Abstracts of Scientific Papers to be Presented at Meeting of Aero Medical Association, Denver, Colorado, May 6-8, 1957

Under the chairmanship of Dr. E. J. Baldes, the scientific program committee of the Aero Medical Association has provided readers of THE JOURNAL with abstracts of the scientific papers to be presented at the society's twenty-eighth annual meeting at the Shirley-Savoy Hotel, Denver, May 6, 7 and 8, 1957. Prepared by the speakers for the Association's most extensive scientific session, the abstracts were edited for publication by Dr. John P. Marbarger. They are listed alphabetically by the last name of the senior or single author of each paper. The complete program for the meeting, published in the February JOURNAL, includes more than 175 speakers. The highlights include panels on "The Medical Problems of the Jet and Turbo-Jet Age" and "The Forthcoming Air Transport." A group of distinguished scientists will present a symposium on "Space Travel."

Nuclear Science and Aviation Medicine. H. L. ADAMS, PH.D., and C. M. WHITLOCK, JR., M.D., Convair, San Diego, Calif.

The integration of nuclear science into the human factors matrix in aviation is discussed, based upon the analysis of the (1) effect of radiation on human beings, somatic and genetic; (2) human radiation allowance in air operations and the reasoning behind any departure from such allowances for fixed nuclear installations; and (3) changes in human factors design parameters that may be expected from the use of nuclear reactors.

Report of a Large-Scale Field Trial of Jet Injection in Immunization for Influenza. CAPTAIN E. A. ANDERSON, MC, USN, LT. COL. R. B. LINDBERG, MSC, USA, and MAJ. D. H. HUNTER, MSC, USA. Naval Air Station, Norfolk, Virginia, and Walter Reed Army Institute of Research, Washington, D. C.

A brief résumé of automatic jet injection development and technique is presented. A total of 20,436 young adults received influenza vaccine by this method in 1955 and 1956. Clinical evaluation of jet injection was assessed by observing recipients for bleeding, pain, acceptability to patients, environmental effects on penetration, and race and muscularity of subject. Antibody titer rise in a sample of the test group was found to compare favorably with those observed following needle and syringe injection. The authors conclude that jet injection can be of inestimable value to the medical profession in large scale immunization programs, in civilian disaster, and in modern warfare in treatment of mass casualties.

Civilian Residencies in Aviation Medicine. WILLIAM F. ASHE, M.D., Department of Preventive Medicine, Ohio State University, Columbus, Ohio.

This paper presents the status of civilian residency training in the specialty of aviation medicine in the United States. Board certification requirements are reviewed. The varying points of view concerning the needs of a civilian medical director versus a military officer in this area are presented. The curriculum is reviewed, and the need for support of the Aero Medical Association in this development is emphasized.

Navy Test Pilots and Test Flying. LT. COMDR. F. H. AUSTIN, JR., MC, USN, Naval Air Test Center, Patuxent River, Md.

The author relates some of the philosophy and working concepts of test pilots and military test flying which he has gleaned from a short but intimate contact with them at the Naval Air Test Center, Patuxent

River, Maryland. Many areas of this interesting phase of aviation are unavailable to flight surgeons generally, due partly to their lack of association with such a restricted group and often also to limited technical understanding, or time and interest. A detailed review and study of aviation medical problems at the test center is presented.

Recent Studies in Altitude Tolerance. BRUNO BALKE, M.D., School of Aviation Medicine, Randolph Air Force Base, Texas.

The normal hypoxic threshold occurs at an alveolar pO_2 of 30 mm. Hg., or at an altitude of about 24,000 feet. In temporary acclimatization to high altitude, hyperventilation is one of the main adaptive mechanisms—that, and the lowering of the critical alveolar pO_2 to about 25 mm. Hg. allow for reaching a critical altitude of 33,000 feet. Native residents of the high Peruvian Andes display a cirtical alveolar pO_2 as low as 20 mm. Hg., but they are not superior in achieving a higher critical altitude. They show only a mild hyperventilatory response to increasing oxygen lack. Altitude tolerance can also be limited by manifestations of dysbarism. The partial denitrogenation taking place during a few days spent at 14,000 feet resulted in complete protection from bends and chokes at 38,000 feet exercising and/or at 50,000 feet sitting at rest.

Some Recent Developments in Safety Equipment. K. M. BARNES, Hardman Tool and Engineering Co., Los Angeles, Calif.

A general presentation and discussion of the progress in equipment related to human safety in high performance aircraft are contained in this paper. Comparisons in reliability, weight and simplicity between contemporary equipment, equipment under development, and that of five years ago are made. A pictorial presentation of some current development programs by military groups concerned with safety equipment is shown.

