Abstracts of Papers from Scientific Program of 1959 Meeting of Aero Medical Association, Statler Hilton Hotel, Los Angeles, April 27-29

The Effect of Glycine Administration in a Human Response to a Standardized Cold Stress. T. ADAMS and E. J. HEBERLING, Arctic Aeromedical Laboratory, Ladd AFB, Alaska.

Glycine (amino-acetic acid) and other calorigenic, dietary adjuncts have received considerable attention recently and have been reported to modify whole body responses to cold exposure and hypothermia. In addition to any pharmacologic action, the potential value of glycine and similar materials lies in their ability to provide additional calories to the cooling organism via the mechanism of specific dynamic action. Thirty grams of glycine was administered orally to a group of five volunteer subjects who were subsequently exposed nude to an environment of 10° C. Measurements of rectal and extremity surface temperatures and whole body metabolic rates failed to show any statistically significant group effects that could reasonably be attributed to the influence of glycine, as compared to glucose control measurements, throughout a one hour cold exposure. At this level of cold stress and drug dosage, glycine could not be seen to affect cold elicited, physiologic responses and its values in mitigating human cold exposure is questioned. Reports of glycine effects for more severe cold stresses or during deep hypothermia may possibly be attributed to a more precipitous rate of heat loss or to a greater degree of cooling.

Threshold of Aural Pain to High Intensity Sound. HARLOW W. ADES, PH.D., USN School of Aviation Medicine, Pensacola, Fla.

Deaf and normal human subjects were exposed monaurally to high intensity noise stimuli including pure tone and broad band noise. The stimulus was continuous, beginning each run at 120 decibels and increasing by 2 decibels steps every two seconds. The subject gave prearranged hand signals to indicate (1) first awareness of any sensation, (2) beginning of discomfort, and (3) pain. The threshold of pain to pure tone varied from 140 decibels to over 160 decibels, the lowest being observed in the 250-500 cps range, the highest in the 2,000-3,000 cps range (3,000 cps being the highest test frequency). There was considerable individual variation, but in general, thresholds for deaf subjects were slightly higher than for normals. Possible explanations of this difference will be discussed.

Liquid Air Personnel Cooling and Breathing System. HELEN E. AGEN, A.B., USA Quartermaster Research & Engineering Command, Natick, Mass., and WALTER DRAY, B.S., Pioneer Central Division, Bendix Aviation Corp., Davenport, Ia.

This presentation covers a liquid air auxiliary cooling system designed to relieve heat stress and to provide breathing air to the occupant of an impermeable suit while working in hot humid climates. This system is capable of removing approximately 1,500 Btu. per hour, permits freedom of motion throughout a wide radius of operation, and insures protection to the wearer while working in contaminated areas. This system, currently under development, consists primarily of a liquid air container, a dual heat exchanger, and a venturi for amplifying the flow rate. The heat exchanger case, worn on the back, acts as a pack for the detachable liquid air container. The liquid air enters the dual heat exchanger situated in the stream of circulating air, is vaporized and the vaporized air is directed into a venturi, where the flow rate of conditioned air is amplified by entrainment of interior suit air. The conditioned air is circulated over the body skin surface of the suit wearer. Fresh vaporized air is supplied in sufficient quantity for breathing, and an equal amount of interior air is eliminated through dump valves maintaining a positive pressure within the suit. Vaporized air introduced into the system is controlled in such a way that it compensates for the variable heat input to the system through energy expenditures. Design and development of the liquid air cooling system is presented along with the solutions of the various complex problems encountered.

Factorial Structure and Validity of Naval Aviation Selector Variables. ROSALIE K. AMBLER, M.S., JOHN T. BAIR, PH.D., and ENSIGN ROBERT J. WHERR, JR., MSC,

USN, USN School of Aviation Medicine, Pensacola, Fla.

An aviation score sheet is executed for all aviation officer candidate and naval aviation cadet applicants. This form summarizes the attributes, other than physical fitness, that are assessed in the selection of flight trainees. The sheet provides for quantification of essential qualitative appraisals such as interview results, selection board ratings, and references. In addition educational background and results of the psychometric tests which comprise the aviation selection battery are incorporated. This study evaluated the components of the score sheet in terms of validity in predicting pre-flight grades and flight attrition from naval aviation training. Factor analysis was used to define the different areas tapped by this array of variables and their relevance to the pre-flight and attrition criteria. Subjects were 790 naval flight students. Among the score sheet variables the psychometric tests were the best predictors of both types of criteria. Mathematics and physics credit hours had some validity, while over-all scholastic standing demonstrated none. The qualitative appraisal type variables did not demonstrate validity for these criteria, but analyses against flight performance and fleet criteria are suggested before final judgment is made concerning their usefulness. Five factors were tentatively identified by using the centroid method. These were flight ability, appearance of maturity, military conduct, motivation to take risks, and academic interest. The flight ability factor accounted for most of the explained attrition criterion variance, but the positive loading of voluntary attrition on the academic interest factor indicated future motivational research possibilities.

A Test of Motivation to Fly. JOHN T. BAIR, PH.D., USN School of Aviation Medicine, Pensacola, Fla.

A persistent problem in the area of personnel selection of potential applicants for flight training has been the motivation to fly. This paper describes a test designed to measure a candidate's information about naval aviation. This test was then validated against his stated desire to enter the flight training program or not. A test of general information about naval aviation was administered to 743 midshipmen from the U. S. Naval Academy before and after a two-week indoctrination tour at Naval Air Station, Pensacola. These same men were also questioned during both administrations of the test regarding their interest in entering the naval aviation training program. The essential results of this experiment showed a highly significant gain in general information about naval aviation after the two-week air indoctrination tour. None of this information was presented in any of the official course material of the tour. This increase in general knowledge about naval aviation was positively correlated with a significant increase in the number of midshipmen wanting to enter naval aviation after completing the orientation cruise.

Problems Involved in Providing Protection for Aircrewman During Escape. ARNOLD I. BECK, and BERT COOPER, Republic Aviation Corp., Farmingdale, N. Y.

The problem areas concerned in providing adequate protection for aircrewmen prior to and during escape sequences from high performance aircraft are complicated by the physiologic considerations and the physical nature of the escape itself. The human limitations to imposed forces, both initial and sustained, and the method used to eliminate and/or reduce them will be presented. Pertinent data resulting from sled test runs and crew escape studies will be discussed using actual filmed sequences of research effort. The presentation will consider the present state-of-the-art of crew escape systems and will present the problems yet to be solved to produce reliable escape potential for proposed new weapons systems. Factors such as positioning, restraints, time sequences, personal equipment, altitude and speed and related problems will be reviewed and possible solutions offered to meet the demands arising from the ever expanding flight envelopes of the most modern weapons systems.

Discussion of the Abnormal Stresses Imposed on the Pilot during the Manhigh III Balloon Flight. I. Physiological Data and Other Factors Contributing to this Stress. CAPTAIN ELI L. BEEDING, JR., USAF (MSC), Aeromedical Field Laboratory, Holloman Air Force Base, N. M.

Confining area of capsule will be discussed and illustrated. Applicable physiological data will be discussed and illustrated graphically. This will include heart rate and rectal temperature which reached 180 per minute and 106.5° F. respectively. The contribution of the unventilated partial pressure suit and low fluid reserve will be discussed.

Stress Aspects of the Manhigh III Balloon Flight. CAPT. ELI L. BEEDING, JR., USAF (MSC), and 1ST LT. CLIFTON M. MCCLURE, USAF, Aeromedical Field Laboratory, Holloman AFB, N. M.

The general configuration of the capsule is described and illustrated with slides to

indicate the degree of confinement and complexity of the system. Flight location, altitude and duration is given. Applicable physiologic data are illustrated graphically and discussed with special emphasis on heart rate and rectal temperature. Visual apparitions reported by the pilot are related to this physiological data. The pilot tells of his thoughts and actions during the latter stages of the flight under these high stress conditions.

Some Effects of Angular Acceleration on Postural Mechanism. FLIGHT LIEUTENANT A. J. BENSON, RAF, Institute of Aviation Medicine, Farnborough, England.

Labyrinthine stimulation giving rise to inappropriate sensations is one mechanism of disorientation in flight; reflex movements of the limbs consequent to such labyrinthine stimulation may contribute to loss or impairment of control. In human subjects changes in stretch reflex excitability and in the integrated electromyogram of the gastrocnemius-soleus muscle group produced by a simple labyrinthine stimulus, were investigated. Deceleration from an angular velocity of 95° per second to 0° per second in 1 second, caused an increase in the amplitude of the ankle jerk response ranging from 50 to 400 per cent; this facilitation was maximal during the first 3 seconds and then underwent a decay which did not follow a simple exponential law but showed subsidiary peaks of facilitation at in from 5 to 10 second intervals. A similar pattern of activity was seen in the integrated electromyogram records. The magnitude of the initial peak was linearly related to the angular velocity of the turntable prior to deceleration, but differed according to the direction of rotation. Labyrinthine stimulation failed to alter the size of the electrically elicited H. reflex response. It is thus inferred that the labyrinth exerts its influence upon the somatic musculature via the γ efferent system acting on the muscle spindles rather than by the more direct pathway to the α motoneurones.

Human Quality Control in Naval Air Training. JAMES R. BERKSHIRE, M.A., USN School of Aviation Medicine, Pensacola, Fla.

The quality control requirements for training programs resemble those for industrial production processes. A raw material must be selected in accordance with some minimum standards. It is then put through a series of processings which change it progressively until a desired end product is reached. In order to turn out a consistently satisfactory product, the training process must include minimum standards that will eliminate potential job failures. In order to avoid training waste these must come as early as possible in the training program. The success of research to improve selection for training began with World War I and is well known. The first efforts to provide in-training minimum standards in naval air training were reported in 1952. Until 1956 work was concentrated on developing minimum standards for early training which would predict later training failure. In 1956 and again in 1957, approximately half of the fleet squadrons were visited to identify graduates of the training program who were job failures in the fleet. These data were then related to the training records. Several early training measures that are useful for quality control have been identified. It is estimated that the enforcement of minimum passing scores in these measures will result in a 40 to 50 per cent reduction in the number of unsatisfactory graduates reaching the fleet, together with a substantial reduction in over-all training costs.

A Preliminary Report on Quantitative Estimation of a Urinary Metabolite of Epinephrine and Norepinephrine as Possible Indicator of Tolerance to Gravitational Stress. FIRST LIEUTENANT M. LAWRENCE BERMAN, USAF, Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

3-Methoxy-4-Hydroxy-D-Mandelic acid is a urinary metabolite of epinephrine and norephinephrine. To determine whether estimation of this compound might prove useful as indicator of gravitational stress, six human subjects rode the Air Force centrifuge at 6G forward acceleration for three minutes; periodic sampling of urine was made before and after acceleration. Determination of performed creatinine showed the rate of excretion of this substance to increase in four subjects immediately after acceleration, while in two subjects the creatinine rate dropped. Preliminary results from quantitative measurement of 3-methoxy-4-hydroxy-D-mandelic acid by two dimensional paper partition chromatography suggest a rise in the metabolite immediately after acceleration and this rise is independent of the rate of excretion of creatinine.

The Need for Radical Development of Restraining Devices for Manned Flight. CAPTAIN ALBERT T. BERNARDINI, Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Today's "weapon system" has moved rapidly from the "aeroplane," through the "aircraft" phase, and is heading for the "manned missile" development. Each conno-

tation depicts the evolution of manned flight. We have arrived at a stage which demands a reappraisal of restraint concepts so that resultant products of new thinking may rise, analogous to beneficial mutants in nature, in order to provide proper restraint for present and future manned flight.

Helicopter Problems: Noise, Cockpit Contamination and Disorientation. MAJOR CHARLES A. BERRY, and MAJOR HERBERT K. EASTWOOD, USAF (MC), USAF School of Aviation Medicine, Randolph AFB, Texas.

The helicopter has been increasingly recognized as a useful vehicle in many civilian and military operations. Many types, ranging from small, one-man aircraft to large models carrying numerous passengers, are in use. Three problem areas are usually mentioned by those concerned with helicopter operations. As a class, helicopters are almost uniformly noisy. Cockpits are frequently contaminated by fumes felt to represent carbon monoxide and operations are frequently restricted during night and weather operations due to the possibility of developing disorientation. The problems of noise, cockpit contamination and disorientation are discussed in relation to several operational helicopter types.

Aeromedical Problem Cases; A Summary of Three Years Experience in an Aviation Medicine Consultation Center. MAJOR CHARLES A. BERRY, and CAPTAIN ARTHUR H. KING, USAF (MC), USAF School of Aviation Medicine, Randolph AFB, Texas.

In recent years the disposition of flyers with medical problems has been recognized as an increasingly important task. Decisions and recommendations as to the effect of the particular medical condition on the future flying ability of the aircrewman have far reaching significance to the individual and to the Air Force. Three aviation medicine consultation centers were established in the Air Force. Aeromedical problem cases are evaluated at these centers on request. During the three year period 1956-1958, more than 1,000 aircrewmen were evaluated in these centers. A tabulation of the diagnostic entities seen, with breakdown by age, aircraft types, and years experience is presented. Case histories of representative cases are included.

Physiological Phenomena Pertinent to the Design of Oxygen Breathing Equipment. AARON BLOOM, Sierra Engineering Co., Sierra Madre, Calif.

Engineering of protective oxygen breathing and associated high altitude safety equipment necessitates the application and broad understanding of the physical phenomena of the science of respiration. Each engineer should take into consideration all of the available published data reporting and defining experimental and clinical experience. The purpose of this paper is to promote a better understanding of the terminology and physical dynamics of the respiratory system of the human body. Various sources will be quoted as either alternate or controversial; however, in the main, literature and publications generally available will be quoted. The purpose of this paper is to promote common understanding of the basic terminology and not create controversy regarding the related data. Unfortunately, in some respects, much of the applicable definitions and formulations pertaining to respiration are hidden in the texts and publications basically written for the physician and physiologists. Conversely, and fortunately for the engineer, a great deal of the work defining the dynamics of respiration has been done and the only lack is in communicating this information for useful application. There are a few undefinable areas which must be left for further experimental and statistical confirmation. With the tremendous strides being made by the medical profession, all areas soon will be completely defined.

Solid Chemical Oxygen Sources. ROBERT M. BOVARD, M.S., MSA Research Corp., Callery, Pa.

Tests recently conducted have shown that two relatively new oxygen sources could be used as a means of controlling a closed chamber atmosphere. They are potassium superoxide and sodium chlorate candles ($\sim$ 90% Na Cl 0_3). Potassium superoxide is presently used in the Chemox self-breathing apparatus. This canister type apparatus has been approved by the Bureau of Mines for ¾ hour of strenuous work. Potassium superoxide has the unique property of releasing oxygen when it reacts with exhaled moisture and carbon dioxide. Sodium chlorate candles are a solid oxygen source that contain a volume equivalent oxygen density equal to liquid oxygen. A portable oxygen generator has previously been built around the oxygen candles. They also have been used as a quick start means for the KO_2 canisters. The oxygen candle fills the breathing bag with oxygen and warms the canister to initiate the reaction of the KO_2. This same combination has been used in a small rescue canister. A small 7 cu. ft. chamber and a 210 cu. ft. chamber were

constructed for closed atmosphere tests. Potassium superoxide was used to control the atmosphere inside the chambers. The metabolic requirements of a small animal (7 cu. ft. chamber) and that of two men (210 cu. ft. chamber) were satisfactorily fulfilled by circulating the atmosphere over a potassium superoxide canister. The potassium superoxide adequately supplied the oxygen, removed the carbon dioxide, odors and a portion of the water vapor. Data collected on the chemical behavior of potassium superoxide in these applications are compared with lithium hydroxide and other carbon dioxide adsorbers. The possibility of using sodium chlorate candles as an emergency source or surge of oxygen in conjunction with the potassium superoxide system has been demonstrated.

Mediastinal Emphysema Following Rapid Decompression: A Case Report. MAJOR HARRY R. BRATT, USAF (MC), USAF School of Aviation Medicine, Randolph, AFB, Texas, and MAJOR T. H. MOWRY, USAF and FIRST LT. R. N. OLSON, USAF (MSC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

The occurrence of mediastinal emphysema in the eighteen-year-old white male following rapid decompression is reported. A review of the literature of reports of similar cases, the clinical findings and hospital course of this case, a discussion of mechanism of injury, and recommendations for prevention and management are presented.

Cardiac Irregularities during Combined Hyperventilation and G. FLIGHT LT. H. P. BRENT, FLIGHT CADET G. J. LEITCH, DR. J. W. SCOTT and GROUP CAPT. W. R. FRANKS, RCAF Institute of Aviation Medicine, Toronto, Canada.

At the RCAF Institute of Aviation Medicine, aircrew officers were investigated under conditions of voluntary hyperventilation, positive acceleration on the human centrifuge, and combined hyperventilation and acceleration. Electrocardiograms and electroencephalograms were recorded throughout the course of these experiments. Ectopic beats appeared more frequently during combined hyperventilation and G than during either of these conditions imposed separately; disturbances in consciousness were produced only when the two stimuli were combined. In the course of analysis of the ECG, successive instantaneous heart rates were computed from intervals between R-waves, and plotted against the time sequence of the experiment. Thus, changes in heart rate from beat to beat were depicted. In some subjects, abrupt fluctuations in heart rate occurred during the hyperventilation-plus-G runs, usually in association with either general convulsive seizures or slow activity in the EEG. Comparable graphs prepared from ECG records of patients undergoing clinical grand mal attacks, or showing EEG epileptic discharges without clinical manifestations of seizure, showed no such cardiac irregularities. It therefore appears that the cardiac irregularities during combined hyperventilation and G resulted from these physiological stimuli directly, rather than as sequelae to any cerebral disturbances. For further comparison, graphs were prepared from the ECGs of patients who had developed ventricular fibrillation during surgery. It was noted that the cardiac disturbances during hyperventillation-plus-G were in some respects similar to those immediately preceding onset of ventricular fibrillation. The possibility that the latter event is responsible for some of the many "obscure" fatal crashes must be considered.

Research on Human Performance during Zero Gravity. CAPTAIN EDWARD L. BROWN, USAF (MSC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

This laboratory is conducting research on several aspects of human performance during zero gravity periods. The zero gravity condition is produced by flying a C-131B aircraft through a Keplerian trajectory. Periods of apparent weightlessness lasting from 12 to 15 seconds can be achieved. Several experiments on simple motor tasks are being conducted. One experiment is concerned with the speed and accuracy of humans making vertical, rotary switch, push button switch, toggle switch and horizontal motions. Motion pictures have been taken of human subjects during unrestrained free-floating in the cabin of the aircraft. The motion pictures demonstrate that nearly all subjects tend to use underwater-type swimming motions to assist in the control and locomotion of their bodies during zero gravity periods. These motion pictures will be shown at the presentation of this paper. The pilots on this experiment (including the author) report no greater difficulty in flying the airplane during zero gravity than during normal gravity. The subjects who have experienced free-floating in the cabin during the zero gravity periods report that the feeling of complete weightlessness, with no restraints on the body, is very exhilerating. In as much as the zero gravity experiments are continuing, it is expected that at the time this paper is presented the results of several controlled experiments on human performance during zero gravity will be reportable.

