and magnitude of nocturnal myopia among an aviator population and to develop a procedure by which nocturnal myopia can be measured clinically.

BACKGROUND

The phenomenon of nocturnal myopia, an apparent increase in the refractive power of the eye resulting in a myopic condition under dim illumination, has been well documented for many years. Unfortunately, the results of the many studies relating to nocturnal myopia have not been in agreement so there is still no generally accepted explanation of the underlying cause(s) of the phenomenon. Although there is much individual variation, the magnitude of nocturnal myopia reportedly ranges between 0.50 and 3.00 diopters.

Of practical significance to the military aviator is the considerable deterioration in visual acuity caused by the myopic shift in refractive power. Since night aviation operations are becoming increasingly emphasized, the refractive posture of the eye in reduced light levels becomes an important consideration. Previous studies have sought to determine the underlying cause(s) and have not yielded an acceptable technique for routinely measuring nocturnal myopia in a clinical mileau.

METHODOLOGY

This investigation will utilize a laser refraction technique which has been developed and used with some success to replace more conventional refraction techniques. Since it is felt that the aviator population is a visually exceptional group, and therefore might demonstrate a magnitude of nocturnal myopia different from that reported on more general subject groups, all observers will be rated aviators.

STATUS

This project has been temporarily suspended due to the transfer of the principal investigator. To date, twenty-eight (28) rated aviators have been examined utilizing the laser refraction technique. The preliminary results are promising,and the project will be resumed when personnel availability allows.

STEREOPSIS AND DEPTH PERCEPTION TESTING AND STANDARDS IN ARMY AVIATION

OBJECTIVE

The objectives of this investigation are to develop a clinically valid instrument to measure central stereopsis and spatial orientation based uponperipheral retinal stimulation and to determine if the parameters of exposure duration and retinal illuminance have a significantly differential effect on depth perception within an aviator subject population. If these latter parameters are found to have a highly variable effect among different aviators, acceptance standards should be established to identify those aviators who possibly should be restricted from flying under certain conditions.

BACKGROUND

Previously published investigations have demonstrated that the present methods of testing stereopsis as prescribed in AR 40-501 have sufficient deficiencies to yield spurious data limiting the validity of their results. Several technical reports have indicated that monocular cues for depth are probably more important than judgements based upon stereopsis for the aviator. No method is now available to examine aviators' spatial orientation based upon peripheral retinal information. Informal reports have indicated that depth perception among aviators is highly variable during mesopic luminance conditions. Yet, techniques for evaluating retinal illuminance effects are not available.

METHODOLOGY

Psychophysical information will be obtained from aviator subjects. Stereopsis and spatial orientation information will be obtained from specially-designed alignment and measuring instruments under restricted viewing conditions, controlled retinal illuminance levels, and various observation periods. Additional visual information will be recorded from each subject for inclusion in the analysis of the data.

STATUS

The experimental design has been completed, and construction of the instruments is almost completed. Data acquisition will begin very soon.

AIRCRAFT CONSPICUITY

OBJECTIVE

The objective of this investigation is to improve aircraft conspicuity to reduce accidental man-blade contact with tail rotor and propeller blades, and to increase air-to-air visibility to reduce mid-air collisions.

BACKGROUND

Aircraft conspicuity is an important parameter in air and ground collision avoidance, especially in high density operations. During the past several years, this Laboratory has been engaged in developing techniques and designs and testing materials to improve the visibility of aircraft.

METHODOLOGY

Following laboratory pilot investigations, field studies are conducted to evaluate techniques for improving aircraft conspicuity. These involve exterior aircraft markings utilizing high reflection paints and/or tapes and high intensity lights. Observer forced-choice procedures are used to evaluate various conspicuity schemes, and periodic measurements are made to test the durability of lighting assemblies, paints, and tapes.

STATUS

Based upon minor modifications of the USAARL studies, a high visibility paint scheme for propellers and rotor blades has been submitted for international standardization. The U.S. Army Aviation Systems Command has published proposed changes to TB 746-93-2 to incorporate the new painting scheme based upon USAARL recommendations.

A major purchase effort is being made by the U.S. Army Aviation Systems Command to equip all Army aircraft with a high intensity xenon lighting system which will provide separate day and night levels for anticollision purposes. This Laboratory has provided major testing and consultative input for the Aircraft Anti-collision Beacon System, High Intensity Light (AABSHIL). The Bio-Optics Division has accepted the responsibility for being the photometric qualifying laboratory for competing prototype systems.

SOFT (HYDROPHILIC) CONTACT LENSES IN U.S. ARMY AVIATION

OBJECTIVE

The objective of this study was to evaluate the efficacy of fitting one type of hydrophilic contact lens to be worn by personnel working in an aviation environment.

BACKGROUND

The advantages of contact lenses in lieu of regular spectacles in the military environment are numerous, particularly in aviation. If an adequate contact lens could be found, aviators requiring corrective lenses would benefit in such ways as: improved visual performance in inclement weather, elimination of interfering spectacle reflections, improved performance when using optical equipment such as sighting devices, instant compatibility with gas mask, increased visual field, improved visual acuity in specific cases, improved acoustic protection and increased comfort with the elimination of spectacle temples when wearing a helmet.

Unfortunately, the use of standard PMMA or "hard" contact lenses has been relatively unsuccessful in the military aviation environment, particularly when worn by personnel flying rotary-wing aircraft. The more recently developed hydrophilic lens reportedly obviates some of the probblems experienced with the "hard" lens. However, previous investigations have been restricted to controlled civilian environments, and no data have been available from personnel wearing the soft lenses in an aviation environment.