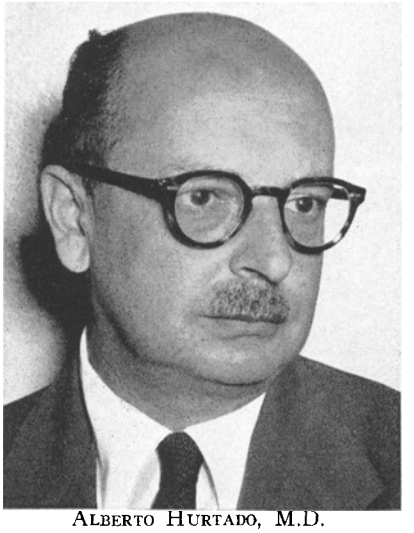
Aero Medical Aspects of the Strato-Lab Program. CAPTAIN NORMAN L. BARR, MC, USN, Naval Medical Research Institute, Bethesda, Md.

The paper is concerned with the measurement of pilots' response to the stresses of high altitude balloon flights in both open basket and sealed gondola. The objectives of the physiologic studies are stated. The physical characteristics of the environment are given, and special elements of stress are described. The physiologic studies conducted and the methods used in making measurements are discussed. The results of the studies are given.

Evaluation of Glycine as an Anti-frostbite Agent. CAPT. WILLIAM R. BEAVERS, USAF (MC), and FIRST LT. BENJAMIN G. COVINA, USAF (MSC), Arctic Aeromedical Laboratory, Ladd Air Force Base, Alaska.

Glycine has been reported to elevate resting metabolism significantly, and to increase the temperature of the digits by several degrees when the subject is in a thermoneutral environment. The present study is an attempt to determine the practicability

LOUIS BAUER LECTURER



ALBERTO HURTADO, M.D.

Alberto Hurtado, M.D., research director of the Institute of Andean Biology, Lima, Peru, and an internationally known high altitude physiologist, will present the third Louis H. Bauer Lecture on May 6, 1957, the opening day of the twenty-eighth annual meeting of the Aero Medical Association, Shirley-Savoy Hotel, Denver. His subject will be "Natural Acclimation to High Altitudes."

of utilizing the specific dynamic effect to decrease digital vasoconstriction due to cold. Glycine and a control substance were given on different days to each of six subjects. Two hours after ingestion the subject donned Arctic gear and was put into a cold room at 0° F. with hands inactive and exposed. Finger blood flow, finger temperatures, average body temperature, and metabolic rate were determined, and these data are presented.

Development of an Optimum Altimeter Presentation. FLT. OFFICER F. E. M. BELDAM and FLT. LT. R. G. FLETCHER, Royal Canadian Air Force Institute of Aviation Medicine, Toronto, Canada.

A study was initiated in 1956 to develop an altimeter presentation which could be read both quantitatively and qualitatively, have a check reading function, and require no computation on the part of the pilot. These were desired under all conditions of flight. The proposed presentation is composed of a central five digit counter, modified to indicate direction when unit and ten counters rotate too rapidly to be read accurately, and a gross circular scale which is uncovered by a rotating disc. A unique method of presenting this dial configuration for comparison with a standard was developed. Rates of climb were calculated in terms of frames per second of 16 mm. film; a film was produced by exposing single frames so that the finished picture represented an instrument operating through a series of rates of climb and descent. The finished film is compared with a duplicate film showing a standard Kollsman counter-pointer altimeter under equivalent conditions.

Grade IV Chamber Reactions or Neurocirculatory Collapse Occurring in the USAF 1950-1955. MAJOR CHARLES A. BERRY, and CAPTAIN HOWARD H. WAYNE, USAF (MC), School of Aviation Medicine, Randolph Air Force Base, Texas.

Neurocirculatory collapse is increasing in incidence because of the larger numbers of air crewmen exposed to high altitude flight and training in low pressure chambers. To shed new light on the chamber or altitude "reactor," the records of Grade IV reactors in the USAF were examined. A Grade IV reaction to simulated altitude is by definition a reaction requiring hospitalization. This frequently implies neurocirculatory collapse. During the period 1950 through 1955 there were about 130 Grade IV reactions. These reports were tabulated for such patient data as age, height, weight, altitude of onset, first symptom noted, physical signs and findings, and treatment. These data were then analyzed for trends. A new classification of reactions is suggested and case histories illustrative of these various reaction types are presented. The possible implications of these data on the study and treatment of neurocirculatory collapse are discussed.