Some Effects of Cabin Pressure Failure in High Altitude Transport Aircraft. FLIGHT LT. A. C. BRYAN, and SQUADRON LDR. W. G. LEACH, Royal Canadian Air Force Institute of Aviation Medicine, and F. A. SUNAHARA, PH.D., Defence Research Medical Laboratories, Toronto, Canada.

The effects of sudden cabin pressure failure in high altitude transport aircraft have been simulated in the decompression chamber. Subjects have been decompressed from 8,000 to 40,000 feet in 2.5 seconds and the time of useful consciousness at 40,000 feet determined. An attempt was made to measure the time within which oxygen had to be given to preserve continuous consciousness. Commercial passenger oxygen masks were evaluated under these conditions and were found to have definite limitations. The effect on the passenger of failure to get supplementary oxygen during the aircraft descent is being studied. To extend these exposures monkeys are being used and arterial oxygen saturation, blood pressure, respiration, electrocardiograms and electroencephalograms are being recorded after a rapid decompression to 40,000 feet followed by descent at 8,000 feet per minute.

The Effect of Temperature on Tolerance to Positive Acceleration. LIEUT. COMDR. BENJAMIN F. BURGESS, JR., MSC, USN, Aviation Medical Acceleration Laboratory, Johnsville, Pa.

With the advent of space flight the problems associated with the physiological effects of extreme temperatures may become a critical factor relating to pilot performance under conditions of high acceleration. In order to determine the effects of high environmental temperatures on G tolerance, six trained centrifuge subjects were exposed to positive acceleration in the heated gondola of the Johnsville centrifuge. Seven thermocouples were located at strategic places over the body surface in order to obtain an accurate recording of skin temperature. Although humidity was not controlled, it was recorded during all centrifuge runs. The environmental temperatures studied to date range from 75° F. to 115° F. where a decrement in G tolerance of ¼ G has been obtained at the upper temperature range. Further studies will be made at higher temperatures approaching conditions of heat exhaustion.

A System for Monitoring the ECG Under Dynamic Conditions. W. J. CARBERY, M.S., W. E. TOLLES, M.S., and A. H. FREIMAN, M.D., Airborne Instruments Laboratory, Mineola, N. Y., and Sloan-Kettering Institute, New York, N. Y.

A monitoring system has been developed that permits the continuous recording of the ECG during body movement and exercise. The lead system which is bipolar, consists of one electrode over the sternum and two electrodes over the vertebral column. The ECG signatures presented by this lead system are similar to those presented by leads II or III; tests have shown that a wide range of heart pathologies are readily detectable. The main problems involved in using standard electrocardiographic procedures during exercise are the generation of muscle potential interferences from contracting muscle groups, and D/C level shifts caused by intermittent change of skin-to-electrode contact. These problems have been satisfactorily overcome by, (1) the use of new electrode placements; (2) the design of new electrodes, readily attachable to the skin; and (3) the judicious reduction of the recording bandwidth. The main advantages of the new monitoring system over conventional ECG monitoring systems are uninterrupted diagnostic interpretability, long-term stability, applicability to various body types, complete freedom of body movement, and conservation of recording bandwidth. Therefore, this system is believed to be particularly well-suited for use in studying heart action of subjects during aircraft and satellite flights. This system has the additional importance of offering a new research area in the diagnosis of incipient heart disease by way of exercise ECG. It is expected that exercise ECG will present the cardiologist with another valuable diagnostic procedure for determining the ECG status of a patient presenting marginally normal findings in the resting state.

Emergency Egress Oxygen Requirements. R. L. CARTER, North American Aviation, Columbus, Ohio.

Increasing altitude capabilities of manned weapon systems demand larger emergency (bail-out) oxygen supplies. The amount of oxygen used at constant pressures, i.e., in a pressure suit descent from high altitudes where the suit pressure is constant, is easily calculated using the basic gas laws. This paper presents a method for calculating the oxygen used during descent with constantly changing altitudes (pressures), as will occur during descent from any altitude in non-pressure suit operations and during descent from 35,000 feet in pressure suit operations. The principles presented will apply to both demand and constant flow systems. The essential steps are as follows: (1) write the equation for the descent, expressing altitude as a function of time; (2)

express instantaneous oxygen consumption as a function of pressure at any altitude, minute ventilation (or flow rate) and sea level pressure; (3) express the pressure at any altitude as a function of altitude and substitute this expression into the equation for instantaneous oxygen consumption; (4) integrate over the time period covered by the descent. The solution of a sample problem is presented.

Human Tolerance to Forces Imposed Upon an Airman during Simultaneous Seat Bottoming, Knee Elevating and Leg Positioning and Restraining in the A3J-1 Escape System. R. L. CARTER, and G. A. HOLCOMB, North American Aviation, Columbus, Ohio.

The seat bucket on the A3J-1 escape system adjusts to accommodate various height airmen while the rest of the seat and the seat catapult remain stationary. The seat bucket must be bottomed prior to firing the seat catapult in order to have proper center of gravity—rocket thrust relations when the seat leaves the rails. At the same time the seat is being bottomed, the knees are being elevated and the legs positioned and restrained. This prevents flailing of the lower extremities, insures symmetry of the ejected mass, and reduces the decelerative forces imposed by the dynamic wind pressure. All these operations are accomplished in 0.2 seconds by ballistically powered units. This paper presents data that show that all forces imposed upon the airman during these operations are within human tolerance limits. Production units were tested using anthropomorphic dummies and a human subject. No deleterious effect whatsoever was experienced, not even mild, transient pain. The knee raising bar impacted the legs with a maximum velocity of 7.6 feet per second. The leg restraining hooks impacted the legs with a maximum force of 110 pounds. Raising the knees did not produce spinal flexure. Movies of the human test are presented.

Centrifuge Simulation of the X-15 Research Aircraft. CARL CLARK, PH.D., Aviation Medical Acceleration Laboratory, Johnsville, Pa., and C. H. WOODLING, National Aeronautics and Space Administration, Langley Field, Va.

In the period March, 1957, to July, 1958, three X-15 centrifuge programs were carried out as a cooperative effort of the North American Aviation, Inc., the NASA, the USAF, and the USN. The first program involved 168 runs under cam control, with the subject receiving accelerations predicted for the X-15 as if he were a passenger. For the other two programs, the newly developed technique of pilot-computer "closed-loop" control of the centrifuge, or centrifuge dynamic control flight simulation, was utilized with the pilot receiving accelerations computed for the X-15 under his own control while he carried out the assigned flight mission, involving re-entries at various angles of attack and peak normal loads with and without speed brakes, and with or without control augmentation (dampers). During these two programs, 991 "static" flights (centrifuge at rest) and 433 "dynamic" flights (centrifuge in motion) were made on the centrifuge simulator. Pilots who were properly fitted into the seat and restraints; had at least 10 hours of static simulator practice; and had previous high acceleration experience could control the X-15 centrifuge simulator through parts of the design missions (computed aircraft speeds greater than Mach 2) while receiving the accelerations greater than 1 G continuously computed in magnitude and direction as a consequence of their control and used as centrifuge drive signals. Pilots who did not meet these specifications did notably less well dynamically than statically, a consequence attributed to their incorrect control responses while under acceleration or to their less rapid detection of and correction for the involuntary pilot inputs produced by the flight loads. Even the pilots who were scheduled first to fly the X-15 "crashed" the centrifuge simulator on their first experiences with certain of the more difficult flight conditions involving unaugmented controls. During these programs, improvements in instrument arrangement, kinematic design and grip of the right hand console control stick, and pilot restraint, notably a head support and seat design, were made. The final cockpit configuration and the dynamic control characteristics were acceptable to the pilots who will first fly the X-15.

Studies of Primate Tolerance to Some Complex Accelerations. CAPTAIN NEVILLE P. CLARKE, USAF (VC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Theoretical calculations and preliminary experiments have shown that stabilized ejection seat and capsule escape systems as well as other aerodynamically unstable bodies reentering the denser portion of the atmosphere will oscillate during the early stages of deceleration. To simulate a portion of the acceleration pattern, experiments were done in which small primates were subjected to oscillations of up to 40° amplitude about their center of gravity at frequencies up to and including five cycles per second. The animals were exposed to simulated linear decelerations of up to 20g during the oscillation. Calculations show the animals sensed alternating headward-footward ac-

celerations of 6.8g (at head level) and alternating backward accelerations of 34g and 3.5g during maximum amplitude and frequency of oscillation at 20g. Clinical evaluation of the unanesthetized subjects and later post mortem examination revealed no changes of a magnitude to indicate permanent damage.

Cardiopulmonary Responses to Lethal Concentrations of Carbon Monoxide. LIEUT. COMDR. KENNETH R. COBURN, MSC, USN, EARL T. CARTER, M.D., JOSEPH F. TOMASHEFSKI, M.D., and FRED A. HITCHCOCK, PH.D., Ohio State University, Columbus, Ohio.

Anesthetized mongrel dogs were exposed to lethal concentrations of carbon monoxide in air (0.3 per cent to 0.4 per cent). The ventilatory responses were measured by means of a Tissot apparatus and the cardiovascular responses measured as indicated below. The blood pressure was constantly monitored by means of a fluid filled strain gauge which fed into a strain gauge amplifier and direct writer recorder. Cardiac output was measured at three intervals during the experimental procedure; following surgery prior to the administration of the carbon monoxide mixture, after 15 to 20 minutes of breathing the carbon monoxide mixture and just prior to exodus as indicated by a sharp drop in the blood pressure. Standard dye dilution techniques using BSP as an indicator were utilized for cardiac output determinations. These outputs correlated with the blood pressures taken simultaneously give an approximation of the peripheral resistance. The cardiovascular data when combined with the data calculated from the raw ventilatory response provide a time course of the cardiopulmonary changes involved in acute carbon monoxide poisoning.

The Passive Dynamic Mechanical Properties of the Human Thorax-Abdomen System and of the Whole Body System. ROLF R. COERMANN, DR. ING, GERD H. ZIEGENRUECKER, M.D., ALBERT L. WITTWER, B.S., and HENNING E. VON GIERKE, DR. ING., Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

The vibration dynamics of the thorax-abdomen system and of the whole body system have been studied more extensively with sinusoidal vibration excitation. The new results to be reported are combined with previously published data and observations on the dynamics of the system under various types of load: whole body vibration, transient acceleration, blast exposure, respirator excitation and rapid decompression. An attempt is made to give a generalized, unified model of the mechanical system with approximate values for its constants, so that it can be used to calculate the dynamic mechanical response to different loadings. This model should serve as a guide in future experimentation, in the planning and interpretation of physical measurements, in the interpretation of the various types of damages and in developing and understanding protective measures.

Pathology of Visceral Displacement in Animal Subjects Exposed to Abrupt Deceleration. CAPTAINS JAMES E. COOK, and JOHN D. MOSELY, USAF (VC), and HARALD J. VON BECKH, M.D., Aeromedical Field Laboratory, Holloman AFB, N. M.

Eight Canadian black bears, approximately two years of age and averaging 160 pounds, were subjected to abrupt deceleration. The subjects were autopsied and analyses were made of the pathologic findings in relation to the G loads sustained. These findings were correlated with positioning and the restraint system used. Studies made on human volunteer subjects exposed to similar forces will be discussed. A description of a self-positioning rat G couch will be shown. The performance of this automatic G-orienting device, during the bear sled-runs, will be discussed.

Clinical Observations on the Toxicity of Boron Hydrides in Man. ROGER W. COOPER, M.D., Olin Mathieson Chemical Corporation, Niagara Falls, N. Y.

Clinical observations, laboratory data, and biochemical research involving 172 cases of boron hydride intoxication in 80 persons are reported. Symptoms referable to acute diborane exposures, subacute diborane exposures, pentaborane exposures, and decaborane exposures are recorded in percentages. An unusual case of pentaborane exposure involving hyperpyrexia is described. A nonspecific treatment of higher borom hydride exposures using oxygen, methocarbamol (Robaxin), and "lytic cocktails" has been found most effective. A possible mechanism of action of higer boron hydride intoxication is postulated. Contrary to previous reports in this field, no liver or kidney toxicity is to be expected in mild-to-moderately severe cases of higher boron hydride intoxication. No permanent pathology or disability arising out of boron hydride intoxication has been noted. An ion amperometric borane detector has been developed for monitoring processes in which these compounds are used. The device is demonstrated, and techniques of use are discussed.

The Lightweight Full Pressure Suit System of the U.S. Navy. JAMES V. CORREALE, JR., B.S., EDWARD L. HAYS, B.S., and JOHN E. LESHKO, B.S., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

The lightweight full pressure suit system of the U.S. Navy is described in full detail. Specific points are established where developmental progress resulted in vastly improved operational acceptance of the system by fleet units. Areas wherein design difficulties still require extensive developmental effort are reviewed. An idealized method for handling this specialized aircrew safety system in operational situations is established for consideration. A brief presentation as to the design features that are suitable for "space suit" application is made with editorial comments as to features which would require development or inclusion to improve the suit system for this purpose.

Routine EEG in Aviation Medicine. MICHELLE B. DELL and A. ROBERT, Service Médical de la Compagnie Air France, Paris, France.

Routine EEG examination is of value in the detection of Epilepsy. 0.8 per cent of candidate pilots, 1.2 per cent of candidate stewards and 3.4 per cent of candidate hostesses had bilaterally synchronous wave and spike episodes in their records. It seems justifiable to the authors to reject these few young men and women from a career in which safety must be the first consideration. EEG should be recorded at the time of engagement, so as to be available for comparison (1) in the event of later head injury; (2) if a subsequent EEG shows abnormalities; and (3) as part of a periodic medical survey. If EEG is meant to be used as a means of selection, it is to be considered meaningful only when treated as part of the total clinical picture of each individual.

Time, Space, and Stereoscopic Vision; Flight Safety Considerations of Time-limited Stereopsis at Supersonic Airspeeds. STANLEY DIAMOND, M.D., Pan American World Airways, San Francisco, Calif.

The stereoscopic time-distance concept has been advanced to show the limitation of depth-in-time, an important factor in high speed flight, as the pilot sneaks through his stereoscopic ranges. It appears that unaided stereoscopic vision is of questionable value at present and future military supersonic speeds, due to practical threshold limitations, but probably still of value for the slower sub-sonic speeds of commercial aircraft, the usual landing speeds, and for formation flying. How fast can a pilot safely fly and still utilize stereoscopic vision for the judgment of depth in space? This may vary from 400 to 580 mph. if the critical range of stereoscopic vision is limited to 450 to 650 meters, as present knowledge indicates. Theoretically, at sub-sonic speeds, (landing speeds and current commercial flight speeds) ample time appears to be available; between one and three times the speed of sound, increasingly keen thresholds (not available to unaided binocular vision) appear to be necessary and beyond three times sound, stereoscopic vision seems to be of no aid (even if available by optical aids) because of insufficient time. Unaided binocular visual depth perception, therefore, is basically unsafe at supersonic airspeeds. The lack of time for stereoscopic vision at sonic and supersonic speeds (stereoscopic scotoma) should be considered as a possible contributory factor in some air accidents involving high speed aircraft. Optical aids may increase flight safety to a limited degree, but at extremely high airspeeds they appear to be of no value for binocular depth perception. Electronic engineered depth and distance control probably will be necessary in future high performance aircraft for adequate safety.

Enhanced Contrast of an Indefinitely Contoured Object by Movement or Intermittent Illumination. G. TORALDO DI FRANCIA, A. FIORENTINI and M. BITTINI, Istituto Nazionale di Ottica, Florence, Italy.

It is known that the perceived image of an object with a diffused border (e.g., as seen through fog) shows a peculiar contrast effect consisting mainly in the appearance of the Mach bands. This effect is enhanced by a movement of the image perpendicular to the border. The particular case of an oscillating movement has been investigated and the best frequency and amplitude have been determined as a function of the width of the diffused border and of illumination. The best frequency turns out to be rather low (< 10 cps). The natural movements of the eye give a non-negligible contribution, too. This is borne out by an experiment where the image is fixed on the retina and, as a result, the Mach bands disappear. Some analogous results may be obtained by the use of an intermittent illumination. At low levels the detectability of a poorly contrasted object can be enhanced by a pulsing illumination near fusion flicker frequency. This effect is found to depend on the shape of the pulse, a sawtooth pulse being more efficient than a rectangular pulse of equal energy, and on the color.

Toxicity of Propellant Fuels and Oxidizers. D. B. DILL, PH.D. and K. H. JACOBSON, Directorate of Medical Research, U. S. Army Chemical Warfare Laboratories, Md.

With joint support from the military services, our laboratory has been engaged for several years in assessing the toxic hazards of "military chemicals." The major share of our effort is now being devoted to the fuels and oxidizers developed for use in rocket engines as well as in air-breathing engines. A synopsis of information from our studies of some of these materials, with particular reference to hydrazine, 1,1,-dimethylhydrazine (UDMH), and several boron hydrides, will be presented. Attention will be given to acute and chronic toxicity, mechanism of action, and treatment measures. The scope of projected studies will be outlined.

An Intra-Plant Labeling Program for Hazardous Materials. DARREL D. DOUGLAS, B.S., Boeing Airplane Co., Seattle, Wash.

The paper describes a program for the application of warning labels to safety cans or other containers into which hazardous materials may be placed after entrance into the plant. Ideally, any warning label should inform the user of any and all hazards that the material may have. In order to do this each material used must be investigated and a specific warning label written for it. Each warning label should give the following information about the material: toxicity of material; corrosiveness to living tissue; flammability of material; and indicate if the material is considered poisonous. The warning label should contain signal words, statements of hazard and precautionary statements. In order to produce a set of standard labels the statements of hazard and the precautionary statements should be limited to a few standard statements. Mixtures of toxic materials are handled by noting the relative toxicity of each and putting the material that is considered to be the most toxic on the label. Consideration is given to relative toxicities and the amount of each present in making this decision. The actual mechanics of our warning label system is handled as follows: Materials are classified and assigned warning labels by the industrial hygiene unit. The classifications are listed in a warning label index. The index is distributed to shops which have occasion to dispense materials. When a material is dispensed, the index is consulted to find the proper warning label. By using the above system of standardized signal words, statements of hazards, and precautionary statements we have been able to adequately label all the common materials used in our plant with a set of 43 different warning labels.

Problems in Space Feeding. HARRY C. DYME, PH.D., Aero Medical Laboratory. Wright-Patterson AFB, Ohio.

The stresses anticipated in space have been studied for their effect on nutritional requirements and the protection against stress that may be afforded by various nutrients. The effects of inadequate, unbalanced or abnormal feeding that may be necessary in space have been evaluated. Based on nutritional requirements that have been established and information as to current and future operational conditions, characteristics of special foods for use in space environments and of equipment necessary to utilize them have been determined. Pre-cooked dehydrated foods with special reconstituting properties that make their use practical in space are under development. Liquid foods, semi-solid foods, and solid foods have been developed for use by men under unique environmental conditions and encased in protective equipment. The proper conditions (temperature, humidity, sanitation, pressure, radiation flux) were determined for storing, preserving, preparing, and dispensing foods and beverages to maintain high quality, safe and nutrionally valid feeding in space. Based on a combination of these, appropriate space feeding systems have been formulated.

Disorientation in U. S. Air Force Helicopter Pilots. MAJOR HERBERT K. EASTWOOD, and MAJOR CHARLES A. BERRY, USAF (MC), USAF School of Aviation Medicine, Randolph AFB, Texas.