This investigation evaluated the physiological and environmental differences of the soft contact lens compared to the known unacceptable features of the "hard" lens.

METHODOLOGY

This study was designed specifically to provide information in three areas and was thus divided into three phases. Phase I dealt with the clinical aspects of the lenses. Phase II was concerned with the incidence of foreign body involvement, since this is considered to be a prime factor contraindicating the use of "hard" contact lenses in aviation. Phase III was designed to provide information about continuous wear for an extended period. The rationale for this portion of the investigation lies in the mission requirements frequently encountered in a combat situation. Due to these requirements, the aviator is often unable to achieve sufficient rest which can have an adverse affect on the wearing of "hard" lenses. The time frame defining extended operations is based upon physiological and psychological limits of the individual. It is

assumed that if the lenses can be worn continuously with reasonable comfort for a 72-hour period, they adequately fulfill the operational requirement.

Nineteen U.S. Army rotary-wing aviators were selected to be fitted with the hydrophilic lenses. Each was required to fly a minimum of fifteen hours per month. Standard fitting techniques and clinical examination procedures were used to evaluate the lenses and the eyes. The subjects were carefully instructed on the care of the lenses and the specific wearing schedule to follow. Each subject returned to the Laboratory at pre-determined times to be examined and to complete a questionnaire.

STATUS

The results of this study have been published in USAARL Report NO. 74-10. The hydrophilic lens offered some advantages over conventional PMMA lenses for the specialized application in an aviation environment. However, there were distinct problems encountered which may be lessened with the introduction of new lens materials and asepticizing techniques.

At the time of this investigation, the Food and Drug Administration had only approved one hydrophilic lens. Recently, however, another lens material has been approved, and it is anticipated that many more will be released for use in the immediate future. Because of the possible significant advantages of utilizing hydrophilic lenses to correct ametropia, additional studies of similar design will be conducted as these new lens materials become available.

NIGHT VISION GOGGLE (AN/PVS-5)

OBJECTIVES

1. A phenomenon entitled "brown eye syndrome" had been reported following use of the night vision goggle (NVG). One objective was to provide an explanation for this and to measure its effect, if any, on color vision.

2. A second objective was to quantify the reduction in the level of dark adaptation following use of the NVG and to measure recovery time to the dark adapted state following removal of the NVG.

3. A third objective was to correlate pilot performance with known amounts of moonlight and starlight and to determine the light level below which the goggles would not be effective for aviation use.

4. Another objective was to more accurately determine the size of the bifocal segment, if any, needed in the NVG for maximum pilot performance at distance and near.

BACKGROUND

1. A flight surgeon at Ft Knox, KY received a report from two aviators that, following removal of the NVG, a brown afterimage persisted and they were concerned as to the permanency of this phenomenon and its effect upon their color vision.

2. The question was raised by the Low Level Night Operations Committee as to a pilot's capability to see at night if he was suddenly required to remove the NVG. The LLNO group requested our laboratory to evaluate same.

3. There were very little hard data in existence as to how much a pilot's performance was improved and at what light levels with the NVG. The laboratory, at the request of the Low Level Night Operations Committee, undertook the task of this performance evaluation.

METHODOLOGY

1. Five subjects used the NVG for periods of 30 minutes to one hour to insure their adaptation to the light emitted by the goggles. The subjects were then given three laboratory color vision tests and the results compared with their performance prior to wearing the NVG. There was no change in any of the subjects' performance following wearing the NVG.

The color of the afterimage was explained through known physiological optics principles as being the compliment of the green color of the NVG emitted light.

2. Six subjects' dark adaptation curves were plotted to threshold by use of the Goldmann-Weekers dark adaptometer. They then wore the NVG for 5 minutes and the curves replotted to threshold.

3. Photometric measurements were made at several moon phases and at several moon angles relative to the horizon. Pilot performance was recorded simultaneously using the helicopter instrumented monitoring system (HIMS).

4. A 40 degree field simulator was made and various bifocal segment heights were tested statically to determine instrument panel visibility and exterior viewing capability. A 20 percent segment of the executive style (covers the entire width of the NVG tube) was recommended for inflight study and is currently being manufactured.

STABILIZED VIEWING DEVICES

OBJECTIVE

This is a joint Army-Navy investigation with a twofold objective. The first is to investigate reports of motion sickness while using the XM-76 monocular, gyrostabilized viewing device. We also are interested in establishing an experimental procedure to evaluate any viewing device designed for use in the air.

BACKGROUND

The U.S. Marine Corps reported that aviators were becoming motion sick while using the XM-76 in the OV-10 Bronco. The Naval Aeromedical Research Laboratory brought this out at a joint Army/Navy meeting.

The Army's scout helicopter scenario calls for increasing distances for target acquisition. This mission cannot be accomplished without magnification of the object. However, viewing a magnified object from a vibrating helicopter greatly degrades the image. Stabilization is required to obtain a usable image.

METHODOLOGY

A total of twenty-four observers, in groups of six, will be required to view a series of high contrast Landolt rings in each of three configurations. The targets are viewed first with the unaided eye then, on successive days, with a stabilized and an unstabilized XM-76. The order of the last two configurations is varied between subjects. Each observer is given five passes at the targets on a given day. Two passes are flown straight in, two are pop-up maneuvers, and one consits of "S" turns. The orientations of the Landolt rings are changed after each pass.

Each run is begun 8 to 9KM from the targets. The helicopter is flown within a radio-radio range which provides continuous location information.

The subjects are rated prior to, during, and following each flight. In addition they self rate with questionnaires following the flights.