Correlation Between the Post-Valsalva Overshoot of Arterial Pressure and G Tolerance. CAPTAIN STUART BONDURANT, USAF (MC), Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Reflex peripheral vasoconstrictor activity is recognized to be a major determinant of tolerance to positive G forces. Measurement of individual peripheral vasoconstrictor reaction to a standard stimulus might therefore permit prediction of G tolerance. The Valsalva maneuver produces reflex peripheral vasoconstriction resulting in a post-Valsalva overshoot of arterial pressure easily measurable with a sphygmomanometer. The overshoot after a standard Valsalva maneuver has been measured in sixteen subjects whose blackout threshold was subsequently determined on the human centrifuge. Overshoot of systolic pressure of this group ranged between 8 and 62 mm. Hg. Blackout range was between 3.5 and 5.0 G. A close, direct correlation was observed between the height of the post-Valsalva overshoot and the blackout level, (correlation coefficient .793). This simple test may permit accurate prediction of individual G tolerance.

Selection of Personal Flight Equipment. L. T. BONNER, JR., Glenn L. Martin Co., Baltimore, Md.

In keeping with the weapons system concept of aircraft engineering, the selection of air crew safety and survival equipment has been elevated to an integral part of aircraft design. Each aircraft must be con-

sidered independent in order to achieve the degree of safety, comfort, and utility that is desired. Using the Martin XP6M-1 *Sea Master* as an example, the complete head-to-toe selection of personal equipment is outlined. Aircraft operating capabilities, air crew task evaluation, and emergency conditions are discussed with relation to equipment selection.

The Fine Structure of Lung Tissue as Revealed Electron-Microscopically and the Influence of Oxygen Poisoning on Alveolar Tissue. SUE BORN, B.A., and D. E. BEISCHER, PH.D., U. S. Naval School of Aviation Medicine, Pensacola, Fla.

The possibility for study of the fine structure of lung tissue has been greatly furthered by the development of techniques of electron-microscopy. The recent work of a number of electron-microscopists has ended a half century controversy on the fine structure of the alveolar membrane. The blood-gas barrier, consisting of both epithelial and endothelial tissue separated by basement membrane and frequently a large amount of interstitial tissue, is now clearly visible. Hence, this improved knowledge of the structure of the normal alveolar membrane can be used to judge pathologic effects of noxious agents on alveolar tissue. Rabbits exposed to atmospheres of high oxygen content are found to suffer subsequent damage to their lung tissue. This damage produced is discussed with the aid of electron micrographs.

Synergism Between Effects of Hyperventilation, Hypoglycemia and Positive Acceleration. FLT. LT. H. P. BRENT, FLT. LT. T. M. CAREY, WING COMDR. T. J. POWELL, J. W. SCOTT, M.D., FLT. LT. W. G. R. TAYLOR, and GROUP CAPTAIN W. R. FRANKS, Royal Canadian Air Force Institute of Aviation Medicine, Toronto, Canada.

Both hyperventilation and positive acceleration lead to reduced blood supply to the brain. Similarly hypoglycemia reduces the fuel supply. Synergism of these three factors is, therefore, possible. Young male air crew members have been studied under hyperventilation, and on the human centrifuge at varying times, relative to glucose feeding. During the fasting state, fourteen of twenty-one subjects showed slowed EEG activity on hyperventilation *per se*. Two showed similar EEG changes while under 3 G-positive acceleration lasting for five seconds. Eleven of the above fourteen showed equal or greater slowing of rhythm with shorter periods of hyperventilation while under 3 G. Three of these also became unconscious under this modest acceleration which was well tolerated in the absence of hyperventilation. Two of the three also manifested major convulsions during the runs. The EKG record may show similarly profound changes under the combination of modest G and hyperventilation. Glucose feeding reduced the incidence of these changes.

The Effect of Positive Acceleration on Visual Reaction Time. JOHN L. BROWN, PH.D., and RICHARD E. BURKE, M.A., U. S. Naval Aviation Medical Acceleration Laboratory, Johnsville, Pa.

The time required to respond to a visual signal light was measured for two subjects at levels of positive acceleration between 2.0 and 5.4 G. Two luminances of the signal light (4560 and 0.025 millilamberts) and two positions of retinal illumination (7°24′ and 28°22′ from the fovea) were investigated. Results indicate that there is a highly significant increase in reaction time ($P<0.0.$) as acceleration is increased. With the lower signal luminance, reaction time increases significantly before subjects report any subjective effects of acceleration. At the higher luminance, reaction time is not prolonged significantly until subjective dimming of the test light is observed. The use of different test light positions did not

HOTEL ROOMS IN DENVER

Hotel reservations for the 1957 meeting should be requested of the Denver Convention and Visitors Bureau, 225 West Colfax Avenue, Denver 2, Colorado, giving your arrival and departure dates for the Aero Medical Association meeting, May 6, 7 and 8. Headquarters for scientific and social events is the Shirley-Savoy Hotel, but rooms are available in other nearby hotels. To obtain the accommodations you desire, wire for your reservations now.

result in any difference in reaction time either during control periods or under acceleration.