In recent years much has been written concerning the importance of disorientation as a cause of aircraft accidents and pilot confusion during flight. The helicopter, in deference to conventional aircraft, is grossly difficult to fly. The flight instruments in the helicopter are usually located in front of only one of the pilot seats; the instructor pilot usually occupying the seat farther from the instrument panel. From this position he experiences great difficulty in performing attitude instrument flying. Instructor pilots in an operational USAF helicopter squadron were queried concerning their experiences with disorientation. One hundred per cent of these instructor pilots had had one or more instances of disorientation in various helicopters. Volunteers from this group were given a more detailed questionnaire and interviewed concerning the details of specific disorientation instances. The results of these questionnaires and excerpts from the specific episodes are reported. The pilots' recommendations as to preventive action will be presented.

Abrupt Deceleration Studies Related to Automobile Crash Forces. 1ST LT. DANIEL L. ENFIELD, USAF, Aeromedical Field Laboratory, Holloman AFB, N. M.

Anthropometric dummies and human volunteers have been exposed to experimental car crash deceleration. Statistically-determined typical accidents were duplicated using salvage vehicles and dummy passengers. The types of crash force thus measured were applied to human volunteers by test devices. Force magnitude was gradually increased until a human tolerance limit was reached.

Laboratory Approximation of Individual Tolerance to Aircraft Carrier Deck Noise. LT. A. ENGEL, MC, USNR, and E. S. MENDELSON, A. B. Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

Medical officers are expected to regulate the exposure to noise of flight deck personnel aboard naval aircraft carriers. Existing estimates of noise tolerance limits are extremely tentative and intentially conservative. They are generally based upon group tolerance rather than upon the tolerances of the individuals involved, largely because of ignorance regarding all of the important factors in individual exposure. Using a laboratory method for assessing auditory reflex reactions in a subject, our experiments deal with a new type of individual tolerance limitation to noise exposure. The magnitude of the measured reflex displacement of the tympanic membrane when the ear is exposed to loud sound may be related to the intensity of the sound. Continued loud acoustic stimulation with tape recorded aircraft noise leads to a depression of the magnitude of the reflex change. This probably signifies that the middle ear muscles no longer protect the inner ear from acoustic insult as effectively as they did at the start of the exposure. Measurements will be reported demonstrating these processes.

The High Altitude Protection Afforded by a Pressure Breathing Mask with Trunk and Lower Limb Counterpressure. SQ. LDR. J. ERNSTING, FG. OFF. I. GREEN, FLT. LT. R. E. NAGLE and SQ. LDR. P. R. WAGNER. RAF Institute of Aviation Medicine, Farnborough, England.

A short duration pressure breathing system employing a pressure sealing mask and counterpressure applied to the trunk and lower limbs has been developed. The system employs a maximum breathing pressure of 60 mm. Hg. at an altitude of 56,000 ft. giving an intrapulmonary pressure of 121 mm. Hg. absolute. Subjects using this system have been exposed to a simulated altitude of 56,000 ft. for periods of up to 6 minutes. In each experiment the physiologic state of the subject was assessed by recording the electrocardiogram, the arterial blood pressure, the respiratory rate and the electroencephalogram. The general performance of each subject was measured by means of a two channel tracking task. In addition each exposure to reduced barometric pressure was recorded on cinefilm. The results of these experiments indicate that this system provides an acceptable degree of short duration protection against exposure to altitudes of up to 56,000 ft.

The Effect of Pressure on Sweating. HELEN M. FERRES, RAF Institute of Aviation Medicine, Farnborough, England.

Kuno's statement that "lying on one side caused a remarkable increase in sweating universally over the upper side of the body" has been confirmed. An attempt to determine whether a similar effect could be produced by pressure on one side of the chest showed no significant increase in sweat production on the opposite side. Application of pressure to one side of the chest must normally be counterbalanced by pressure on the opposite side or by a change in posture, but if the subject lies in a gravitational field of 2 G or 3 G then twice or three times the pressure is exerted on the lower side, and the posture is unchanged. Experiments were made with the subject lying on his side in fields of 1, 2 and 3 G, while sweat was collected on both sides from areas of 26 cm^2 over the lower ribs in the mid-axillary line. The dry bulb temperature was 40° ± 5° C. The sweat production on the upper side increased with increase in G while that on the lower side remained relatively constant. The ratios for upper side/lower side for 1, 2 and 3 G, respectively, were 1.8, 3.0 and 4.3. This increase in the ratio with increasing G suggests that pressure may be the factor which causes the increase in sweat production on the upper side.

An Instrumentation Package for the Measurement of Physiological Response. TOBY FREEDMAN, M.D., and W. V. BLOCKLEY, North American Aviation, Los Angeles, Calif.

Instrumentation has been developed for recording electrocardiograms, skin and deep body temperature, inspiratory mass flow rate, and for telemetering pressure transducer signals. The development of design criteria with consideration for compactness, minimum weight, reliability during physical stress, and comfort of the subject over a prolonged period of application is discussed. Methods for instrumenting the subject are

reported, as are techniques for lead placement and electrode attachment. Modification of the package for total telemetry, additional parameters and remote read-out is proposed. Sample information obtained from instrumented subject is presented.

Design and Operation of a Gravity Independent Photosynthetic Gas Exchanger. ROBERT D. GAFFORD, PH.D., D. E. RICHARDSON, P. E., and AVINOAM DAFNI, M.S., The Martin Company, Denver, Colo.

The use of photosynthesis as a means of regenerating oxygen from carbon dioxide in space cabins has been shown to be biologically feasible. One difficulty of a purely engineering nature encountered in the practical design of such a system results from the necessity of growing algal cultures in contact with air for prolonged periods in the absence of an effective gravitational field. This difficulty is increased by the fact that the algal suspension must be illuminated for photosynthesis to occur. This report describes a method for obtaining the necessary exchange of CO_2 and O_2 between liquid and gas phases in an illuminated culture chamber without depending on the effect of gravity for separation. The design of the apparatus and results of experiments conducted with this equipment are described. These results indicate that in a properly designed system, a hydraulically continuous culture may be obtained and that gas exchange rates are adequate to utilize the potential CO_2 absorbing and oxygen producing capability of a dense algal suspension. A possible design of a system for use in a satellite laboratory is presented.

The Use of Polygraphic Analysis of the "Syncopal Reflex" in Predicting Predisposition to Syncope. PROF. H. GASTAUT, Univ. of Marseilles Faculty of Medicine, France.

The author has studied the clinical and electrobiologic manifestations of about 100 cases of syncope provoked, in a sample of 1,000 subjects, by strong ocular compression. Simultaneous recording of the electroencephalogram, the electrocardiogram, and arterial tension showed that syncopal loss of consciousness, and the convulsions which accompany it in one-third of the cases, always result in a cerebral ischemia secondary to a cardiac inhibition or, exceptionally, from vaso-depression initiated in a reflex fashion by the ocular compression. Thus the syncopal reflex is but an exaggeration of the oculo-cardiac reflex. It is principally observed in subjects who present a spontaneous or acquired neurovegetative instability, and who have a strong tendency to faint in a variety of situations (emotion, pain, orthostasis or thermal elevation). Since transitory losses of consciousness are particularly dangerous in pilots, it would seem worthwhile to screen them for predisposition to reflex syncope by the method of ocular compression during polygraphic recording.

Statistical Analysis of the Electroencephalogram in 500 Young French Military Recruits. PROF. H. GASTAUT, DR. J. BERT, DR. A. ROGER, and DR. M. LEE VAN GOETHEM, Univ. of Marseilles Faculty of Medicine, France.

Previous research suggested to the authors the desirability of studying the EEGs of pilot candidates in order to: (1) eliminate those showing a predisposition to convulsions or syncope; (2) study those who possess the most normal records and who thus can be presumed to have the greatest chance of success as pilots; and (3) develop norms for use in future screening and diagnostic work. It is considered highly important to possess objective criteria of EEG normality in young men of the group from which pilot candidates are drawn. EEGs were therefore recorded for a sample of 500 male military recruits, homogeneous with respect to age (20 years), state of general health, and intellectual level. The "static" and "dynamic" EEG variables for which data were collected consisted respectively of: (1) the presence or absence of the alpha, beta, delta and theta rhythms, and of the frequency, amplitude topography and symmetry of such rhythms when present; (2) of the reactivity and/or tendency to habituation of the said rhythms during stimulation by opening of the eyes, hyperventilation, luminous flicker, and repeated long and short sounds. Data were obtained for a total of 33 EEG variables. With the aid of an electronic computer, these variables were correlated with each other, and with 45 psychological test variables. The analysis also permitted determination of a certain number of patterns characterizing the EEG record of the normal, 20-year-old French male. Results of the comparison of these patterns with selected psychometric variables will also be reported.

A Device for Simulation of Reaction Control Problems in Orbital Maneuvers. JAMES G. GAUME, M.D., The Martin Company, Denver, Colo.

Many human factors researchers are convinced that man is capable of adapting to the conditions under which he would function as a controlling force in space vehicles. The economics of training a man as the controlling element of the space craft dictates that simulation of all possible control problems be accomplished on the ground prior to actual flight tests. This paper de-

scribes a method for simulating some of these control problems, and the design of a device which utilizes this method to accomplish the desired results. Three methods of supporting the simulator were investigated: the gimbal support, the hydraulic support, and the air bearing support. After analysis, the first two methods were discarded as undesirable in future advanced forms of the simulator such as the astronavigation trainer, whereas the air-bearing method is most adaptable to such sophistication. The simulator is capable of unrestrained movement in all of the pitch, roll, and yaw axes, thus allowing three degrees of freedom. Movement is essentially frictionless, and pilot-controllable by the use of reaction jets, thereby duplicating the problems encountered in the use of this attitude control system in a space vehicle. Uses of this reaction control simulator in selection and training of the space pilot, in physiologic and psychologic research, and in the improvement of controls design, are discussed briefly.

Work Proficiency in a Hermetically-Sealed Cabin. S. J. GERATHEWOHL, PH. D., Army Ballistic Missile Agency, Redstone Arsenal, Ala., and J. A. ULICH, PH.D., Psychological Institute, University of Munich, Germany.

Airman first class D. G. Farrell took a simple mental test during his seven-day stay in the space cabin simulator at the USAF School of Aviation Medicine. The objective of the study was to investigate the physiologic and psychologic effects associated with prolonged confinement on proficiency and personality variables. Kraepelin's figure adding test (as modified by R. Pauli, Munich) was taken daily in the capsule, preceded and followed by base line studies on ground level. Because of the known effects of preceding activities, the 60-minute test was administered 5 minutes after the morning work period. There was a steady increase in the number of additions but also in the error and correction scores which, in connection with the increase in variability, indicate that the subject maintained his overall ability to learn and to perform satisfactorily, although he became more and more irritable as time progressed. The results also show that the subject after having reached his proficiency plateau at the sixth day, pulled himself together during his last performance; most probably in anticipation of the end of his confinement. Later results obtained during the ten-day experiment of Balke and Karst will be incorporated if available.

Dynamic Visual Acuity in an Applied Setting. ENS. JAMES E. GOODSON, MSC, USNR, USN School of Aviation Medicine, Pensacola, Fla., and JAMES W. MILLER, PH.D., Kresge Eye Institute, Detroit, Mich.

The recent advances in speeds of operational aircraft and the development of high-speed, visual-contact missions have caused an increasing emphasis to be placed upon the visual problems of the aviator. One of these problems involves the ability to resolve the critical detail of moving targets (dynamic visual acuity). Ludvigh and Miller found that dynamic acuity deteriorates in a manner which cannot be predicted from static acuity when speeds exceed 20° per second. If their findings are applicable in the flying situation, they should be beneficial in improving pilot selection methods. There are two reasons, however, why the same results may not be obtained in the air as were obtained in the laboratory: (1) Laboratory conditions may facilitate a reliability in the results which is masked in the air by such factors as vibration, varying atmospheric conditions, buffeting and anxiety toward flight; and (2) the targets in laboratory studies moved at constant velocities, whereas targets in the applied setting are constantly moving at either accelerating or decelerating speeds. In the present study, a Navy AD-5 (attack bomber) was used to fly subjects over targets (Landolt C's) at angular velocities decelerating from 20°, 75°, and 110° per second. Then the dynamic acuity of each subject was tested in the laboratory using constant angular velocities comparable to those above. Exposure times in the air were the same as those in the laboratory. Three additional laboratory measures of acuity were determined: one static and two other tests of dynamic acuity. The test results are compared, and implications of the relationships are discussed.

Functional Relationships Between Semicircular Canals and Otolith Organs. R. FLANAGAN GRAY, M.A., USN School of Aviation Medicine, Pensacola, Fla.

Evidence concerning some functional relationships between semicircular canals and otolith organs is discussed. The difficulty of distinguishing the functions of these organs is pointed out and these problems are related to rotation at a large radius of turn.

High G Protection. R. FLANAGAN GRAY, M.A., and LT. COMDR. MARTIN G. WEBB, MC, USN, Aviation Medical Acceleration Laboratory, U. S. Naval Air Development Center, Johnsville, Pa.

The principal distortions of the body of a person exposed to increased acceleration include displacement of blood within the

body with undesirable secondary effects such as: (1) loss of vision, (2) loss of consciousness, (3) petechia, (4) pain, (5) heart failure. Other distortions in various parts of the body may also lead to pain. Advantages, problems, and limits of older types of G protective systems are discussed. Theories are presented for methods of using liquid or form-fitting external supports for the body along with respiratory pressurization to counteract the distorting forces. Actual devices worked out to apply these theories are shown. These devices include: (1) the "Mayo tank" first used by Wood, Code, and Baldes in 1942 to test G protection by submersion in water. This has been slightly modified to bring about substantial increase in G protection in 1958; (2) the "G-capsule" and associated equipment which most thoroughly of all devices so far built, is an application of these new theories of body support; and (3) the "NASA-AMAL moulded couch" built by the National Aeronautics and Space Administration according to some of these ideas and incorporating several other devices or procedures such as partial supination to avoid chest pain as indicated by Wright AFB studies. Through the use of these various devices during the past year, several new records of tolerance to centrifugal acceleration have been established, indications have been gained for improvements on these devices, and it is expected that higher levels of G tolerance will be attained.

Comparison of Air Force Noise Fields and Protection Available. MAJOR ELIZABETH GUILD, USAF, Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Noise protection afforded by standard U.S. Air Force ear plugs, muffs, headsets and helmets is described, followed by examples of noise fields encountered on the flight line and in the cockpits and cabins of USAF aircraft in flight. The protection provided by the appropriate devices is then subtracted from the noise levels measured to show the effective noise level for the personnel exposed. Ground support equipment is discussed together with several of the noisiest aircraft, including the turboprops and the latest turbojets. The results are related to the hazardous noise criteria guides. Although current efforts toward development of increasingly easy to use, comfortable and versatile items must and will continue, it is shown that presently available devices can provide protection sufficient for all noise situations to date.

Electronmicroscopical Nerve Cell Changes in the Brain of Syrian Hamsters Following Acute Hypoxia. H. HAGER, W. HIRSCHBERGER, and W. SCHOLZ, Department of Neuropathology, Deutsche Forschungsanstalt für Psychiatrie, Max-Planck-Institut, Munich, Germany.

In order to study the changes of the nerve cells within the cerebral cortex following acute hypoxia, Syrian hamsters were repeatedly exposed to pure nitrogen atmosphere and low atmospheric pressure, another part of the animals was treated with potassium cyanide. A special method of osmic acid fixation by perfusion was developed to avoid a postmortem autolytic breakdown of the ultrastructures. The changes of the submicroscopical structures concerned regularly the perikaryon; the nucleus was generally better preserved. The mitochondria were swollen; the mitochondrial cristae appeared broken and within some of the swollen mitochondria they had more or less disappeared. In the outer zone of the perikaryon, the granular and lamellar components of the endoplasmic reticulum were also disintegrated. The ultramicroscopical findings suggest the interpretation that severe acute hypoxia causes a rise of the intracellular osmotic pressure due to an increasing concentration of osmotically active components.

Prolonged Exposures in Navy Full Pressure Suit at Space Equivalent Altitudes. COMDR. A. L. HALL, MSC, USN, and COMDR. R. J. MARTIN, MC, USN, Naval Air Station, Norfolk, Va.

A U.S. Navy flight surgeon-aviator was fitted and indoctrinated in a Navy Mark III, Mod 2 lightweight full pressure suit. The subject was then exposed to a low pressure chamber to simulated altitudes of 35,000 to 140,000 ft. for 72 hours. Total time above 80,000 feet was 47 hours and 8 minutes. Clinical determinations were made on urine, blood and vital capacity. He was given a psychological battery test before and after the exposure. Continual ECG readings were taken throughout the exposure. Water input was 12,476.7 cc.; water recovered in the urine was 2,000 cc. Total caloric input was 5,550 calories with weight loss 6½ pounds. Oxygen expenditures averaged 11 liters per minute, standard temperature and pressure, dry. Physical examination after the exposure revealed a number of pressure points on the subject, but heart, lungs, liver, gastrointestinal tract, and nasopharynx were normal. The only immediately observable effect of breathing 100 per cent oxygen for 72 hours was a slight conjunctivitis. Examination of the laboratory findings showed the results of a moderate stress situation (eosinophil count up from 222 to 244/cc., 17 keto-steroids from .70 to .88 mgm. per cent). Normal transaminase

values (increase from 16 to 23 GOT units/ml.) indicated absence of muscle or organ pathology.

Performance and Habitability Aspects of Extended Confinement. THOMAS D. HANNA, B.S., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

Six men were isolated and confined in a small chamber for seven days breathing a relatively high oxygen concentration. All men worked every day at each of three work stations a total of 10 hours, slept 8 hours, and spent the remaining time eating, leisure area tasks, recreation, and other duties. Stations 1 and 2 involved two simultaneous visual tracking tasks. In addition, an auditory comprehension task was imposed at station 2. Station 3 consisted of "abstract reasoning" tasks which were concerned with arithmetical reasoning, learning, and intellectual flexibility. During the rest periods, each man performed on weight judgment and time judgment tasks three times a day. Performance on simple routine psychomotor tasks was variable while that on more complex tasks was consistent and sometimes increased in effectiveness toward the end of the confinement period. In spite of expressed limitations in the physical environment, it is concluded that intellectual and psychomotor performance of subjects in conditions like those under test should not deteriorate over a seven-day period. It is apparent that simple routine tasks should be supplemented with more complex tasks requiring higher level behavior.

Effect of Prolonged Cold Exposure on the Blood Chemistry of the Rat. JOHN P. HANNON, Arctic Aeromedical Laboratory, Ladd AFB, Alaska.

Blood chemistry of adult male Sprague-Dawley rats maintained at 5 ± 1° C. for one month was compared to control rats maintained at 26 ± 1° C. Whole blood was assayed for hematocrit, hemoglobin, total ketone bodies and blood sugar. Plasma was assayed for total protein nitrogen, non-protein nitrogen, total lipids, phospholipids, cholesterol, sodium, potassium, calcium, magnesium, chloride, phosphate, water content and specific gravity. Comparisons of fed and 24-hour fasted animals were made. Cold exposure led to increased levels of non-protein nitrogen, phospholipids, cholesterol, magnesium and water content. Cold exposure led to decreased levels of total protein nitrogen and specific gravity. The only differential effect of fasting was on ketone bodies: cold led to an increase in fed animals and a decrease in fasted animals as compared to the fed and fasted controls. Little, if any, difference between cold-exposed and control animals was found in the remaining blood constituents studied.