Upon completion of the field series, each group is taken to the Naval Aeromedical Research Laboratory at Pensacola, Florida. They are accompanied by a USAARL optometrist, who determines visual acuities, refractive errors and visual history. They are then given a series of tests by the NAMRL investigators in order to determine their susceptibility to motion sickness.

STATUS

Eighteen of the twenty-four subjects have completed the testing. The final results will be published in a Joint Army/Navy Report.

REDUCTION OF UNDESIRABLE LIGHT REFLECTIONS WITHIN THE CREWSTATIONS OF ARMY AIRCRAFT

OBJECTIVE

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^{R} 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-reflection coatings as a means of reducing reflections, at least when dealing with external reflections.

It is anticipated that this study will be the beginning of a long-term project in which what is learned on the aircraft used in this study will later be applied to all Army aircraft.

METHODOLOGY

This study will progress in the following order:

1. A laboratory evaluation will be 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 will be measured at angles of 0, 15, 30, 45, 60, and 75 degrees.

2. Small portions of the aircraft interior will be coated with a low reflectance substance and any reduction in reflection from the part of the windscreen will be measured. This will be accomplished by photographing the relevant portion of the windscreen before and after the application of the low reflectance material and then measuring the difference by densitometry.

3. The entire crewstations of the LOH-58 and UH-1 will be changed to low-reflectance configurations and the amount of reduction of unwanted reflection will be established by photography and subsequent densitometry. Consideration will be given to both daytime and nighttime aspects of this problem.

STATUS

Phase 1 has been completed and Phase 2 is in progress.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DA OD 6739	74 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. DISB'N INSTR'N	8a. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
73 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	119
b. CONTRIBUTING				
c. ~~/////////~~	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
60 07	Cont	DA	C. In-House

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

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 74	8	90
	CURRENT 75	14	565

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SOCIAL SECURITY ACCOUNT NUMBER
ASSOCIATE INVESTIGATORS
NAME: Mozo, Ben T.
NAME: Patterson, James H., SPT, 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; (U) Weapon Effects; (U) Acoustic Detection; (U) Electronic Engineering; (U) Communications; (U) Information Theory; (U) Radio Communications.

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

23. (U) To 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 de-
scriptions at the generators or sources as well as descriptions of subsequent
changes that may be precipitated by various propogating media. The second ap-
proach will involve studying the effects of these sounds on human receivers.
Both approaches will employ valid research practices.

25. (U) 73 07 - 74 06. Progress in this area is reflected by reports on the following
topics: 1) Sonic Ear Valvs (Models I, II and IV); 2) Willson Sound Defender
with Communication Equipment: 3) Premier 555 Cycle Helmet with Sonic Valv;
4) David Clark Communication Headset - FSN 5965+563-4750; 5) David Clark Com-
munication Headset - FSN 5965-234+0219; 6) Telephonic Communication Headset -
FSN 5965-823-4871; 7) Split V-51R Earplugs: 8) Gentex DH-167 Circumaural Com-
munication Headset; 9) Bilsom Propp. Foam-Filled Circumaural Hearing Protec-
tor; 10) Bilsom Propp. Fluid-Filled Circumaural Hearing Protector; 11) Con
Edison (Hard Hat with Willson Fluid-Filled Muff); and 12) General Electric
Silent Partner. Also three reports on the Quality Control Tests of Real-Ear
Sound Attenuation Characteristics of SPH-4 Protective Helmets; and fourteen
reports on the Quality Control Tests of Real-Ear Sound Attenuation Charac-
teristics of DH-132 Helmets manufactured by Gentex Corporation.

*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 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 47 through 53.

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 miltiple-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 for subsequent application to the military communication systems in Army aircraft.

STATUS

A new method for the testing of the near-field linearity and the far-field cancellation characteristics of noise cancelling microphones is being developed. The new generation noise cancelling microphones - the bimorph and electret - are presently being tested with this method. Tests of experimental systems and microphones are in progress for the construction and tests of new generation systems. These will be tested in a variety of applications. The systems will be smaller in size and more durable for field environments.

ACOUSTICAL ENVIRONMENT OF U. S. ARMY AVIATION PERSONNEL

OBJECTIVE

The objectives of this work are to determine noise spectra of the various environments in which U. S. 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 U. S. 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

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

In anticipation of a change of the standard method for testing real-ear attenuation, plans are in progress for the purchase of a reverberation chamber. Sixteen reports on the quality control tests of the real-ear sound attenuation characteristics of helmets have been completed. The real-ear sound attenuation characteristics of twelve hearing protective devices have also been completed.

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 ameliorization of the automatic audiometric testing conditions in U. S. 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 U. S. 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 U. S. 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 ameliorization of audiometer calibration and audiometry in the U. S. 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 significant, 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 environments of audiometric testing facilities in the Army will be investigated.