The Effect of Hypoxia on Human Tolerance to Positive Acceleration. LT. COMDR. BENJAMIN F. BURGESS, JR., MSC, USN, U. S. Naval Aviation Medical Acceleration Laboratory, Johnsville, Pa.

The gondola of the Johnsville centrifuge has the capability of being depressurized to a simulated altitude of 60,000 feet. The G tolerance of humans has been studied at selected simulated altitudes between 5,000 and 20,000 feet. The effect on G tolerance of a wide range of exposure times at various altitudes prior to the acceleration stress has been determined. The efficiency of anti-G suits under these hypoxic conditions was also investigated. Physiologic recordings obtained during these tests consisted of an electrocardiogram, ear pulse, and ear opacity.

A Physiological Assessment of the Flack (40 MM.) Test. FLT. LT. P. O. G. BUTLER, WING COMDR. T. J. POWELL, and F. A. SUNAHARA, PH.D., Royal Canadian Air Force Institute of Aviation Medicine, and Defence Research Medical Laboratories, Toronto, Canada.

The Flack test is a prolonged Valsalva maneuver with a maintained intrapulmonary pressure of 40 mm. Hg. The dynamics of the Valsalva maneuver have been recently evaluated by a number of workers but only for maximum periods of from 20 to 25 seconds. In this investigation, carried to the breaking point, the arterial blood pressure, venous pressure, mouth and esophageal pressures, plethysmography, and EKG studies show there is a diminished venous return with a progressive fall in blood pressure and increase of heart rate. At the moment of releasing the expiratory pressure there may be a profound fall in blood pressure. There is a subsequent, marked rise in blood pressure with slowing of the heart. The reason for the sudden failure to maintain the pressure is not clear; hypoxia, hypercapnia, and the fall in blood pressure are factors, but there is also fatigue of the respiratory muscles and a psychologic inability to continue.

The Need for Rearward-Facing Seating in Our Airlines. HORACE E. CAMPBELL, M.D., Denver, Colo.

Survivals in falls from high buildings reveal that the human organism can absorb impacts of 200 G without injury if the forces are widely distributed. Standard ditching procedure in military aircraft is to place back and head against a forward bulkhead. This same protective position can be achieved in airliners by rearward-facing seats. This has been done in the Military Air Transport Service; and an eight-year experience in the Royal Air Force resulted in reduction of passengers killed and seriously injured from 21.6 per cent in forward-facing seats to 6.4 per cent in rearward-facing seats. Critics point out that equal results could be achieved with forward-facing seats if seat attachments and floors were made stronger. This is not a valid argument against rearward-facing seats but shows the need for stronger floors and seat attachments, under which circumstance rearward-facing seats would save even more lives than with current weak floors.

Immersion in Cold Water and Body Tissue Insulation. L. D. CARLSON, PH.D., A. C. L. HSIEH, M.D., and F. FULLINGTON, B.A., Department of Physiology and Biophysics, University of Washington, Seattle, Wash.,

Subjects with fat content of from 15 to 40 per cent of body weight were immersed at 33°, 25°, and 20° C. and, in some cases, at 9° C. One subject was a professional distance swimmer. All experiments were initiated with a control period at 33° C. and then the water temperature was lowered to the desired temperature. Body insulation, calculated by the Burton equation, varied from 0.10°C/Cal/m²/hr to 0.40°C/Cal/m²/hr directly with specific gravity. However, the fraction of the body calculated to be involved as insulation was always greater than the estimated fat content. The professional swimmer increased metabolism without visible shivering or loss of tissue insulation. Visible shivering always was accompanied by a reduction of body insulation. These results seem to explain the wide variation in survival times during cold water immersion.

Effect of Altitude on Maximum Breathing Capacity. EARL T. CARTER, M.D., PH.D., Departments of Physiology and Preventive Medicine, Ohio State University, Columbus, Ohio.

Theoretical analysis of the factors concerned in the work of breathing reveals that a decreasing ambient pressure would so alter some of the factors to permit a greater breathing capacity at altitude while other factors would be so altered as to prevent any increase. To test such an analysis, determinations of the maximum breathing capacity (MBC) were made on thirteen young adult males at several pressure altitudes in a decompression chamber. All determinations were made on a 13.5 liter Collins respirometer filled with 100 per cent oxygen. The group average at ground level was 170 1/min BTPS. The mean MBC rose in a smooth curvilinear fashion to a value of 250 1/min BTPS at 225 mm. Hg. (30,000 feet), the maximum altitude utilized. Calculations indicate that the total work of breathing was essentially the same at all altitudes, but that the "turbulent work" decreased in proportion to the barometric pressure.