Heat Load and CO_2 During Simulated Space Flight. CAPT. WILLARD R. HAWKINS, USAF (MC), GEORGE T. HAUTY, PH. D., and LT. COL. GEORGE R. STEINKAMP, USAF (MC), USAF School of Aviation Medicine, Randolph AFB, Texas.

After a careful preflight examination and indoctrination one subject underwent three simulated space cabin flights of 48 hours duration each and 30 days apart. Each flight was conducted at one-half atmosphere or 380 mm. Hg. pressure in which the cabin oxygen was automatically maintained at 150 mm. Hg. pressure. The work program was the same for any 24 hour period. The only changes in the flight profile involved the carbon dioxide concentration to which the subject was subjected, his diet, and the heat load as generated by the wearing of a partial pressure suit. During the first flight the subject was required to wear a partial pressure suit throughout the flight and his diet had a low acceptance rating. The carbon dioxide concentration was allowed to build up gradually over the first 18 hours, reaching a maximum concentration of 38 mm. Hg. pressure. This concentration was maintained for 2 hours and then absorbed. The second 24 hour period was characterized by constant absorption of the carbon dioxide until the 18th hour at which time there was a rapid build up of carbon dioxide, exposing the subject to a maximum concentration of 38 mm. Hg. pressure for 2 hours. The flight profile for the second 48 hour flight was the same except that the partial pressure suit was not worn, thus reducing the heat load. The third and final flight was made under more or less optimum conditions, that is, the carbon dioxide was constantly absorbed throughout the entire flight; a comfortable "shirt-sleeve" attire was worn; and the poor acceptance diet was replaced by those foods which the subject liked. The findings of this study are presented.

X-Ray Examination of the Human Subject During Transverse Accelerations. CAPT. EDWARD J. HERSHGOLD, USAF (MC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Visualization of the thoracic and abdominal viscera by X-ray examination has been accomplished in five human subjects centrifuged in various vectors of transverse acceleration. At 6 G of right sideward acceleration, striking shift of the mediastinum to the left occurs, the heart resting against

the chest wall. The right hemidiaphragm is displaced downward and stretched taut beneath overexpanded lung, while the left hemidiaphragm is elevated. The left lung is quite dense. Barium swallowed under these conditions reveals the upper gastrointestinal tract to be flattened against the left wall of the abdomen. Several of the subjects experienced aching abdominal pain. The ECG at this time shows shifting of the transition zone and slight counterclockwise rotation and left axis deviation. Lateral films taken during forward acceleration in both the upright and 25° forward bending postures demonstrate obliteration of the posterior mediastinum by the retrodisplaced heart, and upward displacement of the diaphragm somewhat more marked in the upright subject. Vascular markings are lost in the anterior portions of the lungs, and there is backward displacement of the trachea and bronchi. There is significant contraction of the thoracic cavity in both the sagittal and anteroposterior diameters, with resulting decrease of the lung area in these planes. This diminution must result in a decreased lung volume, which, together with the visible changes in lung perfusion, could well explain the dyspnea during this acceleration vector.

The Potential Application of Hibernation in Space Travel. RAYMOND J. HOCK, Arctic Aeromedical Laboratory, Ladd AFB, Alaska.

Imminence of space journeys of lengthy duration is focussing attention on problems such flights will impose, such as food and oxygen supply, protection against cosmic radiation, boredom, weightlessness, and the aging of the crews. One possible approach allowing amelioration of these problems consists of the application of a condition approaching hibernation to the crew members.

What do we need to know before man can be safely put into a condition resembling hibernation? First, we must be able to safely lower body temperature to about 50° F. or below, without ventricular fibrillation occurring. Second, we must be able to maintain men for long periods in this condition, instead of the few hours to a day currently employed. Third, arousal from this condition must be achieved with more positive measures than the mere application of heat. A research program aimed at such a practical goal must not lose sight of the necessity for understanding how the true hibernators have solved the problem. Pharmacologic means can then be attempted to induce these changes in man. One example is the shift of energy during hibernation, as this may explain why non-hibernators, such as rats, cannot be maintained for lengthy periods at low temperature. The reasons why hibernators periodically enter and arouse from hibernation points to the fact that some physiologic process or processes cannot be carried on at low temperature. We must understand these limitations, and be able to overcome them in man.

The Application of Basic Human Engineering Principles to a Cockpit Design. GALEN A. HOLCOMB, North American Aviation, Columbus, Ohio.

Basic human engineering data have been available many years which would have enabled the designer-engineer to achieve marked improvement in cockpit layout and composition. A fundamental requirement is the placement of cockpit design control in the hands of one authority, trained in basic human engineering practices. Engineering personnel are required of this authority in order to maintain these standards in terms of practical mechanical considerations. A second requirement is relaxation of dated specification which may lag from 3 to 5 years behind the needs of that particular weapon system. The third requirement is the ability to establish cockpit design under the Weapons System concept. Engineering and product design personnel, with no formal training in experimental or engineering psychology, made radical departures from existing cockpit design practices, in the design of the A3J cockpit. This was accomplished essentially using previously qualified components and making full use of existing data compiled by recognized experimentalists. Design was then given to the engineering psychologist for refinement. Final alterations in control placement resulted from the continuing application of task and link analysis techniques. Design was proven for full pressure suit operation by live evaluation. Slides and motion pictures of the new cockpit will be shown.

Changes in Peripheral Vascular Resistance during Radial Acceleration. SQ. LDR. P. HOWARD, RAF, Institute of Aviation Medicine, Farnborough, England.

Simultaneous measurements of arterial blood pressure and of blood flow through a forearm segment have been used to calculate the peripheral vascular resistance during exposure to 2G and 3G on the human centrifuge. Vasoconstriction has been demonstrated with subsequent vasodilation when the stress is removed. The method used has some disadvantages. It requires a long exposure to the acceleration (5-10 minutes), and cannot be employed in studies of negative G. A simple method of assessing changes in vasomotor tone, depending upon the rate of decline of pressure in an occluded artery, has been used to extend the

work. It has been found that the vasoconstriction increases progressively up to 8 G, which was the highest value employed. With negative G, a decrease in vascular resistance occurs, which is likewise proportional to the level of acceleration.

Bibliographic Control of Aviation and Space Medical Literature. ARNOLD J. JACOBIUS, PH.D., Library of Congress, Washington, D. C.

The modern scientist's dilemma of finding himself lost in a seemingly unpenetrable maze of source materials in his field of specialization is experienced even more acutely by the aeromedical researcher. None of the established indexes and bibliographic tools adequately deal with such a heterogeneous field as also, space medicine. It is for this reason that comprehensive bibliographic coverage has been recognized as an essential implement of an efficiently administered aeromedical research program. This paper endeavors to discuss briefly the scope, purpose, and organization of aviation and space medicine bibliographies in general, and of the one currently prepared by the Library of Congress in particular. Data are presented (based on two years of comprehensive coverage) as to worldwide aeromedical research activities, broken down by countries, ratio of report *versus* monographic and journal literature, and percentual representation of main subject areas. Problems that have arisen during the compilation of the bibliography are discussed, such as how to cope with the increasing volume and ramification of aeromedical and allied literature, whether or not to advocate greater restrictiveness in subject coverage, or what the advantages are of informative abstracts over descriptive annotations or no annotations at all. In conclusion, the aims and outlook for the future are briefly summarized.

Engineering of the Sealed Cabin Atmosphere Control System. STUART L. JACOBSON, Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

The increased emphasis on manned space vehicles has given rise to an intense interest in the environmental control of sealed cabin spaces. In designing an atmosphere control system, the engineer's initial problem is one of selection. The best possible method for accomplishing the function of each subassembly of an atmosphere control system must be determined. Much research and writing has been devoted to increasing the fund of knowledge about various atmosphere control system subassembly schemes. Design of the best total system must begin with an analysis aimed at determination of the weight and volume characteristics for each subassembly as a function of time. These functions must then be added in all reasonable combinations and the sums plotted against time of mission. Because the least dense system is desired (within vehicle volume tolerances) this weight-time curve enables one to choose the mathematically optimum system for a given mission. Choice of the optimum system is then arrived at by consideration of such additional factors as time available for perfection, reliability, and cost. Representing the application of knowledge and experience gained through Air Force work on the problem, the paper presents the results of an extensive general analysis of atmosphere control problems and schemes. Control of carbon dioxide, temperature, and humidity, as well as supply of oxygen and ventilation, are analyzed. Optimum choices are arrived at. In this manner, an outline schedule for future research and development work is indicated.

The Importance of the Utricle in Orientation. W. H. JOHNSON, PH.D., Defence Research Medical Laboratories, Toronto, Canada.

The role played by the different components of the non-auditory membraneous labyrinth in spatial orientation merits attention in the field of aviation medicine. Most attention in this regard has been concerned with the activity of the semi-circular canals. The otolithic receptors, merits special attention because of their apparent stimulation by other types of accelerations which occur during certain types of aircraft maneuvers. The importance of these receptors during the weightless state involving high performance aircraft, rocket flight and orbiting satellites requires elucidation. Difficulty in interpreting the importance of the utricle has been mainly due to lack of confirming experimental evidence. This can be decided most reliably by inactivation of the appropriate branch of the vestibular nerve concerned while leaving the semi-circular canals in a functional state. A program designed to enable this type of investigation will be described together with movies showing the reactions of the operated animals when exposed to the gravity free state involving jet aircraft. Control animals were similarly exposed to zero-gravity and differences were noted in the responses of the two types, thus indicating the significance of the otoliths in the perception of gravity.

The Effect of Boredom on Suggestibility. MARSHALL B. JONES, PH.D., and ENS. JAMES E. GOODSON, MCS, USNR, USN School of Aviation Medicine, Pensacola, Fla.

Pilots frequently report having experienced boredom during long, uneventful flights. There are numerous intimations in the literature that boredom increases suggestibility. This complication might well prove dangerous to the pilot, particularly if he were highly suggestible to begin with. These intimations, however, have never been formally tested. In the present study, twenty-four naval aviation cadets were deprived of all social contact for periods approximating eight hours. Each subject was seated in a narrow stall with only a desk to lean on and blank walls to look at. Sound stimuli were, for the most part, limited to the hum of an air conditioner. The resulting boredom did not stem from an inability of the subject to experience any aspect of his environment (sensory deprivation); rather, it depended upon the absence of anything interesting for him to experience. Immediately following the isolation period the cadets were tested individually for suggestibility. An equal number of control subjects, who had been taking apitude tests for the eight hours, were interspersed among the experimental subjects in a random fashion so that the suggester did not know whether he was dealing with a control or an experimental subject. The subject was instructed to close his eyes, and then was told repeatedly that he was falling forward. The experimental subjects fell more frequently and more quickly than did the control subjects. The possibility that this result might be due to the physical inactivity of the experimental subjects or to a desire on their part to please the experimenters was ruled out by direct experimental tests. It would appear, therefore, that boredom does tend to increase one's suggestibility.

Subcortical Photically and Somesthetically-evoked Electric Activity in the Human Brain during Attention. M. JOUVET, M.D., Department of Neurology and Department of Physiology, University of Lyons, Medical School, France.

During ventriculography before brain sugery or during stereotaxic surgery for Parkinsonism, under local anesthesia, in 14 conscious subjects, a multipolar electrode is stereotaxically introduced in the *radiatio optica* or in the *nucleus ventralis postero lateralis thalami*. Evoker potentials from light flashes of constant intensity or from skin mechanical stimuli are recorded. It has been shown that evoked potentials are greater than the patient pays attention to the stimuli. When the patient's attention is focused on another kind of stimuli (pain, smell, auditory stimuli or mental calculation), there is a great reduction of amplitude of the recorded evoked potentials. In two patients with brain stem lesion and in a comatose state, no variation of photically-evoked potentials could be observed during other stimulations. These findings are correlated with results obtained in animals. It is suggested that a centrifugal system control transmission of afferent stimuli during attention in wakefulness.

Human Psychomotor Performance Under Varied Transverse Accelerations. RICHARD C. KAEHLER, University of Southern California School of Medicine, Los Angeles, Calif.

A series of experiments have been conducted on the human centrifuge to quantify human psychomotor performance under varying conditions of transverse acceleration. The psychomotor parameters under investigation were response time, reach time and adjustment time. These measures were obtained from manipulations of five typical aircraft controls (lever, trim wheel, knob, "push-to-test" button and toggle switch) located in eight different workplace locations. Five subjects were exposed to front-to-back accelerations up to and including 8 G and back-to-front accelerations up to and including 4 G. Approximately 1200 centrifuge runs were made in the course of these experiments. The results demonstrate that all subjects were able to make effective control movements and adjustments throughout the range of the acceleration levels tested. Total time to respond, to reach and to adjust individual controls showed definite increases in front-to-back accelerations of 6 G and above. In back-to-front accelerations, physiologic tolerance is reached at 4 G with only minor decrements in the measures of performance studied.

A Suggested Program Designed to Reduce the Number of Fatalities Occurring During Ejections and Bailouts. CAPT. JOSEPH W. KITTINGER, USAF, Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Sufficient emphasis is placed on parachute and ejection training during the aviation cadet program; however, once the pilot or aircrew member is in an operational outfit this training is not pursued. Regulations require continual refresher training in the use of oxygen equipment, but there is no requirement placed on refresher training on the use of parachutes and escape systems. This lack of familiarity with the escape equipment might cause aircrew members to delay that fatal second when the situation demands immediate action. Several solutions in getting a better aircrew member "psychology of escape" are discussed.

The Effects of Reduced Oxygen Intake on Auditory Sensitivity: I. Bone Conducted Thresholds in a Noisy Environment. SHERWIN J. KLEIN, PH.D., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

This study is one of a series concerned with a systematic attack upon the effects of reduced oxygen intake on auditory sensivity in humans. Seven naval aviators were instructed to inspire, at sea level, a nitrogen-oxygen mixture of 9.6 per cent oxygen. The subjects were regarded as hypoxic after breathing this mixture for a minimum of 8 minutes. Bone thresholds for pure tones, ranging from 256 to 4096 cps in one octave increments, were determined before and after the subject was regarded as hypoxic. Measurements were made in a noisy laboratory where ambient sound pressure levels averaged about 80 db. The data, as treated by the analysis of variance, indicate that the effects of hypoxia on bone thresholds are dependent upon the frequency at which the thresholds are measured. Sensitivity impairment was observed at frequencies below 1024 cps. whereas enhancement was observed at 4096 cps. Sensitivity during hypoxia appeared to be linearly related to frequency. The findings are inconsistent with current hearing theory and several tentative explanations are offered for what appears to be the inverse of expected trends.

The Effects of Reduced Oxygen Intake on Auditory Sensitivity: II. Threshold Shifts in a Quiet Environment. SHERWIN J. KLEIN, PH.D., EMANUEL S. MENDELSON, B.A., and LT. (j.g.) THOMAS J. GALLAGHER, MSC, USN, Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

The object was to determine the effects of reduced oxygen intake on air and bone thresholds in a quiet environment. Five male adults inspired, at sea level, a nitrogen-oxygen mixture of 9.6 per cent oxygen for periods ranging up to 17 minutes. Thresholds were determined before reduced oxygen breathing, 12 minutes after the onset of reduced oxygen breathing, and at 10 minute intervals up to 40 minutes after the subject returned to normal breathing. Determinations were made for frequencies ranging from 256 to 4096 cps. in one octave increments. To minimize practice effects, the orders of presentation of bone and air, at the various frequencies, were randomized throughout. Shifts from the pre-hypoxic to the hypoxic and post-hypoxic thresholds were analyzed by the analysis of variance. The results indicate that during reduced oxygen intake there is an enhancement of auditory sensitivity at 4096 cps. and impairment at all other frequencies. These findings hold for both bone and air conducted signals and are highly significant. It was further observed that enhancement at 4096 cps. persisted throughout the recovery period. The findings are in partial agreement with previous observations. The enhancement phenomenon is explained in terms of compensatory mechanisms.

The Effects of Reduced Oxygen Intake on Auditory Sensitivity: III. Threshold Shifts with Masking in the Opposite Ear. SHERWIN J. KLEIN, PH.D., and ENS. BERTRAM H. LOWI, MSC, USN, and ENS. RICHARD N. FREDA, MSC, USNR, Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

The object was to determine the effects of reduced oxygen intake on bone and air thresholds in the presence of a masked background with an intensity 40 db. above threshold. Five male adults inspired, from tanks, an oxygen nitrogen mixture of 9.6 per cent oxygen for periods up to 17 minutes. As a control, the procedure was repeated with a mixture of 20.96 per cent oxygen. Under the latter conditions, the subjects were led to believe they were inhaling the reduced oxygen mixture. Bone and air thresholds were determined at frequencies ranging from 256 to 4096 cps. in one octave increments. Determinations were made before tank breathing, after 12 minutes of tank breathing, and at 10 minute intervals, up to one hour, after the subjects returned to normal breathing. Orders of presentation for frequency, method of transmission and oxygen mixture were randomized. The masking background was delivered to the ear opposite the one receiving the signal. Analyses were made for: differences between pre-tank and tank breathing thresholds and pre-tank and recovery thresholds; differences between the 9.6 per cent and 20.96 per cent thresholds. Separate analyses were made for tank breathing and recovery thresholds. The results indicate little or no shifts in the thresholds associated with 20.96 per cent oxygen but that the effects of 9.6 per cent oxygen on hearing sensitivity is dependent upon the frequency at which it is being measured. A linear relationship between sensitivity and frequency was observed with impairment decreasing as frequency increases and resulting in enhancement at frequencies above 1024 cps. These differences were significant at the 1 per cent level. The trend was maintained during recovery. The results are in agreement with previously reported findings.

Calculations of the Radiobiological Risk Factors Involved in Future Nuclear Powered Space Vehicles. EUGENE B. KONECCI, PH.D., Douglas Aircraft Co., Tulsa, Okla., and ROBERT TRAPP, M.S., Douglas Aircraft Co., Santa Monica, Calif.

In view of the rapid developments in reactor technology, this study assumes that nuclear power will be available for future space vehicles. In order to extrapolate into the future and evaluate the biological risk factors involved in the operation of a nuclear powered vehicle, theoretical calculations are used to derive ranges of physical parameters involved in an earth-Mars-earth trip. Known radio-biological data is reviewed. A sober appraisal of the possible biological effects, including those from cosmic rays and X-rays from collisions with charged particles in the radiation band around the earth, is made in light of the other multiple hazards involved in space flight. The latter include accelerations and decelerations; hypoxia and decompression due to meteoroidal penetrations, structural leaks and/or leaky seals; accumulation of CO_2 due to ineffective absorption; and reentry heat. Protective devices, like whole and partial body shielding and reduction of ionizing damage or suppression of the radiation sickness syndrome through drugs, are discussed. Preliminary evaluation indicates manned nuclear powered space flight will be feasible. Although the added risk of biological damage to the astronaut due to reactor radiations will depend to a great extent on the exigencies of the mission, it should be possible to hold the dose of acute whole-body radiation within reasonable limits by the proper use of fuel and payload for crew shielding.

Design and Operation of Photosynthetic Gas Exchangers for Closed Ecological Systems. WILLIAM A. KRATZ, PH.D. and LT. COL. JOHN D. FULTON, USAF (MC), USAF School of Aviation Medicine, Randolph AFB, Texas.