STATUS

An augmented audiometric branch is being planned which is to do various research probjects for the Army. An audiologist has been assigned to USAARL. New improved audiometers have been added to the laboratory.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1 AGENCY ACCESSION	2 DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA OD 6738	74 07 01	DD DR&E(AR)636

3 DATE PREV SUMRY	4 KIND OF SUMMARY	5 SUMMARY SCTY	6 WORK SECURITY	7 REGRADING	8a ORGN INSTR'N	8b SPECIFIC DATA - CONTRACTOR ACCESS	9 LEVEL OF SUM
73 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. ///////////	CARDS (114F)			

11 TITLE (Provide 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; 015400 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. DATE/EFFECTIVE — EXPIRATION

b. NUMBER — Not Applicable

c. TYPE — d. AMOUNT

e. KIND OF AWARD — f. CUM. AMT

18 RESOURCES ESTIMATE	PRECEDING	CURRENT	a. PROFESSIONAL MAN YRS	b. FUNDS (In Thousands)
FISCAL YEAR	74	75	11.3 13.5	275 512

19 RESPONSIBLE DOD ORGANIZATION

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21 GENERAL USE

Foreign Intelligence Considered

20 PERFORMING ORGANIZATION

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SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS

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22 KEYWORDS (Provide 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) 73 09 - 74 06 Progress has been reflected by the publication of USAARL Reports Nos. 71-2, Army Autorotational Accidents Fiscal Years 70-73; 74-7, Aviator Visual Performance in the UH-1H-Study I; 74-8, Instrument Flight Preference and Field Dependence; 74-9, Static Evaluation of Absolute Altimeter Display Designs. Inputs were made to the following projects/programs: UTTAS; ASH; HLH; SERVAL; LLNO; Medivac ROC; Ali-IQ; and a number of military standards and specifications. At various stages of completion are research efforts involving: Personality and pilot error accidents; Decision making under conditions of risk among aviators; Aviator mission preference as related to personality characteristics; Communication at low levels; Perception of hazard by Army aviators; Perceived velocity as a function of altitude and visual environment; Aviator performance Day/Night, Aid/Unaided, during NOE and low level flight: Perceptual cues used for flight control.

*Available to contractors upon originator's approval

54

DD FORM 1498 1 MAR 68 — PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE AND 498-1 1 MAR 68 FOR ARMY USE ARE OBSOLETE

* U.S. GPO: 1974 540-843/6091

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 number 56 through 82.

RECOMMENDATIONS:

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

AVIATOR VISUAL PERFORMANCE IN THE UH-1H
STUDY I

OBJECTIVE

The objectives of this research effort were twofold. The first objective was to measure the visual use (% time, dwell time, transition data) for various areas of the windscreen during flight maneuvers under visual flight rules in the UH-1H helicopter. The second objective was to compare these measures with subjective estimates made about the percentage of time these areas were used.

BACKGROUND

Though the visual sensory modality is considered, almost without exception, to be highly critical to helicopter flying few research efforts have been directed at measuring where the pilot looks during VFR rotary wing flight. Such information and how it is affected by flight envelopes, tactics, environmental variables, displays, etc., is essential if accurate judgments are to be made concerning vision and its use.

METHOD

The visual performance of 6 Army aviators was monitored using a corneal reflection method and recorded on video tape. These tapes were later scored via ground based electronic processing equipment. Maneuvers flown were: lift-off to stabilized hover; forward hover; rearward hover; hover turn left (90^{o} and 360^{o}), hover turn right (90^{o} and 360^{o}); normal takeoff and approach to hover (left pattern); normal takeoff and landing right pattern. After a period of three weeks, the same aviators were asked to estimate the percentage of time they used each area of the windscreen for the maneuvers they had flown. Again, in three weeks each aviator flew all maneuvers again and immediately upon completion estimated the percentage of time they used each area.

STATUS

The results of this investigation have been published in USAARL Report No. 74-7 entitled, "Aviator Visual Performance in the UH-1H - Study I."

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 disproportionant 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

The analyses have been performed and it was found that 86% of the aviators tested could be correctly classified as to their pilot error accident involvement by using the personality scores as predictor variables.

A draft has been written on all sections of the investigation.

Current efforts concern final revisions and the drawing of figures and graphs.

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.

VISUAL PERFORMANCE DURING DAY NOE AND LOW LEVEL FLIGHT

OBJECTIVE

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

BACKGROUND

When flying nap-of-the-earth 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, up to the present, little research has been attempted 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 NOE and low level flight.

METHODOLOGY

Subjects will be six Army aviators. Visual performance will be measured using an Eye Mark Recorder linked to a video recording system. 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 video tapes 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

Data is presently being collected on the six aviators.

AVIATOR MISSION PREFERENCE AS RELATED TO 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.

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.

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 will be published shortly.

INSTRUMENT FLIGHT PREFERENCE AND FIELD DEPENDENCE

OBJECTIVE

The objective is to investigate group differences in the mode of perception of IFR qualified aviators who like and dislike IFR flight.

BACKGROUND

There exists data to support that people vary to some degree in their perception of the world. One of the perceptual areas in which persons differ is in their ability to recognize and separate an item from the field which surrounds it. Some have termed this ability field independency. It has been demonstrated that an individual's mode of perception can be discriminated along a continuum of field dependence-field independence with the Embedded Figures Test and the Rod and Frame Test.

The principal difference between Visual Flight Rules (VFR) flight and Instrument Flight Rules (IFR) flight is that the latter must be performed independent of a real world visual ground or horizon reference. It is possible that the perceptual processes required for IFR flight can be placed on a continuum, because persons flying IFR must perceive and manipulate an aircraft without regard to the background by which it is surrounded. It is commonly accepted that aviators vary with respect to their aptitude, ability, and skill in performing IFR flight and it is possible that the above variables may be dependent in part upon perceptual differences in a person's field dependent-independent mode of perception as ascertained by the Rod and Frame Test and a modified Hidden Figures Test.

METHODOLOGY

The subjects will be 43 instrument rated Army aviators. They will be assigned to one of two groups on the basis of their stated preference for actual instrument flight.

These groups will then be tested by way of the Rod and Frame Test and the modified Hidden Figures Test. The results of these tests will be analyzed to ascertain if these groups can be considered different on mode of perception as measured by the tests.

STATUS

The results of this investigation have been published in USAARL Report No. 74-8 entitled, "Instrument Flight Preference and Field Dependence."