Long range studies have been conducted with photosynthetic gas exchangers which provide a continuous recycling of carbon dioxide and oxygen in a spatially restricted closed ecological system. The recycling phase has successfully provided the oxygen requirements for small animals over an extended period of time and the concurrent carbon dioxide requirements of the photosynthetic organisms. Designs of present and future photosynthetic gas exchangers are considered in the following ways: (1) increased efficiency, (2) geometric design, (3) ability to utilize solar energy, and (4) maintenance of a steady state condition of cell synthesis and gas exchange.

Disorientation: An Evaluation of the Etiological Factors. COL. RALPH N. KRAUS, USAF (MC), USAF School of Aviation Medicine, Randolph AFB, Texas.

Dr. Isaac H. Jones described the role of the labyrinth in relation to equilibration in 1918 when he wrote: "Equilibration in general depends upon impulses from three sources--the kinetic-static sense, the sight and the muscle sense." Subsequent experience proved that orientation cannot be maintained while flying without a visual reference. Although the usefulness of the turn indicator, which provided a visual reference, was demonstrated by Ocker in 1918, the practicability of "blind flight" was not generally accepted for over ten years. Today, no one questions the necessity for visual references while flying. Instruments are installed in all aircraft which provide adequate visual cues. Nevertheless, almost all pilots have been disoriented at one time or another. This report will point out some of the factors that lead to disorientation. The length of time required for a pilot in a jet aircraft to transition from VFR to IFR, variations in flight attitude while copying an ATC clearance, and procedures which prevent the pilot from monitoring his flight instruments, will be reported.

Visual Factors in Aircraft Collision Avoidance. J. LAZO and CAPT. R. A. BOSEE, MSC, USN Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

Laboratory and field investigations have been conducted to determine the effect and relative value of such factors as brightness, hue, size, and shape of exterior aircraft coloration schemes on the visibility and noticeability of airborne aircraft. The results of these studies and their application to the increasingly acute collision problem of high performance aircraft is discussed. Coloration patterns for various size aircraft are tentatively proposed for military and commercial aircraft. Further studies to investigate the employment of high visibility (daylight fluorescent) paint preparation to improve in-flight aircraft conspicuity are outlined.

The Use of Skin Resistance to Monitor States of Consciousness. CAPT. EDWIN Z. LEVY, USAF (MC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

A technique of recording skin resistance has been developed which permits graphic recording of changes in skin resistance over long periods of time. A 24-hour tracing, for example, is recorded on 46 inches of writeout paper. Skin resistance tends to rise in relaxation, drowsiness, sleep, and extreme fatigue. This results in characteristic alterations of the pattern of the graphic recording for each of these states. Similarly, a discrete pattern is found for a given person when awake and intensely engaged in an activity, in contrast to the record obtained when he is less involved. Considerable individual variations are found, and it is noted that physical influences such as environmental temperature can profoundly alter the record. Taking all these factors into account, an experimental tool has been devised which furnishes very useful information about a subject's state of consciousness. Using relays, the output of the resistance meter can be employed to signal when a subject may be nearing sleep, or if asleep, when he is waking up. Such a device is potentially valuable in operational circumstances such as prolonged and extremely high altitude flights.

Pre-Solo Flight Grade as a Quality Control Measure. CAPT. VERNE W. LYON, MSC, USN, and JAMES R. BERKSHIRE, M.A., USN School of Aviation Medicine, Pensacola, Fla.

The training records of all graduates for one year were reviewed. Those whose overall grade was in the lowest 10 per cent were identified. For each of these the next case alphabetically was selected as a control. The names were rostered by squadron of assignment. All squadrons at stateside bases were visited and the senior officers asked to identify, from the names, any men who, in their opinion, should not have graduated and to indicate whether the man was unsatisfactory as a pilot, as an officer, or both. They were also asked to identify any other men, not on the lists, who were unsatisfactory. Upon completion of the survey, the training records of the fleet unsatisfactory men were compared with those of the satisfactory men, with the objective of finding minimum grades below which a majority of the men either failed in later training or were unsatisfactory in the fleet. In successive studies of graduates of fiscal years 1955 and 1956, it was found that, of whose pre-solo flight grades were in the lowest 7 per cent, half attrited later in training. Of those in the lowest 7 per cent who graduated, 40 or 50 per cent were unsatisfactory in the fleet. Pilot error accident frequencies among these men were twice normal both in training and in the fleet. It was shown that dropping these men immediately would reduce fleet unsatisfactory graduates by about 20 per cent, while reducing over-all training costs by about 7 million dollars a year.

Problems and Progress in Oxygen Systems of the U.S. Navy. DINO A. MANCINELLI, B.S., EDWARD L. HAYS, B.S., and FRANCIS A. FLORIO, B.A., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

The rational behind newly designed oxygen systems of the U.S. Navy is developed and design details are revealed. The miniaturization of components and the resultant benefits are described. The inclusion of new requirements, generated from operational applications, are reviewed and the resulting design features are discussed. Information regarding handling problems of liquid systems are presented and details describing methods for increasing handling efficiency are disclosed. A brief forecast of supply systems being proposed to overcome many of the handling problems associated with liquid oxygen or high pressure source supplies is set forth. The possibility of these systems as environmental components for "space flight" is briefly discussed.

A System of Positive Identification of Casualties in High Performance Aircraft. COL. VANCE H. MARCHBANKS, JR., USAF (MC), Loring AFB, Me.

Accident investigation in high performance aircraft such as the B-52 jet bomber and KC-135 (military version of Boeing 707) involves multiple casualties and is more complex than conventional type investigations. The impact force and disintegration contributes to the complexity, and remains are disintegrated to the extent that gross identification is impossible without the use of clinical laboratory assistance. A system of investigation is presented to organize the investigation in such a manner that casualties can be identified by using a grid map; blood types (to include subgroups); dental identification; and gross identification markings such as finger and foot prints. The system is designed to facilitate positive identification to meet legal, military and personal requirements.

Projecting Man's Brain Into Space. ALFRED M. MAYO, Douglas Aircraft Co., El Segundo, Calif.

The control of remote devices by a human being can be made more effective and flexible by allowing the human operator mentally to place himself in the vehicle he is controlling. Control need not be continuous as in air-

craft and automobile systems. The ability to reprogram automatic systems to take advantage of incoming data on a real time basis may be the key to safe and effective probing of potentially dangerous situations. The operator of the system can be remotely positioned in an environment conducive to high mental efficiency. His actual location can be a function of the effectiveness of remote sensory and transmission systems. His effectiveness will be a function of the quality of the computation and display system providing him with decision making and functional data.

Suppression of Vestibular Sequelae Following Rapid Rotation. BRIAN F. MCCABE, M.D., and MERLE LAWRENCE, PH. D., University of Michigan Medical School, Ann Arbor, Mich.

It appears highly probable that man can, upon occasion, alter the functions of his normal vestibular centers. Evidence is taken from a group of individuals who demonstrate this ability quite clearly. Expert figure skaters, without recourse to "spotting" but through some process which is probably central suppression, can avoid all the usual sequelae to brief rapid rotation, viz., staggering, dizziness, disorientation, nausea and nystagmus. This is demonstrated and studied by means of high speed and regular motion picture photography. A 15-minute movie will be presented.

Discussion of the Abnormal Stresses Imposed on the Pilot during the Manhigh III Balloon Flight. II. Subjective Impressions of the Manhigh III Pilot. LT. CLIFTON M. MCCLURE, USAF, Aeromedical Field Laboratory, Holloman, AFB, N. M.

Noted in particular is the complete absorption in this flight to the point that vital normal functions, such as eating and drinking, were overlooked well past their normal time. Also observed is the inability to detach onself from such interesting work long enough to recognize one's own physical symptoms that would bring about rejection of the cause-situation. The reactions and thought processes are also discussed when the pilot realizes the actual physical situation, its possible results, and the time element that is clearly established before this condition can be relieved.

Automatic Inflation of Personal Flotation Gear Prior to Water Entry. R. L. MCLAUGHLIN, Douglas Aircraft Co., Santa Monica, Calif.

There is evidence to suspect wind blast alone is sufficient to render a man unconscious during ejection seat egress from an aircraft travling at speeds near Mach one. Add to this non-fatal injuries resulting from flailing arms and legs or impact with flying debris and you have a crewman who needs some automatic assistance to survive, especially in water, even though the ejection itself is considered successful. By the same token, there is reason to believe the crewman who effects an over the water escape from an aircraft, completely unharmed, also needs help to survive. Cold water can numb minds and fingers quickly. It is not necessary to go down three times to drown, but rather it is possible to drown or enter into a strangling tracheal spasm on one gulp of water. Parachute canopys and shroud lines can entangle and restrict the most powerful swimmer. The help needed is automatic inflation of personal flotation gear. Because it is possible to drown or strangle so easily, personal flotation gear should be inflated in the air *before* water entry to hold submersion time to the minimum.

Renal Plasma Flow under Positive Acceleration. JOHN P. MEEHAN, M.D., Univ. of Southern California, School of Medicine, Los Angeles, Calif.

Exposure to positive acceleration elicits a pressor response that may reasonably produce a change in the over-all vascular resistance of the kidney. A study of PAH and creatinine clearances has been undertaken in an effort to determine the extent to which the renal circulation is involved in this pressor response. Subjects were exposed to an acceleration of 3 G for 10 minutes on the human centrifuge. By means of a constant infusion technique, PAH and creatinine clearances were determined for a 20 minute period that included the 10 minute G exposure. Automatic blood sampling permitted proper timing for the blood samples. Renal plasma flow during acceleration is below resting control values. Because of changes in renal arterial and venous pressures under positive accelerations, renal vasoconstriction is indicated.

Objective Determination of Sound Attenuation by Ear Defenders in Intense Sound Fields. E. S. MENDELSON, A.B., LT. A. ENGEL, MC, USNR, and ENS. R. LENTZ, MC, USNR, Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

A new method for determining the protective value of ear defenders has grown out of studies on the auditory reflex. The relationships between the magnitude of reflex displacement of the tympanic membrane and the stimulus amplitude may be established for various audible sounds. The up-

ward shift in effective amplitude of stimulus required to elicit comparable magnitudes of the reflex reaction provide an estimate of the effect of an ear defender upon ambient auditory overload. In general, the values obtained with various ear plugs and with ear muffs by this method parallel the threshold shift values determined at the lower amplitudes of audible acuity.

Effect of Continuous Human Exposure To an oxygen Tension of 418 mm. Hg. for 168 Hours. E. L. MICHEL, M.S., LT. R. W. LANGEVIN, MC, USNR, and CAPTAIN CHARLES F. GELL, MC, USN, Air Crew Equipment Laboratory, Naval Air Material Center, Naval Base, Philadelphia, Pa.

The present study attempts to define more clearly that upper critical oxygen tension involving humans at decreased atmospheric pressure. Six volunteers were confined for 168 hours in an altitude chamber at 10,000 feet (523 mm. Hg.) simulated altitude breathing 80 per cent oxygen. This continuous exposure to an oxygen tension of 418 mm. Hg. was without marked effect on the general appearance, activity, and physical well being of the subjects. However, signs of pulmonary irritation indicated that the tolerable human limitations for prolonged exposure to a higher than normal oxygen concentration may have been approached.

Final Philosophy and Design of Oxygen Equipment for Jet Transports. ARTHUR E. MILLER, Scott Aviation Corp., Lancaster, N. Y.

The six-year history of the events leading to the development by the industry of new present-day jet transport oxygen equipment is reviewed. The many controversial aspects, and the compromises and solutions effected, are recalled. Final requirements representing a compromise between the industry and the CAB are itemized and explained. Examples are cited of the cooperation between airplane manufacturers, airlines, oxygen equipment manufacturers, and regulatory bureaus. Passenger oxygen systems of the several newest jet transports are illustrated and discussed, and the latest designs of oxygen masks for flight crews are reviewed and compared.

"Motion Sickness" in a Helicopter Simulator. JAMES W. MILLER, PH.D., Kresge Eye Institute, Detroit, Mich., and ENS. JAMES E. GOODSON, MSC, USNR, USN School of Aviation Medicine, Pensacola, Fla.

Simulation of operational aircraft has become an increasingly important aspect of flight training for a number of reasons, e. g., economy, safety, expediency. In 1956 a helicopter simulator (2-FH-2) was installed; was designed for the dual purpose of evaluating a point source system of optical projection and as a possible means of facilitating the training of helicopter pilots. During the initial stages of utilization a number of problems arose concerning the desirability of employing this device as a training instrument. One of the most serious difficulties encountered was that of so called "motion sickness." The term motion sickness used here must be qualified because the cockpit did not actually move. All sensations of motion were produced by visual cues. In spite of this, a large number of individuals experienced severe vertigo and nausea while "riding" in the simulator or upon completing a "flight." Instructors seemed to be considerably more subject to these symptoms than did students to the extent that from 50 to 60 per cent of instructors "riding" in it experienced some degree of unpleasantness. The problem became so serious that it was one of the chief reasons for discontinuing the use of the simulator as a training device. The purpose of this paper is to describe some of the factors thought to be responsible for producing these experiences.

Supersonic Ejection Tests at SMART. FIRST LT. F. MOORE, JR., USAF, Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

To investigate further and attempt to define more accurately the human tolerance limits to open ejection seat escape, a program of supersonic tests was conducted at the SMART facility during the fall of 1956 and spring of 1957. Chimpanzee subjects were ejected and successfully recovered at speeds from approximately MO.9 to M1.4. The problems of equipment and instrumentation design are discussed; a brief résumé of test results and conclusions as well as test philosophy will be summarized. An 8 minute 16 mm. color sound film is available for presentation which traces a typical test run from start to finish, including a description of specialized test equipment.

A Consensus of Design Criteria for Oxygen Mask Retention Devices. WILLIAM D. MORTON, JR., B.S., Sierra Engineering Co., 123 E. Montecito Avenue, Sierra Madre, Calif.

Current statistical information on the number of military crew members attempting emergency escape from jet aircraft and

being fatally injured because of involuntary loss of their helmet and oxygen mask, points out the need for an improved design in mask to helmet retention devices. Subjective comments from military flight personnel, and engineering evaluation of a number of approaches to this problem, has provided analytical design criteria valuable to ascertain a fully effective mask and helmet retention system. Utilizing this consensus of design criteria, a few practical designs of retention devices have been fabricated. The paper will cover the results of evaluation of the retention devices when submitted not only to high windblast which is only one part of the essential design criteria, but to the critical tests of comfort, fit and integrability. Subjective tests were conducted and reaffirmed the conclusion that variables other than windblast retention dictate the final design criteria. It is concluded from work described above that suitable mask-to-helmet retention devices must incorporate features which satisfy the maximum comfort and fit as well as ultimate strength to meet the overall objective in retention mechanism design.

Aircraft Accident Fatalities; A Challenge to Aviation Medicine. Col. H. G. Moseley, USAF (MC), Norton AFB, Calif.

During World War II, approximately 70 per cent of USAF combat fatalities were due to aircraft accidents. During the same period, over 14,000 military personnel were killed in aircraft accidents in the United States. Since this time there has been no significant decline in deaths due to this cause, and aircraft accidents currently account for more fatalities among USAF flying personnel than all diseases and other injuries combined. Concerning future flight, increased aircraft performance carries increased destructive potential. The causes of aircraft accidents and fatalities are known and are not expected to change significantly. These causes are discussed in detail and remedial measures are reviewed. The role and responsibilities of aviation medicine in this enterprise are emphasized.

Nontechnical Human Factors in the Mixed Missile-Aircraft Organization. Channing Murray, Arctic Aeromedical Laboratory, Ladd AFB, Alaska.

Nontechnical personal and social factors, such as the mission value of various U.S. Air Force occupational specialties and contingent personal *esprit* and *esprit de corps* elements, are described in relation to emotional reactions to the "black box" of personnel being displaced due to technological change. Some special mental hygiene problems encountered when the pace of such change and allied military practices blur the distinctions between contract civilian scientists and engineers and operational military personnel are noted. Unplanned mental hygiene implications of military technical performance such as countdown, backout and trouble-shooting as well as consequences of planned incentive measures such as flight pay, individual or group rotation of duty assignment are outlined. Tentative suggestions regarding unconventional morale measures are mentioned.

The Neutralization of the Acute Effects of Hypercapnia by a CO_2 Buffer. Gabriel G. Nahas, M.D., and Capt. E. C. Jordan, MC, USA, Walter Reed Army Institute of Research, Washington, D. C.

Hypercapnia was induced in dogs by "apneic oxygenation," a condition of ventilatory arrest induced with succinylcholine (following 1 hour of ventilation with 100 per cent O_2) and during which the trachea is connected to a reservoir of pure O_2. After 1 hour of apnea one observed: (1) a 50 per cent fall in arterial O_2 saturation; (2) a rise in arterial pCO_2, e.g., to 376 mm. Hg.; (3) a fall in arterial blood pH, e.g., to 6.56; and (4) a drop of the plasma $\frac{HCO_3}{H_2CO_3}$ to 3. Signs of severe hypercapnia are present: Wide fluctuations in blood pressure, bradycardia, cardiac arrythmias, a 200 per cent increase in intracranial pressure, a rise in serum potassium and anuria; 40 per cent of all dogs die within the hour of apnea. In the present experiments, 8 female dogs were submitted to 60 to 80 minutes of "apneic oxygenation." At the onset of apnea an intravenous isotonic infusion of 2 amino-2 (hydroxymethyl) 1-3 propane diol was administered at the rate of 1 ml./kg./min., a quantity deemed sufficient to neutralize the estimated amount of CO_2 produced. After 1 hour of apnea: (1) Arterial O_2 saturation was 100 per cent, (2) average arterial pCO_2 was 89 mm. Hg, (3) arterial blood pH was maintained within .1 pH unit of the pre-apneic level and averaged 7.37, and (4) the plasma $\frac{HCO_3}{H_2CO_3}$ was 19. Mean blood pressure was unchanged; heart rate decreased but no arrythmias occurred; cerebrospinal fluid pressure did not change. Serum potassium remained constant; instead of renal shutdown there was profuse diuresis; 24 per cent of the estimated CO_2 produced during apnea was recovered in the urine. All these animals survived with-

out any apparent ill effects, 3 of them undergoing successfully a second period of apnea 2 to 3 weeks after the first one.

"Passenger Phlebitis; A Complication of Long Distance Aerial Travel." LT. COL. MAX J. NAREFF, USAF (MC), Hq., U. S. Air Forces in Europe, Wiesbaden, Germany.

A series of eight cases of thrombophlebitis is presented. All occurred following long flights in military transport aircraft with varying seat configurations. One patient died, two had prolonged morbidity due to pulmonary infarction and in another pulmonary embolism was presumed; one developed chronic venous obstruction. Pathogenic mechanisms are discussed. Prolonged sitting and immobility played dominant roles in causation. The occurrence of previous venous disease or thrombosis in five of the patients indicated predisposition. "Passenger phlebitis" should be suspected whenever leg or chest symptoms follow long flights. Passengers should be briefed regarding prolonged immobility, particularly where previous venous disease or thrombosis has occurred. This complication of long distance travel may be more common than heretofore appreciated. If so, the need for restudy of seat configuration and "high-density-seating" is suggested.

Leadership Measures in the Prediction of Fleet Success. LT. (JG) WILLIAM F. O'CONNOR, MSC, USN, USN School of Aviation Medicine, Pensacola, Fla.