PERCEPTION OF HAZARD BY ARMY AVIATORS

OBJECTIVE

The purpose of this study is to investigate the possibility of important differences in the way aviators and safety experts view the hazard associated with various aspects of aviation-related activities and that such differences, if signficant, can be used to identify areas of flying safety in need of additional or changed emphasis.

BACKGROUND

For many years aviation-oriented people have been actively working toward the reduction of aviation accidents through prevention. The Army's aircraft accident rate has been reduced from 32.07 accidents per 100,000 flying hours in 1963 to 11.95 in 1972 (Ricketson, 1973). During the whole period, about 83% of the accidents have involved or been attributed to errors in human judgement.(ibid.) Still the rate is higher than desirable and any efforts toward further reduction would directly benefit the Army in terms of savings in injury to personnel and damage to materiel.

It has been determined that a further reduction of personnel error type accidents may be possible by examining the perception of hazard potential by aviators. That is to say: Are there hazardous situations which arise in the aviation environment that are not perceived by aviation personnel as being particularly hazardous? If the answer is affirmative, it might be possible to determine such situations and to subsequently orient aviator education and accident prevention efforts to stress such areas before they result or become contributing factors in accidents.

METHODOLOGY

This project calls for an inventory consisting of a large number of situations typical of aviation operations involving various degrees of potential hazard (danger). Aviators and safety personnel will be asked to indicate the degree of danger they perceive to be associated with the individual situations or activities. Subsequent analysis will examine the extent to which the two groups agree or disagree on respective items. Significant disagreement will be used to identify areas in need of further training emphasis.

STATUS

An inventory of aviation-related situations has been developed and will shortly be submitted to a small group of pilots for informal validation.

PERCEPTUAL-MOTOR FACTORS IN STRESS-RESISTANT HELICOPTER DISPLAY-CONTROL SYSTEMS II. INSTRUMENT CUED AUTOROTATIONAL LANDINGS

OBJECTIVE

Determine the effects on autorotational landing performance of cueing control actions from absolute altitude, and absolute altitude plus rate in a differential tracking mode.

BACKGROUND

Autorotation is an essential maneuver for crew survival and aircraft recovery upon engine failure, but a substantial percentage of Army aircraft accidents involve unsuccessful performance of this maneuver during actual emergencies or training. Pilot errors are frequent due to the small range of tolerable error envelope in perceptual judgments and control actions for successful performance. Accurate perceptual judgment of the height to begin landing control actions is difficult under optimum conditions, and the stress of actual emergencies probably increases the error in this critical skill. At night, particularly when using night vision devices, the difficulty in making this height judgment is increased further. In instrument meteorological conditions it may be impossible. The Coast Guard, which uses a radar altitude cueing technique for initiating autorotation landings, has a very low autorotation accident rate. Army autorotational accidents have been analyzed and reported in USAARL Report No. 74-2.

METHODOLOGY

An instrumented helicopter will be used to measure autorotation landing performance using direct vision in daylight, landing lights at night, and using night vision goggles. Performance under these conditions will be compared with performance when control actions are cued from radar altimeter readings, and from a modified display with radar altitude rate added so that differential tracking of altitude by rate can be used to guide control application.

STATUS

Pilot familiarization with the night vision goggles has reached a level where exploration of autorotations can begin. A solution has been found to technical problems in operating recording equipment in the test helicopter during autorotations. Data acquisition has begun for some test conditions.

AVIATOR PERFORMANCE DURING NIGHT NOE AND LOW LEVEL FLIGHT

OBJECTIVE

The objective of this research is to obtain information concerning aviator performance and aircraft states during the conduct of night low level and NOE flight operations.

BACKGROUND

The introduction of the tactical concept of nap-of-the-earth flight has placed many demands on Army rotary wing aircrews. The task of navigating and flying to an objective while maintaining maximum concealment has become an operational necessity. Additionally, the need for a 24 hour tactical response capability requires this type of flight profile be performed during the night hours and under less than optimum weather conditions. The consequent effects of these night NOE operations on aviator and aircraft performance must be assessed in an effort to optimize decisions relative to their application.

METHODOLOGY

Six rotary wing aviators, all rated NOE instructor pilots will participate in this investigation. Each aviator will be required to fly day and night low level and NOE flights. After familiarization with the course during the daylight hours, continuous recordings of aircraft and pilot performance will be taken for three consecutive NOE and low level runs. This same procedure will be followed for each aviator for the night runs and performance differences between these two conditions will be assessed. Physiological parameters will also be recorded for all runs. These measures will include heart rate, EKG, and pre- and post-chemical anslyses of urine specimens for increased catecholamine output.

STATUS

Data on six aviators has been collected and is being submitted to analysis.

DECISION MAKING UNDER CONDITIONS OF RISK AMONG AVIATORS

OBJECTIVE

The purpose of this study is to investigate the performance of aviators under simulated conditions involving decision making and risk taking.

BACKGROUND

Although the studies of risk taking and decision making involve a number of variables, each would appear to concern one of two situations. Generally, the work of Cohen, Dearnaley, and Hansel (1958), characteristic of a number of studies, involves a risky situation that is basically static. Consequently, with the exception of shifts in the subject's ability, the various alternatives with their associated probabilities of success or failure do not change over time. The alternative approach is dynamic and has been used to simulate the driving or passing situation (DeKock, 1967).

The utilization of this non-static approach with aviators has been neglected in the past, but would appear to be meaningful for conducting studies concerning risk taking and decision making behavior among aviators.

METHODOLOGY

This project involved the construction and implementation of an apparatus designed to simulate a dynamic decision situation.

The apparatus consists of timers, counters, and indicator lights. The lights are designed to simulate the decision situation and the timers demonstrate the subject's rate of success. A response panel contains the subject switches. At the onset of a light (display panel), the subject will have to make a decision based upon the intensity of the light. He may either go, go-abort, or not-go, all of which of this design have different insights for payoff. The element of variability eliminates the static situation that has been repeated in other studies. Consequently, an element of risk is incorporated, based upon a time interval that changes.

This apparatus will provide information on decision making and risk taking performance among aviators. In the future, certain psychological and physiological variables might be utilized to show their effect on human performance under conditions of risk and decision making.

STATUS

A literature review concerning decision making and risk taking has been completed.

The display and response panels have been interfaced with the logic system.

A pilot study was conducted, followed by the testing of 51 aviators on the decision making task.

The data has been reduced and analyzed and a report will soon be published.

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 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. Also, 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.

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 then 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 in the application of the cueing technique in student flight training, with emphasis on essential aspects, advantages, and drawbacks. A tape record is being obtained of classroom and flight training and discussions, and film records 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

Classroom and flight training of one researcher based on the cueing concept has been accomplished, with audio tape recordings and film records obtained.

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 goggles 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

Data from six subjects has been collected and is being analyzed.

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.

PERCEPTUAL-MOTOR FACTORS IN STRESS RESISTANT HELICOPTER DISPLAY CONTROL SYSTEMS I. IPSILATERAL AND CONTRALATERAL DISPLAY-CONTROL RELATIONSHIPS

OBJECTIVE

The objective of this study is to determine the effects on reaction time/control bandwidth and control errors of ipsilateral/contralateral and compensatory/pursuit display-control relationship in a helicopter-like multichannel control task.

BACKGROUND

Conventional helicopter instrumentation appears to violate certain basic perceptual-motor relationships whose anatomical basis in humans derives from about the fish stage of evolutionary development. Violation of these deeply ingrained primordial perceptual-motor relationships may be expected to increase response times and errors, particularly in stressful situations where there is a tendency to revert to "natural" reactions in place of the cognitive constructs now required for instrument flight. Conventional helicopter instrumentation involves a lateral crossover between the instrument panel location of airspeed and altitude information and the hands used for controlling these parameters in demanding flight control regimes. Decisions will soon be necessary on whether to perpetuate this crossover in new electroptical displays, or whether to correct the display-control relationship to provide maximum performance and minimum errors. Data indicating the degree of performance improvements that might result do not exist.

METHODOLOGY

A set of helicopter controls and a TV-viewed display panel will be used to simulate the helicopter control task. Up to five channels of information will be presented, with increases in the number of channels and rates of change of displays being used to vary workload. The changes in displays will be presented in stepwise fashion in order to clearly define reaction time start points. The time to correct response and the incorrect responses will be recorded and analyzed to compare the tested display-control relationships and workloads in terms of reaction times, errors, and information throughput rates.

STATUS

The experimental approach and test conditions have been defined. Equipment modifications required for stimulus programming and driving have been identified and requested. Logic requirements for display driving and response recording have been defined, as have the data analyses to be used. Logic patchup has begun. Data collection should occur early in FY 75.

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 (IHMS). These data will be submitted to statistical analysis.

STATUS

Data for the six aviators has been collected and analyzed. A report on the outcome of this research is being written.

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 data analysis has started.

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 USAAVS 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.

AVIATOR PERFORMANCE DURING INCLINE (SLOPE) OPERATIONS

OBJECTIVE

The primary objective of this research is to provide data on aviator performance and aircraft states during incline landings. Secondly, since previous subjective observations have noted increased muscular tension during the performance of this maneuver in aviators, physiological recordings to quantify this phenomena will be attempted.

BACKGROUND

Incline landings are viewed by many rotary wing aviators with a certain degree of apprehension. This feeling is not without merit. After a judgment is made that a landing can be accomplished on the chosen terrain, the basic maneuver consists of making a normal approach to a hover over the incline area, lowering the upslope skid to the ground and slowly continuing to decrease collective pitch, while maintaining smooth descent with cyclic control and precise heading with the anti-torque pedals until the downslope skid is firmly resting on the ground. This complete maneuver must be accomplished with a great degree of control precision. Incorrect control may result in severe mast bumping which grounds the aircraft for major repairs or upslope or downslope rollover of the aircraft. Thus, exceeding the limits of any one of the mix of necessary control movements can result in considerable damage to the aircraft and possible injury to crewmembers. Because of the criticalness of aviator control during incline landings and the relative frequency that they are performed both in training and normal operations, it is necessary to gain objective baseline data on the performance of this maneuver.

METHODOLOGY

Continuous recordings of aviator performance parameters and aircraft state variables will be taken for two inclined landings for each of six subject aviators via the helicopter inflight monitoring system (HIMS). Electromyographic recordings of the muscles of the right forearm of each subject will also be taken during each landing. Performance and aircraft data, particularly control manipulanda will be compared across subjects and the degree of muscular tension will be determined from the EMG data.

STATUS

Data on six rotary wing aviators has been collected and submitted for analysis. A report is being written.

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 vegatation 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 line of sight existing to types of features at various orientation and durations.

STATUS

Reduction of the film imagery is in progress.

STATIC COMPARISON OF ABSOLUTE ALTIMETER DISPLAY DESIGNS

OBJECTIVE

The objective of this study is to compare five altimeter designs for possible use in radar altimeters.