In addition to being an able aviator, the fleet pilot must be a satisfactory naval officer. This paper compares the utility of two leadership indices obtained in early training as predictors of fleet success as an officer. Leadership peer ratings are obtained in the seventh week of training. These are the averages of ratings of officer potential awarded by the man's section-mates. The second measure is the officer-like-qualities (OLQ) grade, computed after 16 weeks of training. This is a composite grade, with equal weights given to: (1) military grades based on inspections, drills, deportment, et cetera; (2) leadership ratings made by officer instructors; and (3) the leadership peer rating. Thus the comparison is between a composite and one of its components. Leadership peer ratings and OLQ grades of 1,762 trainees were separately converted to standard score form and the percentages of training failures at each score level computed. Of the lowest 5 per cent on peer rating score, four out of five attrited later in training. Of those at this low level who did graduate, four out of five were unsatisfactory in the fleet. The OLQ grade was less efficient as a predictor or a screening measure. An in-training "tagging" system was recommended, using low peer ratings to earmark trainees of low potential for elimination at their first training difficulty.

Fatal Decompression Illness at an Altitude of 22,000 Feet. MAJOR LAWRENCE T. ODLAND, USAF (MC), Hq. Fifth Air Force, Japan.

A two-place jet aircraft took off at about 2200 hours on a classified mission. Six minutes later, at a flight altitude of 10,000 feet, the pilot stated he was a bit uncomfortable because of certain type of survival equipment being used, but otherwise all right. Twelve minutes after take-off, flight altitude was noted to be 29,000 feet and cabin altitude 22,000 feet. Eighteen minutes after take-off, the pilot complained of feeling sick but continued on the mission. Twenty-nine minutes after take-off, severe chest pain was experienced by the pilot, and the observer requested oxygen regulator be switched to 100 per cent oxygen. Acknowledgment was made of request but five minutes later the pilot became unconscious. The cabin altitude never exceeded 22,000 feet. Twelve hours later, the pilot died without regaining complete consciousness. The working clinical diagnosis was pulmonary or myocardial infarction, and therapeutic efforts were geared toward combatting what proved to be irreversible shock. Gross post-mortem studies revealed considerable obesity, patent foramen ovale, hyperemic and edematous lungs and brain. Microscopic sections stained specially for fat particles revealed multiple fat emboli in the kidneys, lungs, and brain. Coronary vessels were patent and the myocardium showed no evidence of infarction. The oxygen was analyzed and found to be pure within limits of procurement specifications. This case is considered unusual in that it occurred at an altitude lower than any previous fatal aviation decompression illness.

Is He Fit to Fly? A Report on the "Special Board of Flight Surgeons" at the Naval Aviation Medical Center. CAPTAIN PHILIP B. PHILLIPS, MC, USN, USN School of Aviation Medicine, Pensacola, Fla.

The need for, composition of, and studies by the recently established "Special Board of Flight Surgeons" at the Naval Aviation Medical Center, Pensacola, are described. Over 300 aeromedical problem cases have been referred for comprehensive study in the first two years. Several brief charts are

shown to illustrate graphically the types of problems and the advantages of such a specialized group in answering the question, "Is he fit to fly?"

Brain Injury from High-G Pullout? CAPTAIN PHILIP B. PHILLIPS, MC, USN, and COMMANDER J. J. ZARRIELLO, MC, USN, Naval Aviation Medical Center, Pensacola, Fla.

A young flight student experienced a stuck trim tab in a dive bombing run and had to exert exceptional force to stop the dive and save his life. He experienced a 9 G force which apparently resulted in a cerebellar injury with ataxia, dyssynergia, past pointing dysarthria, and dysgraphia. After medical and neurological examination he was grounded, and followed carefully for approximately six months during which all symptoms gradually cleared. He was checked by EEG, the human centrifuge, psychological tests, and by several actual test flights, and finally approved for full flight duty and has been an instructor for several months. No similar case could be found in the literature. This is reported because of the clinical interest it should be to flight surgeons.

Hormonal Factors in the Resistance of the Mammal to Acceleration Stress. B. DAVID POLIS, PH.D., Aviation Medical Acceleration Laboratory, USN Air Development Center, Johnsville, Pa.

The reactions of the mammalian organism to acceleration stress involves circulatory, central nervous and respiratory responses to such an extent that the importance of the endocrine system in adjustment to this adverse environment is self evident. These studies were designed to reveal possible hormonal factors operative in the utilization of biological energy at a cellular level that would contribute to the survival of the animal under high acceleration forces. The heart rate obtained by a transistor amplified ECG adapted for use on an eight-foot animal centrifuge defined a physiologic end point of tolerance to 20 G as the time for the heart rate to fall from an initial rate of 7 beats to a final rate of 2 beats per second. With this criterion normal Sprague-Dawley rats survived 20 G for 10 minutes (50 per cent lethal level). Hypophysectomy provided an appreciable measure of protection against G stress in that the mean survival time was increased to 30 minutes. Injection of ACTH decreased the protective action of hypophysectomy. Adrenalectomy decreased the tolerance of the animal to G stress as indicated by a mean survival time of 4 minutes under 20 G. Adrenalectomy and hypophysectomy reversed the decreased tolerance to G stress obtained with adrenalectomy alone. The data were interpreted to indicate that the protective action of hypophysectomy was due to the elimination of adrenocortical hormones and pituitary hormones which are important for the resistance to other forms of stress.

Electroencephalographs of 1,000 Naval Aviation Candidates. WING COMDR. THOMAS J. POWELL, RCAF and HARLOW W. ADES, PH.D., USN School of Aviation Medicine, Pensacola, Fla.

Electroencephalographs have been taken routinely on all U. S. Naval aviation candidates, including naval aviation cadets, aviation officer candidates, and officers under aviation instruction. The study was undertaken partly to provide a baseline EEG for each future naval aviatior because of the frequent need to evaluate neurological status after head injuries. A potentially more important function is that of obtaining basic information which may help to establish criteria for prognostication of aptitude for aviation or proneness to altered states of consciousness which would be dangerous to the aviator. The percentage of individuals showing abnormal components is comparable to that found in other surveys of this kind, allowing for some variation of interpretation. Particular attention has been given to unusual reaction to hyperventilation and recovery from such reaction. Correlations between EEG characteristics on the one hand and psychological tests, performance in preflight and early flight training on the other, will be reported.

Essential Characteristics of a "Global" Survival Ration. LT. COL. JOSEPH M. QUASHNOCK, USAF (MC), and CHANNING MURRAY, Arctic Aeromedical Laboratory, Ladd AFB, Alaska.

Recent research findings relevant to nutrient requirements under such conditions as fatigue, extreme temperature and unfamiliar, forced, physical activity are considered, including the effects of unbalanced diet composition on psychophysiologic capabilities to adjust to weather stress. Rationale underlying previous and current food packets for preflight, in-flight, trail and survival use are outlined. Unresolved military ration problem areas such as acceptability, stability, kind and quantity of nutrient are mentioned, and tentative criteria for a single global survival ration are presented.

Three Years' Operational Experience With Physical Defects in Active Flyers. LT. COL. ROBERT K. QUINNELL, and MAJOR JACK H. ROBBINS, USAF (MC), Hq. Fifteenth Air Force, March AFB, Calif.

This study, adapted from personal experience and individual medical records, includes more than 1,000 rated officers on flying status who are known to have one or more disqualifying physical defects, yet continue to perform exacting flying duties in combat as well as in administrative aircraft. An outline of the various job requirements, hazards involved, and a general explanation of the physical standards introduce the subject. A tabulation of the number, type, severity, and duration of the various defects depicts the scope of problems confronting practitioners of aviation medicine. Selected medical cases of an unusual or uncommon nature, and representative cases of frequently recurring problems are specifically discussed. Comparative figures for the various defects for the years 1956, 1957 and 1958 demonstrate the need for increasingly vigorous application of the principles of preventive and aviation medicine to maintain an efficient fighting force despite the apparent effects of advancing years, increased complexity of weapon systems, manpower restrictions, and residuals of injuries or disease. Follow-up results include comments regarding the degree of proficiency demonstrated by these handicapped individuals, with implications for the future. The report offers operational experience in support of the physical standards program. An attempt is made to present the practical everyday aspects of aviation medicine as encountered by the average practitioner.

Impact Protection Characteristics of Flight Helmets. J. W. RAEKE, North American Aviation, Los Angeles, Calif.

This study represents an attempt to determine the impact protection characteristics of three types of flight helmets. Tests were conducted at a constant impact velocity of 17.6 ft./sec. and at three impact energy levels: 60, 107.5 and 136.5 ft. lbs. Peak resultant acceleration, rate of onset of acceleration, energy absorption efficiency and in several cases impact stress, were determined either directly or indirectly. High speed motion pictures of helmet shell deformation augment the aforementioned quantitative data. Results show that even under the relatively mild test conditions each helmet type displayed at least one undesirable characteristic. The impact response of each helmet type could be significantly improved by relatively minor design or fabrication changes; however, the test as a whole points up the need for a set of minimum acceptable performance standards.

Motion Sickness: A Psychophysiologic Gastrointestinal Reaction. LT. COMDR. ROGER F. REINHARDT, MC, USN, Menninger School of Psychiatry, Topeka, Kan.

Despite its widespread occurrence and peculiar importance to aviation medicine, there is conceptual confusion regarding the etiology of motion sickness. In a recent textbook of medicine the statement is found that "the basic cause of airsickness is violent head motion." Recent papers by Schock, Phillips and Neville, Simons, Gerathewohl, and Sarnoff and Mebane have on the other hand emphasized the psychologic basis of the illness. This paper presents evidence favoring the concept of motion sickness as an emotional reaction to stress, and suggesting that susceptibility is governed by the pattern of the individual's psychologic development. The primacy and primitivity of the labyrinthine system as described by Spitz; the vital importance of posture and position in the nursing situation; the requirement of the toddler for repeated reassurance and confidence if further development is to be successful; the extremes of individual reactions to the weightless state; and the finding of disturbed personality patterns in a few individuals who have been studied because of their motion sickness, all point to motion sickness as being an overdetermined psychologic reaction to disturbing labyrinthine cues. At the present time many flight surgeons are bothered by uncertainty and are unsure of their approach in dealing with these people, due to the lack of an etiology on which they can "hang their hat." It is both practical, and stimulating of further validation, to consider motion sickness as a psychologic disease accompanied by physiologic (autonomic) disturbances. The etiology can be confirmed only by intensive study of the psychodynamics in individuals subject to motion sickness. There is also a need for psychologic tests which will single out those individuals who will respond to positional uncertainty with the syndrome of disabling anxiety and nausea which we call motion sickness.

A Case of Brain Abscess in a Test Pilot. ANTOINE REMOND, Faculty of Medicine and Salpetriere Hospital, Paris, France.

Progress of a brain abscess in a test pilot has been followed for more than one year, since symptoms were first noticed, with a variety of electrophysiological techniques. A severe occipital pain developed during a series of power dives while equip-

ment was being tested. Two weeks later, just before take-off on another test mission in a jet plane, the pilot developed a generalized epileptic fit. An inflammatory process in the right parieto-occipital region was treated surgically. The patient recovered by the end of two weeks, but the hemianopia ended his career as a test pilot. The battery of examinations, which include electroencephalograms, oculograms, scopograms, and topograms, were employed on this subject. They provide a detailed picture of the development of his symptoms and of their subsequent stabilization. The history of this case can be useful to the problems of selection of flying personnel and of their continuing check-ups.

The Frequency and Significance of Unsuspected Pre-existing Disease in Military Aircraft Fatalities. CAPTAIN RICHARD R. ROBIE, and MAJOR VERNIE A. STEMBRIDGE, USAF (MC), Armed Forces Institute of Pathology, Washington, D. C.

Since 1956, the Aviation Pathology Section of the Armed Forces Institute of Pathology has examined the histopathologic material from approximately 900 cases of aircrew victims of aircraft accidents. Although traumatic and environmental factors have accounted for practically all of the deaths, the possible role of pre-existing disease as either a primary or contributing cause of the accident should be considered. This present study is directed toward establishing the type, frequency and possible significance of previously unsuspected disease entities in aircraft fatalities. An attempt will be made to distinguish those conditions capable of producing incapacitation from those conditions associated with debilitation or no appreciable change. Where possible, the pathologic information will be correlated with the past medical history.

Development of a Physiological Pressure Transducer System for Recording Under Severe Accelerative or Decelerative Forces. LEOPOLD J. ROSSBACH, M.S., Allied Research Associates, Boston, Mass.

This is a report of the design and fabrication of a physiologic pressure transducer system for recording under severe accelerative or decelerative forces. The present system specifications include recording the equivalent of zero to 50 cm. Hg. with less than $\pm$ 3 per cent error full-scale, with a response time of 0.001 sec., under accelerations or decelerations of up to 200 G. The transducer itself is a small, blunt nosed, closed cylinder capable of being introduced into the heart of a small dog through the carotid artery. Its design combines evaporation deposition techniques with strain gage principles to reduce to a negligible value the effects of environmental acceleration inputs. The transducer output is amplified and reproduced on a recording oscillograph. Thus, the intralumen transducer system has a very high natural frequency, is capable of operation under severe environmental conditions, and is free of motion artefacts generally produced by pressure generated within the catheter due to accelerations of the contained column of fluid in standard manometer-catheter systems.

Aeromedical Support of the X-15 Program. LT. COL. BURT ROWEN, USAF (MC), Edwards AFB, Calif.

For approximately ten years aeronautical engineers have been recording in-flight data from instrumented aircraft on ground read-out indicators through telemetry. During the flight phase of a research aircraft such as the X-2, the pilot's physiologic status was not recorded during flight. During the flight phase of the X-15 aircraft, physiologic data will be telemetered so that a flight surgeon observing the ground read-out can tell when the pilot is approaching the limit of his physiological tolerance. This will quantitatively identify the most stressful portion of a particular mission profile. Items such as (1) cockpit and suit pressure differential (2) helmet and suit pressure differential, (3) pilot's body surface temperatures, and (4) electrocardiographic data will be monitored during flight by a flight surgeon at the ground receiving station. The overall objective is to obtain in-flight quantitative physiologic data, and to provide information of the man's ability to perform while under stress. Such data will provide future design criteria for the machine which will include the man as a useful component in the system.

Discussion of the Abnormal Stresses Imposed on the Pilot during the Manhigh III Balloon Flight. III. Psychophysiological Aspects of the Manhigh Flight. CAPT. GEORGE E. RUFF, USAF (MC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

This paper discusses and integrates preflight psychiatric evaluation and psychologic testing, performance during the flight, and post-flight impressions. It summarizes all three previous papers with thoughts on space pilot selection in light of this experience from the psychiatrist's viewpoint.

Studies of Isolation and Confinement. CAPT. GEORGE E. RUFF, USAF (MC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

The problem of psychologic stress in long

range missions and space flight can be approached through laboratory studies of isolation, confinement, and sensory deprivation. The objective of this research is to maintain effective crew function in artificial environments. Reactions to isolation and prolonged confinement have been studied by a battery of sociometric rating techniques, direct observation, psychiatric examinations, psychological tests, bioelectric measures (EEG, GSR, and ECG), and biochemical determinations. Fifty subjects have been observed individually and in groups for periods of one to seven days. Data are recorded before, during, and after the experimental period—either continuously or at intervals, depending on the measure employed. A wide variety of reactions to individual isolation and group confinement have been noted. Each subject structures the isolation experiment to preserve a sense of continuity with his previous experience. Changes in emotion, thought, and perception are common, but can be minimized by proper selection of subjects and arrangement of experimental variables. Group confinement appears to overload subjects' mechanisms for handling interpersonal problems. However, where crew members are able to limit their involvement in the experiment, few signs of stress appear.

A Comparative Study of Audiometric Techniques for Use in the Air Force. MAJOR ARTHUR E. RYAN, USAF (MC), USAF School of Aviation Medicine, and CAPTAIN RONALD G. HANSEN, USAF (MC), and HORACE O. PARRACK, PH.D., Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Personnel of a fighter interceptor squadron have received audiometric surveys on four occasions in the past six years. The first of these utilized manually operated audiometers under poorly controlled conditions. In the second and third surveys manually operated audiometers were also employed but the studies were performed by highly trained, well motivated technicians, and extraordinary efforts were made to obtain accurate results. The fourth survey was again performed without special precautions but automatic audiometers were employed. A comparative study is made of the results of each of the four audiometric surveys.

Human Experiments on Air Transport Crash Protection. JAMES J. RYAN, P.E., Univ. of Minnesota, Minneapolis, Minn, and COL. JOHN P. STAPP, USAF, (MC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Modulated Deceleration. It has been found in experimental tests with human subjects on the principle of the hydraulic cylinder and piston for controlled attenuation, that: (1) Hydraulic shock absorbers afford maximum protection to human occupants upon crash; (2) inherent design makes possible protection for different loads, speeds and displacements; and (3) maximum energy absorption is provided with minimum weight, complexity and modification. Applicability on Air Transports. Although the human tests were made with the automobile as the research vehicle, including restraints accompanied by quick retraction of dangerous projections, the hydraulic energy absorber may be applied in air transport crash protection as follows: (1) attachment to seat tracks in a jet airliner; (2) distribution of absorber forces in aircraft structure; and (3) individual absorbers on seat supports. This paper includes calculations, designs and conclusions for maximum human protection in aircraft utilizing hydraulic shock absorbers.

Biologic Aspects of Audiogenic Stress. A. M. SACKLER, M.D., A. S. WELTMAN, M. BRADSHAW, and P. JURTSHUK, JR. Laboratories for Therapeutic Research, Research Institute of the Brooklyn College of Pharmacy, Long Island University, Brooklyn, N. Y.

One and five-minute repeated applications of intense sound stimulation result in weight gain, reduction and significant changes in both endocrine weight and histologic structure in the laboratory rat. The sound stimuli resulted in adrenal hyperplasia, partial inhibition of ovarian activity, reduction in weight and vascularity of the uterus and a loss in liver weight. No changes in either pituitary or thyroid weight is induced by the intense sound stimulus, but significant changes in pituitary cell type and in thyroid colloid storage result. Appetite is affected in these sound-stressed animals and food consumption is significantly reduced. The data are discussed in connection with the physiodynamic theory of abnormal behavior and in relation to the deleterious consequences of intense sound stimulation for endocrine activity.

Radiation Dosage in Flight Through the Radiation Belt. HERMANN J. SCHAEFER, PH.D., USN School of Aviation Medicine, Pensacola, Fla.

Measurements of the *Explorer* satellites and the *Pioneer* rocket have shown that an equatorial radiation belt beyond 1,000 km. altitude is surrounding the earth within which dosages of at least several r per hour prevail. Since the penetrating power of the radiation seems comparatively high, it can be expected that in larger vehicles a substantial dosage increase due to scatter-

ing and production of secondaries will occur. Possible countermeasures are limitation of exposure time and shielding. The latter should be done with the best possible weight economy. The two main types of radiations involved, electrons and protons, obey basically different attenuation mechanisms. For electrons, secondary x-rays, released in the initial layers of the shield, will pose the main problem. Laminated shields, assigning the task of electron absorption with accompanying x-ray production and of x-ray attenuation to different materials, will minimize weight. For protons, nuclear interactions in the shielding material, producing heavily ionizing nuclear fragments and narrow meson cones, heighten the biological effectiveness of the incident radiation. Yet effective shielding does not impose contradictory specifications as compared to electrons. In general, the weight requirements are excessive. It seems inevitable to trespass the official permissible emergency dose of 25 rem by a large margin.