BACKGROUND

Many studies have shown that the three-pointer altimeter design is far from optimum in terms of reading accuracy, a condition which has resulted in numerous near-accidents or accidents. Consequently, many aircraft now being produced no longer have three-pointer altimeters but contain various pointer altimeters. In addition, many aircraft are now being retrofitted with counter drum pointer type altimeters in order to eliminate the three-pointer. One area where little information exists is one that concerns the use of the counter drum pointer, counter pointer, pointer, circular counter and circular counter drum concept for radar altimeters. Currently, most radar altitude displays use a single pointer with a number of scales, which may not be optimum from an information transfer viewpoint. The need for AGL information for safe flight has become increasingly important for Army aviation in light of the flight envelopes now required and the most efficient way of transmitting such information must be sought.

METHODOLOGY

This study will compare, in the static situation, a number of facial designs using the counter drum pointer, counter pointer, pointer, circular counter and circular counter drum concepts in radar altimeters. The various designs will be compared in terms of reading speed and accuracy.

STATUS

The results of this investigation have been published in USAARL Report No. 74-9 entitled, "Static Evaluation of Absolute Altimeter Display Designs."

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

These data have been obtained and scored. A report is presently being written.

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

Beginning.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA 0D 6735	74 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
73 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	100
b. CONTRIBUTING				
c. CONTRIBUTING	CARDS 114(f)			

11. TITLE (Provide 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: 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 (PREVIOUS) 74	9	274
FISCAL YEAR (CURRENT) 75	7	405

19. RESPONSIBLE DOD ORGANIZATION

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20. PERFORMING ORGANIZATION

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TELEPHONE: (205) 255-3001
SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS
NAME: Haley, J. L.
NAME: Sauermilch, P. W. DA

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Provide 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 (Provide 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, though particular techniques of application will vary as a function of the problem under investigation.

25. (U) 73 07 - 74 06. Progress in this area is reflected in developments or reports dealing with the following areas: injuries related to OH-58 lap belt failures, Testing for Thermal Protection (film), impact evaluations of CVC helmets, helmet flammability studies, crashworthiness of light fixed and rotary wing aircraft, lead laboratory for OV-1 Yankee extraction system MPT, impact protection of modified parachutist helmet, musculoskeletal effects of long-term helicopter vibration, aircrew station geometry, mathematical model of thermal transfer through skin, analysis of helicopter impact injury problems, spinal configuration problems in relation to ejection injuries, 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.

*Available to contractors upon originator's approval

GENERAL DETAIL SHEET

TITLE: Research of Bioengineering Problems Medically Significant to Army Aviation

OBJECTIVE

Provide to 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 85 through 97.

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

Investigation, redesign and evaluation of OH-58 pilot lap belt attachments to prevent failure and injury in survivable accidents. Report in press. Presentation of technical film "Testing for Thermal Protection" to the 21st International Congress for Aviation and Space Medicine, Munich, Germany, September 1973. Ad hoc appointment to the International Tripartite Technical Coordination Panel and presentation of paper, "Operational Stress - Problems of Translating Research to the Operational Environment". Conducted bioassay analysis of various flight suit fabrics for the Canadian Defense Forces. Division representative was appointed as the Army member of the National Material Advisory Board Ad hoc Committee on Fire Safety Aspects of Polymeric Materials. OTSG representative at the invitation of the project managers to mock-up reviews of the advanced attack helicopter, HLH, and UTTAS. Extensive lecturing by invitation to Arizona State University, USAAAVS, the Aeromedical Activity and various Army headquarters.

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 tne 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, ie., 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.

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 LR 74-28-3-5, Evaluation of the Impact Protection Provided by the Parachutists Helmet With and Without a Protective Nape Pad, April 1974.

The triaxial vibration platform has been installed. Final check is scheduled for mid July. First experiments involve head-helmet neck response to operational vibration.

Item by item evaluation of ANSI Z90.1 helmet standard is demonstrating that current test and design criteria are in need of change.

Contractual work has begun with the Engineering School at Auburn University to develop a math-model of the head-neck torso combination useful for helmet design work.

Criteria and design concepts are being validated for an ultra lightweight aviator's helmet with superior retention and crash attenuating characteristics.

Techniques to isolate the mechanical impedance of in vivo brain and the head-neck system as they relate to impact are being developed.

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

A three-axis servohydraulic vibration table is in the process of being man-rated. A Spectral Dynamic shock spectrum analyzer and a mechanical impedance analyzer have been integrated into the system for data collection. A fine wire dynamic EMG technique has been developed. Prototype fully adjustable seat designs have been prepared and are under construction. In-flight triaxial vibration data on Army aircraft is being recorded by the Army Flight Test Center, Edwards AFB, and will be used to drive the table. Data collection will begin during the second quarter of the FY.

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 do 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. Preliminary results published in AGARD-NATO B-14, Conference Proceedings 145, "Vibration, Combined Stress and Vibration Systems." Oslo, Norway. Base line and control data on the swine is being collected. Assay techniques are being refined.

MK-J5 MARTIN BAKER EJECTION SEAT DEVELOPMENT

OBJECTIVE

To provide medical monitoring and evaluation of the Grumman MK-J5D ejection seat during the various phases of testing and development by request of TECOM.

BACKGROUND

The ejection seat presently being used in the Mohawk aircraft has been associated with an unsatisfactory incidence of spinal injuries. A new extraction system has been developed during the past 48 months. This system is designed to facilitate safe, rapid emergency egress from the Mohawk aircraft.

METHODOLOGY

Three pilots were selected for their respective sitting heights and x-rayed while seated in the improved seat. The distance from the middle of the vertebrae to a line paralleling the thrust axis was then measured and recorded. The angle between the vertebrae and thrust axis was computed and recorded.

STATUS

All engineering acceptance evaluations on the Grumman MK-J5D ejection seat system have been completed. After a careful evaluation by USAARL it was found that the proposed system was obsolete in respect to the mission characteristics of the OV-1 Mohawk and that more advanced operational egress systems are available.

The Aviation Center Team has taken the position, on the basis of the operational OV-1 (Mohawk) fatality/injury experience 1961-1971 (USAARL Staff Study), that the improved MK-J5D system retrofit be halted and that a more advanced operational egress system be installed.

As part of TECOM's limited acceptance testing of the MK-J5D systems an x-ray analysis of the spinal alignment of seated crewmembers was completed with the major finding that the 5th and 95th percentile sitting height aviators were more predisposed to spinal fracture than the 40th percentile due to poor seat design. It was also concluded however, that a marked improvement had been made in respect to the Standard MK-J5(A,B) ejection seat.

Publication of the following:

a. USAARL LR 72-10, "Evaluation of the Grumman MK-J5D Ejection Seat in Respect to Spinal Alignment".

b. USAARL LR 74-6, "The Effects of Initial Spinal Configuration on Pilot Ejection".

USAARL has been appointed the lead laboratory for a military potential evaluation of the Yankee rocket extraction system.

MATHEMATICAL MODEL OF THERMAL TRANSFER THROUGH SKIN

OBJECTIVE

To determine mathematical relationships between heat input and resultant burn production in skin and to verify Alice Stoll's 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

By January of 1973 USAARL personnel had written computer codes to predict temperature gradients beneath the skin's surface. The personnel shortages experienced by this facility at that time prompted the laboratory to contract a civilian firm to complete the work. The Illinois Institute of Technology Research Institute completed this work in February 1973. Currently these materials are being reviewed and refined. Additional modeling techniques and optimization programs are being explored.

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 biodynamically sound crashworthy troop seat for UTTAS, prove it statically, and submit it to AVSCOM and Eustis Directorate Air Mobility Laboratory for dynamic evaluation and field service tests.

BACKGROUND

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

METHODOLOGY

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

STATUS

Dynamic evaluation in process at CAMI, Oklahoma City, OK

Publication of the following:

"Analysis of US Army Helicopter Accidents to Define Impact Injury Problems", Ultrasystems Dynamic Science Division, 4th Quarter 73 Report.

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/physiologic 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 evalution 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, eg., 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

Evaluation of a prototype competitive CVC helmet for impact protection, comfort, center of mass and construction. Published USAARL Report 73-13, Bump Protection Evaluation of the P/N 791 CVC Helmet, May 73. Development of a helmet evaluation facility. The facility is operational and has been designated a DOD helmet test facility. USAARL designated lead laboratory for the military potential evaluation of the Yankee extraction system for the OV-1 aircraft. Test program is underway. Other publications include USAARL LR 73-9-3-4, Results, Conclusions and Recommendations from the Evaluation of Helmet Flammability, DH-132 - T56-6 Helmets, May 73. "Crashworthiness of Light Fixed and Rotary Wing Aircraft", Mil Std 1290. On call consultation to various accident investigation boards.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA OE 6732	74 06 30	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
73 06 30	H. Terminate	U	U	NA	NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	61101A	3A161101A91C	00	286
b. CONTRIBUTING				
c. CONTRIBUTING	None			

11. TITLE (Precede with Security Classification Code)*

(U) Simulated In-Flight Monitoring System (SIMUHMS)

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*

001500 Aircraft; 009400 Man-Machine Relations; 013400 Psychology

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
73 07 01	Cont	DA	C. In-House

17. CONTRACT GRANT

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

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 74	.7	110
	CURRENT 75	0	0

19. RESPONSIBLE DOD ORGANIZATION

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NAME DA

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Man-Machine Relations; (U) Bioengineering; (U) Stress Physiology; (U) Human Factors Engineering; (U) Simulation and Systems; (U) Recording Devices; (U) Human Volunteers; (U) Computers

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 US Army aviation information about medical problems related to the human component of the flight system and variable which affect its performance

24. (U) The approach will be the acquistion and implementation of a helicopter simulator dedicated to medical research. Areas of medical importance to be explored will include the effects that stressors, fatigue and drugs have on performance

25. (U) 73 07 - 74 06 Progress has been reflected by a contract award for purchase of a helicopter simulator to be delivered in ten months. Efforts in this area will continue and this project is designated as terminated only because of a funding change.

*Available to contractors upon originator's approval

DD FORM 1 MAR 66 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A 1 NOV 65 AND 1498-1 1 MAR 66 FOR ARMY USE ARE OBSOLETE

SIMULATED IN-FLIGHT MONITORING SYSTEM (SIMUHIMS)

OBJECTIVE

To acquire and utilize a helicopter simulator which will yield information relative to aviator performance and how it is affected by variables to include stress, fatigue, drugs, etc.

BACKGROUND

There exists the need for a helicopter simulator to be dedicated for medical research. This need is based on the fact that some research, because of safety considerations, is best carried out through simulation. Secondly, some research efforts can be carried out in a more cost effective manner through simulation.

METHOD

The method will consist of acquiring a helicopter simulator which will be capable of providing output relative to a number of flight related parameters which could be affected by environmental, physiological or psychological factors. These parameters will include control inputs as well as subsequent airframe changes. Projected areas of research in which the simulator will be employed involve determining the effects of sleep deprivation induced fatigue, isolation of biological indicators of this fatigue and the effects of various drugs on performance.

STATUS

The contract for a helicopter simulator has been let and delivery is expected in 10 months.