A Correlational Analysis of Pre-Solo Flight Grades. LT. (JG) LEONARD M. SEALE, MC, USN, USN School of Aviation Medicine, Pensacola, Fla.

Performance in pre-solo flight training has been shown to be one of the best predictors of subsequent success as a naval aviator. Thus it is of considerable importance that pre-solo flight grades reflect the performance of students as accurately as possible. This study utilizes multiple correlation methods to identify the best combination of the individual grading factors comprising the pre-solo grades for the prediction of subsequent training and fleet success. Pre-solo grades, selection test scores, and ground school grades were collected on all of the men in 19 student classes (N= 432). The progress of each of the students was followed until they either graduated from training or attrited. Further, an estimate of the probable success of the graduates, while serving in the fleet, was made. Multiple correlations between the 27 measures and the criteria of success/failure in training and in the fleet were computed. The multiple correlations indicate that substantial increases in the validity of the pre-solo grade can be obtained by the elimination of certain grading categories and the optimum weighing of others. The multiple correlation of the training grades and the total attrition (training attrition and fleet attrition) indicate that the pre-solo grade can be modified so as to predict the criterion with increased accuracy.

A Simple Mouth-To-Mask Resuscitation Device. HENRY W. SEELER, Aero Medical Laboratory, Wright-Patterson AFB, O.

Mouth-to-mask resuscitation has been recognized as a highly efficient technique for some time. Realizing the need for a simple and foolproof system to administer mouth-to-mask resuscitation, the author has engaged in the development of a simple and foolproof control valve for this purpose. The valve and associated tubing described in this paper employ engineering and physiologic design principles which direct the subject's exhalations away from the operator, and permit prolonged cyclic ventilation without exposing the operator to the effects of hyperventilation. The design has been reduced to practice and could be adapted to any mouth-to-airway or mask-to-mask resuscitation system. It can be used in normal rescue situations and has been adapted for use with appropriate filters to protect the operator and subject in contaminated atmospheres.

Airborne EEG Recording as a Means of Studying and Selecting Pilots and Crews in High Performance Aircraft and Space Vehicles. C. W. SEM-JACOBSEN, M.D., EEG Laboratory, Gaustad Sykehus Vinderen, Oslo, Norway.

With 8-channel airborne EEG equipment it has been possible during 1958 to test a group of jet pilots, as well as personnel with no previous flight experience, in a T-33 during simulated combat flight. A uniform standardized flight schedule was utilized. On the basis of the EEG tracings 30 jet pilots were divided in three groups according to the changes seen in the records. (A minimal, B marked, and C gross.) The same pilots were graded by the air force I, II and III, according to their flight performances. (I. good to excellent, II. fair, with major or minor accidents, definitely or possibly due to pilot error, III. poor, taken off jet flying.) This grading does not reflect on the pilots' aptitude or intelligence. Of the 19 A-pilots, 16 were I. and three were II. The eight B-pilots were all grade II., and the three C-pilots were all in group III. These results strongly support a close correlation between the changes in the brain as measured by EEG during flight stress and the pilots' ability to perform under these conditions. Airborne EEG recording is demonstrated as a new method for studying the stress to which the jet fighter pilot is subjected. The tracings appear to give promising data about pilots' actual physiologic capabilities under the physical and mental stress of flight. By telemetering the EEG data one may follow the pilots' alertness and level of consciousness.

Potable Water Recycled from Urine. JULIUS SENDROY, JR., PH.D., and HAROLD A. COLLISON, B.S., U. S. Naval Medical Research Institute, Bethesda, Md.

One of the primary physiologic needs for the survival of a human being in a sealed space under extraterrestrial conditions is the maintenance of an adequate water intake. Man's own urine, subjected to a recycling process, offers the main source of supply. Owing to the complexity of composition of this excretory product, a satisfactory method of separating from it, a water free of objectionable color, odor, taste, or toxic materials, has hitherto been lacking. An approach to this problem will be presented in the form of a laboratory process which aims at the optimum in respect to the requirements of rapidity, percentage yield, and purity of product. Water so obtained from human urine, in a yield of 70 per cent, has been found to be colorless, and indistinguishable, by taste and smell, from ordinary distilled water. Traces of ammonia, chloride, and spectrophotometrically significant impurities were barely detectable. This water was made available to a colony of 12 rats as their sole source of supply for a period of more than 30 days; their daily consumption of it averaged 13 per cent of their body weight (the equivalent of 8 liters per day by man). Observation during the experimental period indicated comparable weight gains and a lack of clinical symptoms, in both control and experimental animals. Pathologic examination of the primary organs of brain, lungs, heart, kidney, and liver, showed no lesions which could be related to a toxic effect of the water reclaimed from urine.

Human Factors Support of Weapon System Testing at the Air Force Flight Test Center. MAJOR PHILIP S. SHAFER, USAF, Edwards AFB, Calif.

Human factors engineers at the Air Force Flight Test Center are a part of the test force team in the engineering evaluation of aircraft weapon systems undergoing development flight testing. Design and functional characteristics, as related to the man side of the system, are evaluated in terms of mission performance, safety of flight, and maintainability under test and operational conditions. Pilot and maintenance crew opinions are organized into center opinions on optimum design features which are fed back into production systems and into U. S. Air Force design standards. To validate test pilot opinions, follow-up studies were made in the using commands on two aircraft weapon systems. Results indicate that test pilot opinions on cockpit design features have a high degree of validity in predicting operational acceptability.

Myocardial Infarction in USAF Flying Personnel: A Survey of 70,000 Electrocardiograms. CAPTAIN GEORGE B. SMITH, JR., USAF (MC), and LAWRENCE E. LAMB, M.D., USAF, School of Aviation Medicine, Randolph AFB, Texas.

Myocardial infarction cannot be considered as only a disease of the aged. A review of 70,000 electrocardiograms of USAF flying personnel in all age groups has been completed and the instances of myocardial infarction will be discussed, with particular reference to occurrence in younger age groups. One group of individuals has a classical symptomatic history of myocardial infarction. The other group has no significant history of chest pain or of other cardiovascular abnormalities and in this group the diagnosis of myocardial infraction is unsuspected until demonstrated by screening electrocardiogram. The use of the vectorcardiogram in evaluating electrocardiographic criteria suggestive of myocardial infarction will also be discussed. Clinical examples will be used to illustrate these points, and to stress the importance of electrocardiographic examination in young persons on flying status.

The Development of a Zero Altitude Escape System for Subsonic Airplanes. E. W. SMITH, North American Aviation, Columbus, Ohio.

Zero altitude, subsonic escape system design objectives were established as follows: (1) single stage initiation, (2) system reliability-fully automatic, (3) automatic torso retention and release, (4) predictable aerodynamic stability, (5) sustained vertical thrust to gain maximum altitude above airplane flight path, (6) addition of drag to the ejected mass to reduce deceleration time at higher speeds, (7) non-separation of man and seat above 10,000 feet to control free fall stability, (8) parachute ripcord pull by separation of seat and man (elimination of long time delays in automatic parachute openers). A three-stage thrust system was incorporated consisting of: (1) ballistic catapult to eject mass from airplane, (2) rocket to apply sustained thrust to the seat-man in the airstream, and (3) gas expanded bladder to eject airman from seat at separation. Weight studies disclosed a 1.25 inch differential between the 5 and 95 per cent seat-man with respect to the rocket thrust line. Weight and space considerations prohibited the use of aerodynamic aids or elaborate timing systems. Dynamic studies revealed the need for larger head plate area for the 95 per cent man and less for the 5 per cent man. Design provides automatic head plate area variance by accommodation of the 5 and 95 per cent man in order to obtain the

proper eye position. This was accomplished by holding the headrest stationary and varying the bucket height. All functions of the system are automatic after initiation, including separation. This system was developed for the Navy T2J Trainer.

The Development of a Zero Altitude Escape System for Supersonic Airplanes. E. W. SMITH, North American Aviation, Columbus, Ohio.

A zero level-supersonic escape system presents formidable problems not encountered in the subsonic system. These are: (1) heavier structure capable of withstanding 2,500 psf impact pressure, (2) control of drag-weight ratio at high speeds, (3) automatic retention and release of arms, legs, and torso, (4) control of seat-man attitude during high speed ejection to insure transverse G loading, (5) variable parachute opening time delay system acting as a function of dynamic pressure and altitude to activate short time delays at low speed-low-level and longer time delays at high speed. Physiologic design allowables used were: 35 G transverse 20 G positive and 10 G negative. Due to the constraints of space and weight, a simplified "box kite" collapsible fin system was utilized together with a drogue parachute. A lift plate on the seat bottom acts to cancel negative lift forces at the 17° ejection angle to gain altitude at higher speeds. Stability in pitch and yaw at high speed is controlled by dynamically balancing the reactions of the fins, lift plate, head plate area, and rocket thrust. Positive (rearward) pitching is achieved at high speed in this manner, and, at low speeds by rocket thrust moments. Fast drogue deployment is utilized to "catch" positive pitching overshoots at low speeds where significant aerodynamic forces are not present. System was developed for the Navy A3J *Vigilante* attack aircraft.

Medical Disqualification for Flying Status: Compilation of Significant Conditions, Calendar Years 1956 and 1957. LT. COL. FREDERICK S. SPIEGEL, USAF (MC), Headquarters U. S. Air Force, Washington, D. C.

The most numerous medical causes for indefinite suspension from flying status in the U. S. Air Force are presented for the calendar years 1956 and 1957. Recording and tabulations are based upon a modification of the Joint Armed Forces Stastistical Classification and Basic Nomenclature, 1949. The compilation presented is broken down to indicate type of flight rating and whether or not a medical waiver was granted. It has been known for a long time that certain conditions are the most frequent causes for physical disqualification for flying status. Six medical conditions account for one half of the total disqualifications. Of these, encephalopathies including syncope, peptic ulcer including gastric resection, and psychoneuroses comprise one third of the grand total. The method of recording and tabulation as presented, when continued for several additional years, will yield further valuable information which will assist in evaluating the validity of aeromedical policies regarding physical qualification for retention on flying status.

The Use of Task Analysis Techniques in Weapon System Development. ERNEST L. STECH, North American Aviation, Columbus, Ohio.

Techniques have been developed in the last five years which are useful in answering many of the basic questions about the human factors aspects of a weapon system. The primary purpose of these task analysis techniques is to describe the operator's job in sufficient detail so that decisions can be made on the human factor effort required for the weapon system development. Areas in which research is required can be pinpointed and the amount of research necessary can be specified. Unique and unusual problems in the design of cockpits, control systems, and instruments can be anticipated. Training programs, training equipment requirements, and personnel selection criteria can also be predicted. The task analysis techniques are most helpful in predicting and planning where and how human factor requirements can be incorporated in a weapon system. The techniques comprise a useful analytical tool but should not be considered an end in themselves.

Standardization of the Endpoint for Centrifuge Experiments during Positive Acceleration. CAPTAIN SHELDON H. STEINER, USAF (MC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

A plea has been made to standardize the endpoint in human centrifuge experiments at all installations. Light loss is usually taken as a standard endpoint, particularly for experiments involving G protective equipment. The British group use a blackout point which is below that usually obtained at other centers. The advantage to the subject is obvious. At the Aero Medical Association meetings in 1958 it was agreed that all centrifuge centers would compare this system with a white light panel commonly used at many installations in this country. This system involves visualization of 760 mu red filtered light, in a dark adapted subject, adjusted to 0.5 log units above visual threshold for this wave length.

A gradual onset run of 0.1 g/sec is used to prevent temporary blackouts due to slowness of cardiovascular adaptation. Each member of our subject panel was consecutively run to blackout with red light and our standard white light panel. Three runs of various combinations completed one series. Two series were run on each subject. In our hands this technique appears consistent for the same subject, with blackout usually 1.5 to 3.5 G lower than for our standard white light panel.

Carbon Monoxide Determination by Tissue Analysis on Aircraft Accident Fatalities. MAJOR VERNIE A. STEMBRIDGE, USAF (MC), FIRST LT. ABEL M. DOMINGUEZ, USAF (MSC), CAPTAIN HERBERT E. CHRISTENSEN, MSC, USA, FIRST LT. THOMAS L. GLEASON, III, USAF (MSC), and MAJOR F. WARREN LOVELL, USAF (MC), Armed Forces Institute of Pathology, Washington, D. C., and Directorate of Flight Safety Research, Norton AFB, Calif.

Incapacitation by accidental inhallation of carbon monoxide has been proven to be the cause of some accidents in reciprocating engine aircraft and is suspected in many cause undetermined accidents particularly in jet propelled aircraft. Many accidents are associated with severe injury or even disintegration, and it is frequently impossible to perform blood analyses for carbon monoxide because it is non-available. There has been developed and used within the U. S. Air Force a procedure of tissue analysis for determination of an individual's exposure to the gas. This article discusses the development of such a procedure showing that carbon monoxide levels during the initial phase of the development of the technique did not always correspond with known facts concerning possible exposure; however, recent refinements of the analysis are producing a high degree of correlation between results of the determination and known facts. The various methods of tissue analysis for carbon monoxide are explained and correlated with accident data from the USAF Directorate of Flight Safety Research. The significance of this technique as a forensic pathologic procedure is discussed, especially its application to the medical investigation of aircraft accidents.

Aeromedical Support of Advanced Fighter-Interceptor Weapons Systems. COLONELS BENJAMIN A. STRICKLAND, JR., and LOUIS C. KOSSUTH, USAF (MC), and MAJOR DAVID R. STOPHER, USAF, and CAPTAIN HILLIARD D. ESTES, USAF (MC), Headquarter Air Defense Command, Ent AFB, Colo.

Aeromedical problems involving crews of newer century-series, F-101, F-102, F-104, F-106 and F-108 aircraft, are analyzed. Operational applications of protective equipment and physiologic support procedures are described. Human factors in air defense interceptor tactics are outlined and solutions to some current problem areas are proposed. The changing emphasis on stress factors encountered in multimach high-altitude interceptor flying is discussed. Source of material is Air Defense Command's experience since August, 1957.

Toxicity of Diborane in High Concentrations. MAJOR ALFRED R. STUMPE, USAF (MC), USAF School of Aviation Medicine, Randolph AFB, Texas.

Golden hamsters were exposed to diborane in concentrations ranging from 50 ppm (58 mg/m^3) to 1000 ppm (1160 mg/m^3). Observations were made as to signs of toxicity and time of death for each animal at each concentration tested. From the time-concentration curve prepared it was apparent that as the concentration was progressively increased to 600 ppm (696 mg/m^3) a shortening of the mean survival time occured with a narrowing of the time interval for all animals to succumb. A fairly constant minimum, maximum, and mean exposure time for death was found for all concentrations in excess of 600 ppm (696 mg/m^3). The possible mechanisms of action of diborane were discussed.

Symptomatology and Treatment of Boron Hydride Intoxication. ANTON A. TAMAS, M.D., Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

Accidental exposure to boron hydrides is followed by general malaise, respiratory and nervous system reactions. To facilitate diagnosis of acute intoxication, the characteristic symptoms of diborane, pentaborane and decaborane intoxication are described with reference to high energy fuels such as HEF and Hi-Cal. In the absence of any specific antidotes, an empirical treatment which is successfully being used is described. This symptomatic treatment consists of administration of oxygen, methocarbomol (Robaxin) tablets and a combination of injectable promethezine (Phenergan), meperidine (Demerol) and chloropromazine (Thorazine). Although no fatalities have yet occurred from borane exposures and no chronic poisoning has been observed in humans, a strict preventive medical program consisting of pre-employment and periodical physical examination and laboratory screening is emphasized. The current concept on site and mechanism of action is briefly reviewed with special attention to the lipid mechanism.

Bio-Logistics of Space Travel. LT. COL. ALBERT A. TAYLOR, USAF (VC), Hq. Air Research and Development Command, Andrews AFB, D. C.

The details of supplying support to space voyagers engaged in flights of short duration will be calibrated to measures currently used in high performance, high altitude aircraft. However, for longer space flights new bio-logistic concepts are needed. Space travel involving periods of time as long as several months will require the reprocessing of water and oxygen. Flights of still longer duration will, in addition, necessitate the production of food during flight. For these very long flights, a closed and balanced ecological system which can support life and supply man's needs must be developed. Concepts for development and test of biologistic supporting systems for very long duration space flights are presented.

Aeromedical Aspects of Migraine. CAPT. ELLIS R. TAYLOR, USAF (MC), Loring AFB, Me.

One of the most common periodic diseases, migraine, is presented as to its natural history, mechanism of symptomatology, association with decompression sickness, diagnostic criteria, treatment and prognosis. Fliers with migraine disease observed in the aeromedical consultation service, USAF School of Aviation, are considered individually on the basis of their past and present symptoms. Symptoms which of themselves are hazardous to flight are grounds for disqualification, whereas migraine in itself does not constitute a danger to the safety of flight. Three patients' histories are presented: one of mild nature who was returned to flying status, another with obviously dangerous symptomatology who has been disqualified for an indefinite period and a third, the subject of much study and discussion due to the aeromedical complexity of his symptomatology, who was finally suspended.

The Incidence of Hypoglycemia in Flight. CAPT. ELLIS R. TAYLOR, USAF (MC), Loring AFB, Me.

An attempt to determine the incidence of hypoglycemia was made at two single-engine basic flying training bases. A microtitration method using capillary blood was utilized, and diet and other data was obtained by questionnaire. Observations of 193 subjects, pre- and post-flight, failed to reveal any clinical cases of relative hypoglycemia. There were 13 cases in which there was an in-flight drop in blood glucose of over 60 mg. per cent; this was found to be correlated with a high sugar-low protein breakfast. Incidental findings demonstrated that the poor social hygiene of many of the pilots studied included not only improper dietary habits but also insufficient sleep and consumption of alcohol the night before flight. A fundamental task of aviation medicine has been the education and re-education of flyers as to good hygiene for safe flying. This study confirms the continuing nature of this task.

Cardiovascular Changes with Vestibular Stimulation. FLT. LT. W. J. R. TAYLOR, RCAF, W. H. JOHNSON, PH.D., and E. A. SELLERS, M.D., RCAF Institute of Aviation Medicine, and Defence Research Medical Laboratories, Toronto, Canada.

Individuals susceptible to motion sickness are found to demonstrate characteristic cardiovascular reactions in response to selected physical stimuli. These reactions can be shown to differ from those seen in a comparable group of subjects who are more resistant to vestibular stimulation. One hundred randomly selected RCAF aircrew candidates, ages 17 to 27 years, were subjected to controlled vestibular stimulation; 41 subjects by swing, 59 on a turntable. Changes in blood pressure, heart rate and A-V conduction time were analyzed. With vestibular stimulation by either method, both systolic and diastolic blood pressures rose; heart rate initially rose and then fell. The P-R interval decreased initially and then increased. These changes were compared with those occurring in the same subject after exercise, with carotid sinus pressure and with eyeball pressure. The turntable subjects were divided into two groups according to the degree of susceptibility to experimentally produced motion sickness. The motion sick group showed a smaller rise in systolic blood pressure than the less susceptible group, while the rise in diastolic pressure was more pronounced. This decrease in pulse pressure suggests a drop in cardiac output. The elevation in heart rate was much greater in the motion sick group than in the non-sick group. Early in the period of rotation the A-V conduction time of the susceptible group was shorter than the resting value but lengthened toward the end of exposure. No essential change in P-R interval occurred in the non-reactive group. The cardiovascular reaction pattern after exercise, with carotid sinus pressure and with eyeball pressure of the subjects experiencing motion sickness was likewise shown to differ from that of the non-sick group. The findings of this study demonstrate a correlation between autonomic reactivity and susceptibility to motion sickness.

Some Observations on the Personality Structure of Air Force Personnel Engaged in Unusual Missions. CAPT. VICTOR H. THALER, USAF (MSC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

U. S. Air Force members engaged in unusual missions have been interviewed and tested in an attempt to delineate common personality variables. Included were parachutists, rated and other personnel engaged in stressful experimental situations, as well as selected members of bomber and fighter organizations. Individuals engaged in more conventional occupations have been similarly observed and tested and serve as a reference group. The hypothesis was investigated that the man for future Air Force missions will be highly impulsive with a feeling of personal invulnerability. For some time operational units have recognized the limited usefulness of such persons. Results indicate that candidates for unusual missions should be far more conservative and possess the attributes of above average maturity and experience and a high degree of group identification coupled, of course, with the fact of sheer survival. This paper investigates the variables of maturity, the presence or absence of neurotic traits, mission and group identification, fantasy life and experience. Findings indicate once more the great effectiveness and versatility of the mature personality.

Laboratory and Field Studies on Ventilating Systems in the APH-5 Helmet. P. R. TILLER, B.S., and L. M. LIBBER, PH.D., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia.

Laboratory and field studies were conducted to determine the optimum ventilation system and ventilating air temperature for reduction of thermal discomfort to the head while wearing the APH-5 protective helmet. The laboratory studies consisted of two phases. The first was a study of the effect of ventilating the helmet with ambient air under simulated desert and tropical conditions. The second phase dealt with the effect of ventilating the helmet under the same simulated conditions, but using air cooler and dryer than ambient air. Field studies were conducted on pilots under pre-take off conditions in sealed cockpits. The objective results and subjective comments from the laboratory and field studies are compared and concepts for an optimum protective helmet ventilating system are presented.

An Experimental Model for the Measurement of Man's Ecology in Space. PAUL R. TOBIAS, North American Aviation, Downey, Calif.

Multivariate analysis offers improved solution to the study of the complex interactions of physiologic and psychologic data of man's ecology in space. Electronic computing devices programmed for an adequate experimental design compare data received against a basic mathematical model to determine significant changes in the physiopsychologic parameters. Present methods of analysis do not offer the advantage of describing a total interaction of the space traveler with his environment. A conceptual model is developed, the essence of which is the simultaneous reception of numerous measurements of change and a rapid comparison of these data with an analog model representing the condition of the organism on earth. The problem of the intercorrelation of nonlinear data can be solved through the computers' ability to rectify the data by means of suitable transformations. Differences between the analog model and the data received from space are subjected to analysis by sequential sampling plan to determine significance within predetermined limits. The results of this analysis are immediately available and they indicate the functional status of the space subject. One of the benefits of this method is that a progressive record allows insight into the probable causality as well as the composite picture of the organism.

An Improved Tissue Resistance Monitor. W. E. TOLLES, M.S., and W. J. CARBERY, M.S., Airborne Instruments Laboratory, Mineola, N. Y.

An accurate method of measuring tissue resistance has been developed that utilizes an 8 cps square wave of alternating current as the sensing current. This scheme has undergone extensive testing and avoids the pitfalls attending a direct current (dc) measurement. The monitoring system is characterized by long-term stability, sensitivity and freedom from electrode polarization effects. In addition, this method permits the simultaneous measurement of tissue potential between the same electrode pair used in determining tissue resistance. Most methods of measuring tissue resistance devised to date have employed a dc source of sensing current. A finite tissue potential also exists between any two body sites independent of the voltage drop of the impressed current. As a result, the combination of tissue potential and tissue resistance obtained with this conventional method leads to an electrically ambiguous measurement. Experimental results will be presented covering a broad spectrum of stimulus situations, demonstrating the stability and reproducibility of long and short term responses elicited with the improved tissue resistance monitor. Some additional results will be

presented involving the simultaneous measurement of tissue resistance and tissue potential and the relationship that exist during stimulus situations between them.

Factors Relevant to the Development of Aircraft Warning and Caution Signal Systems. JOHN VANLAER, PH.D., and EUGENE H. GALANTER, PH.D., University of Pennsylvania, and SHERWIN J. KLEIN, PH.D., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

An attempt is made to clarify the general nature of the problem of developing aircraft warning and caution signal systems, and to identify specific research problems within that general area. It is pointed out that the primary problem is one of guaranteeing high priority to information relevant to actual or potential states of hazard. In accordance with this requirement, a warning and caution signal system has two distinct functions: an *alerting* function and a *directing* function. Three major sensory modalities—vision, audition, and cutaneous pressure sensitivity—are each examined in some detail with respect to their capacity to serve as input channels for alerting and directing signals. This analysis demonstrates that visual stimuli are poorly suited to serve as alerting signals, but are ideally suited to serve as directing signals, whereas the converse is true of auditory and tactile stimuli. Arguments favoring a single master signal for both warning and caution are presented. A critical review of the pertinent literature is included.

Space Flight Hazards Caused by Weightlessness. HARALD J. VON BECKH, M.D., Aeromedical Field Laboratory, Holloman AFB, N. M.

The lack of neuromuscular coordination and optical illusions, as they might possibly affect the efficiency of the human operator of a space vehicle, are discussed. However, it should be expected that more difficulties would arise from the alternation of high G loads and weightlessness which increases discomfort and lowers human tolerance to G loads.

Importance of the Family History in the Pre-employment Selection of Pilots. EDWARD B. WALDMANN, M.D., and JAN H. TILLISCH, M.D., Mayo Clinic and Mayo Foundation, Rochester, Minn.

With all our valuable physical and psychologic tests for the selection of jet pilots, one of our best methods is at the present time somewhat neglected; and that is a very carefully taken family history and evaluation of it. This is especially helpful in regard to the diseases of diabetes, hypertension, and coronary artery disease, all of which are occurring with increasing frequency at earlier and earlier ages, frequently at a time when the pilot is in his most useful period. The hereditary traits of diabetes mellitus have been described by many authors. Several have reviewed the hereditary aspects of hypertensive heart disease, and Hines has discussed the genetic relation of the hyper-reactivity state and hypertensive heart disease. The familial correlation of coronary artery disease has been more difficult to evaluate, but Thomas and Cohen have concluded that coronary artery disease is four times as prevalent among siblings of individuals with coronary artery disease as among siblings of persons without it. This was recently exemplified when an airline pilot died of myocardial infarction at almost the same age as his father had died of the same cause. Other illnesses of familial incidence, such as glaucoma, otosclerosis, allergies, peptic ulcers, and neurologic and mental disorders, have been considered. This paper reviews the importance of hereditary traits leading to disqualifying diseases in the pilot.

A Practical Approach to Emotional and Behavioral Changes Anticipated in Space Travel. MAJOR JERROLD L. WHEATON, USAF (MC), USAF School of Aviation Medicine, Randolph AFB, Texas.

It is necessary to integrate and apply the large volume of published material concerning basic isolation and sensory deprivation research to the future reality of space travel. This research has indicated areas of importance to the individual's ability to maintain orientation in space and time. These areas are considered in the discussion of perceptual boundaries and various forms of social interaction. The possible emotional and behavioral aberrations that could be anticipated are related to the preceding discussion. The means of preventing unusual behavior are considered in the light of anecdotal observations, experimental results and clinical observations considered pertinent to the problem. There is some basis at present for feeling that unless selected men are completely insulated from all sensory input, they will perform effectively.

An Experiment in Prolonged Vigilance. ENS. ROBERT J. WHERRY, JR., MSC, USN, USN School of Aviation Medicine, Pensacola, Fla.

With the advent of radar, sonar and

numerous other electronic detection devices, a considerable increase in experimentation in recent years in the area of vigilance has taken place. This experiment was a further exploration of the area. In this experiment the question was asked: In a situation of prolonged (nine hours) continuous monitoring, where the stimulus definitely stimulates the signal-receiving sense organ and the response is a simple on-off, essentially fatigue-free response do subjects respond with progressively less efficiency during the session? Do subjects show characteristic individual or group patterns of response change within and/or between repeated (five consecutive days) sessions? In addition to seeking answers to these questions three variations in signal characteristics (direction, amplitude and interval) were introduced to permit a study of their effects. The experimenters found: (1) Monitoring of simple signals over prolonged periods can be done quite effectively. (2) Some systematic effects of time-on-task, days-in-task, and the stimulus aspects were found, but these effects differed between subjects. (3) In general, individuals seemed to differ greatly in how they were affected by various aspects of the monitoring situation. (4) All subjects exhibited relatively long (50-80 minutes) periods in which they monitored quite effectively interspersed with short (10-15 minutes) periods in which they were much less effective.

Experimental Studies of the Effects of Accelerative Stress on Visual Performance. WILLIAM JOSEPH WHITE, PH.D., Cornell Aeronautical Laboratory, Buffalo, N. Y.

Two different aspects of visual behavior have been examined during exposure to a common stress, an increased G force on the body. The WADC human centrifuge was used to produce the increased G forces. Measurements were reported on the effects of accelerative stress upon the absolute threshold of foveal (cone) and peripheral (rod) vision. The ability to read instrument dials was recorded as a function of acceleration and illumination. These experiments show that acceleration has a consistent and progressive effect on visual performance, the size of the effect being proportional to the magnitude of the positive acceleration. The following basic findings resulted from an alaysis of the data gathered from these experiments:

1. Absolute threshold—(a) Acceleration levels of 3 and 4 G approximately double and triple foveal thresholds. (b) Threshold levels in peripheral vision triple at 3 G and quadruple at 4 G. (c) This effect of peripheral vision is compensated in part by anti-G suits. (d) A rise in threshold (decline in visual sensitivity) is found with repeated exposure to acceleration, the rise being smaller than that associated with acceleration.

2. Instrument reading—(a) At the higher levels of instrument illumination, increasing acceleration and decreasing luminance produce relatively small increase in reading errors. (b) At marginal levels of illumination, acceleration and luminance interact to produce a relatively large increase in errors. (c) Intensity of illumination can compensate for the decline in visual performance at stress levels above 1 G.

Modified Diluter-demand Breathing Valve. ORLAND W. WILCOX, B.S., M.E., Sierra Engineering Co., Sierra Madre, Calif.

The National Aircraft Standards 1179 and 1180 define the minimum requirements for the design construction and performance of a passenger oxygen mask to be used in high altitude commercial transport aircraft. The valving for this mask assembly is designed to ensure the following sequential operations: On Inhalation—A reservoir check valve shall open to allow the user to breathe only reservoir contents along with the normal oxygen flow through the supply tubing until the reservoir bag is empty, at which time an ambient air inlet valve shall open to supply supplementary air for the remainder of the inhalation phase. On Exhalation—The reservoir check valve shall close, permitting oxygen to enter the reservoir bag only, and used air shall be expelled through a suitable exhaust valve. The ambient air inlet valve shall be closed before inhalation begins. A study of these desired sequential operations suggested the use of a combination inhalation-exhalation valve with an ambient air inlet valve added to the valve body. This valve is called a modified diluter-demand breathing valve. Dilution, in this case, does not mean dilution of the reservoir bag oxygen, but means that the passenger dilutes the latter portion of his inhalation cycle with ambient air. In a practical sense, he "tops off" with ambient air after having satisfied his oxygen requirement with the first portion of his inhalation. This paper describes the steps taken to develop the modified diluter-demand breathing valve. The design parameters are discussed in detail and the results of the various prototypes and production models described.

The Identification of Future Failures Among Marginal Disciplinary Cases. LT. (JG.) WARREN W. WILLINGHAM, MSC, USNR, USN School of Aviation Medicine, Pensacola, Fla.

The U.S. Naval Pre-Flight School has an

intensive military training program designed to inculcate the principles of military discipline into the behavior of aviation cadets, and to identify those few individuals who cannot adapt themselves. When a cadet commits an infraction, he receives some number of demerits, and if he exceeds a limit of 50 demerits he is subject to being dropped from training. The purpose of this study was to determine the most appropriate procedure for identifying future failures among these marginal disciplinary cases. The subjects were 3,133 cadets detached from the training command during 1956 and 1957. Number of demerits in pre-flight training was studied in relation to subsequent training performance. Number of demerits received in pre-flight training was a very poor predictor of demerits received in basic flight training ($r = .33$), demerits received in advanced flight training ($r = -.02$), or success in training ($r = -.13$). The future success or failure of the marginal disciplinary case could be predicted quite well on the basis of overall pre-flight grade ($r = -.50$). Among marginal disciplinary cases with an above average overall grade, 20 per cent failed to complete training; however, of those with an overall grade one standard deviation below average, 80 per cent failed. It was recommended that, except in the case of serious infractions, number of demerits should not determine whether a cadet is dropped. It was recommended that cadets receiving more than 50 demerits be automatically dropped if their overall grade is more than one standard deviation below average.

Comparison of Hearing Loss of Personnel Exposed and Not Exposed to High Intensity Sound. CAPT. S. K. WILLIS, JR., USAF (MC), COL. I. LOUIS HOFFMAN, USAF (MC), Westover AFB, Mass.

The purpose of the study is to show that there is a greater incidence of hearing loss among persons frequently exposed to high intensity sound as opposed to those not routinely exposed to high sound pressure levels. The noise hazard area has been defined as the area on the flight line where ambient noise levels throughout an eight hour day are equal to or higher than 85 decibels. All of the personnel involved were subjected to automatic audiometry using the Rudmose automatic audiometer. All personnel with a greater than 15 decibel loss in any frequency were tested both for air conduction and bone conduction using the Maico H-1 audiometer. In those where there was a significant hearing loss a thorough ENT examination and history were accomplished and personnel with a conductive type hearing loss were deleted from the study. In using the Herman Hosmer-Scott sound level meter and wave band analyzer, sound pressure levels and predominant wave bands were determined throughout the flight line. During the six month period from April 1 to October 1, 1958, a total of 1,736 persons were tested and 2,230 audiograms were performed. These individuals were classified as having Class A, B, or C hearing in accordance with Air Force Regulations 160-3. There was a further breakdown as to age, and the length of time working in specific noise areas. A control group of about 500 persons who had never worked in areas of high intensity sound were also given audiograms, and an ENT work-up in abnormal cases, and comparison between the two groups was noted. The results re-emphasize the hazard to hearing associated with high intensity sound and adds emphasis to the specific areas involved.

Medical Problems in High Altitude Suit Testing. CAPT. CHARLES L. WILSON and CAPT. MYRON B. ZINN, USAF (MC), Aero Medical Laboratory, Wright-Patterson AFB, Ohio.

During a 10-month period, a detailed study has been made of various problems encountered in evaluating pressure suits and related personal protective garments: 1. All persons who had denitrogenated in 100 per cent oxygen removed their facepieces at one of the three following altitudes during descent: 18,000 feet, 3,000 feet or ground level. Twenty-four hours later they were examined and interrogated for symptoms of delayed aerotitis media. Results indicate that removing facepieces at 18,000 and even 3,000 feet greatly assists in reducing incidence of delayed aerotitis media. 2. Brief discussion of a case of mediastinal emphysema that occurred during a rapid decompression, and its relation to "countdown" systems used. 3. An unusual case where a MC-2 partial pressure suit helmet rubber gasket blew out at 100,000 feet barometric equivalent and caused immediate intense cyanosis, and unconsciousness. 4. A case of traumatic external otitis due to experimental rapid descent with close-fitting experimental earphone covers. 5. Summary of the incidence of dysbarism, experienced in those subjects wearing partial and full pressure suits. 6. Cases of trauma to and perforation of the tympanic membrane. 7. Method and results of decompression in pressure suits. 8. Testing partial pressure suits at —65° F. and 100,000 feet to study flow characteristics of inhalation and exhalation valves. 9. Vapoedema of the hand at 100,000 feet.

Study of Early Greyout Threshold as an Indicator of Human Tolerance to Positive Radial Acceleratory Force. COMDR. J. J. ZARRIELLO, MC, USN, MARY

E. NORSWORTHY, B.S., and LT. H. R. BOWER, MSC, USN, USN School of Aviation Medicine, Pensacola, Fla.

The purpose of this study was to investigate the relationship under increased positive radial acceleratory force between peripheral light loss and blackout or unconsciousness when the light stimulus is located at 80° in the peripheral field; and to determine whether an 80° peripheral light stimulus was an earlier indicator than lights located at 23° in the peripheral field. Under conditions of our experiment, it was found that an 80° light stimulus was an earlier indicator than the 23° light for an endpoint of greyout in regards to magnitude of the G force. The time spread between onset of greyout (80° light loss) and onset of blackout or unconsciousness was determined, and this time spread was found to be slightly increased when compared to the use of a 23° light as an endpoint of greyout. The peripheral light loss has limited usefulness as an early indicator for the onset of critical symptoms of blackout or unconsciousness.

Human Aspects of the Mid-air Collision Prevention Program. ANCHARD F. ZELLER, PH.D., Directorate of Flight Safety Research, Norton AFB, Calif.

A summary evaluation of the mid-air collisions experienced by the U.S. Army Air Corps and the U.S. Air Force from the first recorded collision in 1917 through the first six months of 1958 was prepared. An evaluation of the accidents indicates that although in most instances they were attributed to error on the part of the pilot, the basic cause relates to the situation which in many instances required perception-decision-reaction outside the pilot's capability. An evaluation of the human and machine limitations in relation to the operational setting in which mid-air collisions occur defines, to a great extent, the kinds of anti-collision measures which will be effective and demonstrates the relative uselessness of others. Current anti-collision proposals were evaluated in the light of these findings.

The Flight of the X-15

A condition of weightlessness, in which the gravitational pull of the earth is nullified, will be experienced by the pilot of the X-15 for several minutes as the plane coasts over the peak of the flight path. Recently pilots of other high-performance aircraft have been subjected briefly to this condition without serious impairment of their ability to function properly. Though the effects of weightlessness seem to vary considerably with individual pilots, some becoming nauseated and others experiencing a feeling of exhilaration, the duration of this condition in the X-15 flight trajectory is thought to be insufficient for it to be one of the severe human problems of the program. It is felt that the pilot of the X-15 will have good control over the forces of rapidly accelerated and decelerated flight processes. He will be subjected to about 2 G as the engine is ignited and the plane begins to climb. This force, roughly comparable to that experienced in a catapult launching of an aircraft, will tend to immobilize the pilot but not to the extent of preventing him from performing the tasks necessary to control the aircraft. As the fuel load is rapidly consumed, the speed is increased and the G-forces become stronger. Maximum G-force is reached as the engine burns out prior to the peak of the flight path. It is in the latter stages of the flight, however, that deceleration and pullout forces can combine with atmospheric disturbances to give the pilot most trouble in controlling the X-15. An entirely new control design has been created to avoid involuntary pilot inputs. To study this problem area a series of simulation tests have been conducted in the Navy centrifuge at Johnsville, Pennsylvania.—THE SPIRAL TOWARD SPACE: *Air University Quarterly Review*, Fall, 1958.