Skill Composition as a Function of Remedial Practice on Task Components and Their Combinations. FIRST LT. RANDALL M. CHAMBERS, USAF, Air Force Personnel and Training Research Center, Lackland Air Force Base, Texas.

The results of tests, conducted on nine groups of men who were given specific remedial practice treatments on a complex multidimensional compensatory rate control task, showed that certain components within the total skill complex were reorganized as a function of the remedial practice. The multiplicative composition rule was found to provide a sound basis for predicting the effect of particular skill-component redistributions on total skill performance levels. Certain types of remedial practice resulted in major proficiency gains, even among unpracticed components, with no loss in final skill achievement. Similar criterion task profiles were produced among the different experimental groups, even though stabilization points within the skill complex were reached by essentially different psychologic mechanisms.

Hypoxic Threshold and Altitude Acclimatization. JOHN L. CHAPIN, PH.D., Physiology Department, University of Colorado, Denver, Colo.

The highest oxygen tension which, when approached from above, increases ventilation is called hypoxic threshold. This value has been shown to depend upon acclimatized CO_2 tension. High altitude residents whose CO_2 level is depressed by hypoxia-driven hyperventilation exhibit higher hypoxic thresholds than sea level residents. The present study acclimatized residents of 1600 meters to 3200 or 4300 meters. Hypoxic thresholds were measured from time to time. Each group displayed an overshoot lasting several days before the threshold dropped to the predicted level for that altitude. Subsequent to this initial acclimatization, each group was returned to 1600 meters but re-exposed to high altitude several days each week. The hypoxic threshold appeared to retrace its path back over the overshoot curve as a result of successive re-exposures.

Vertigo as a Cause of Pilot Error in Jet Aircraft. BRANT CLARK, PH.D., and CAPTAIN ASHTON GRAYBIEL, MC, USN, San Jose State College, San Jose, Calif., and U. S. Naval School of Aviation Medicine, Pensacola, Fla.

One hundred and thirty-seven jet pilots were studied to obtain information regarding their experiences with vertigo in jet aircraft. Individual interviews and a check list of vertigo experiences were used. It was found that 96 per cent of the pilots had experienced vertigo while flying a jet aircraft, and that the nature of the vertigo was essentially the same as that previously reported during flight in propeller driven aircraft. The most frequent illusory experience was found to involve confusions with regard to the altitude and motion of the aircraft. The jet pilots believe that certain unique aspects of jet flight may contribute to difficulties in spatial orientation.

Semi-Automatic Biochemical Analyses. CARL CLARK, PH.D., and MARIA CHIANTA, B.A., U. S. Naval Aviation Medical Acceleration Laboratory, Johnsville, Pa.

Detailed descriptions of the molecular changes which accompany flight stresses

have not been feasible because of the lengths of time required for the many separate chemical methods. Yet an understanding of these changes may make possible the development of methods to increase tolerance to these stresses or the selection of flight crews who already have high tolerance. A program under development of chemical fractionation, infrared absorption, and x-ray diffraction measurements, and computer analysis is presented.

Protection of Aircrews Against Thermal Injury. CAPTAIN NEVILLE P. CLARKE, USAF (VC), CAPTAIN GEORGE D. ZUIDEMA, USAF (MC), and CAPTAIN JAMES R. PRINE, USAF (VC), Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

The hazard of fire poses an ever-present problem to aircrews. Fire following aircraft accidents claims the lives of many crew members who are severely but not fatally injured by the crash itself, and who might otherwise survive. To diminish this toll, a study was undertaken to determine the role of clothing in increasing or decreasing burn injury. Thirty-three standard Air Force fabrics were tested experimentally under the conditions of contact burns in which the fabrics were heated to ignition. The same materials were also tested for their ability to protect against a simulated fuel explosion. Anesthetized white rats were the experimental animals, and both gross and microscopic pathologic studies were made. Protection against contact burns and this type of flash burn injury is discussed.

Development of Pressurized Aircraft Cabins. MAJOR JOSEPH J. CLARO, USAF, (MC), School of Aviation Medicine, Randolph Air Force Base, Texas.

Beginning with the fundamental work of Paul Bert, the step-to-step development of cabin pressurization is traced. The original American attempt of 1920 is recounted, followed by a description of the background engineering work of Younger and the physiologic investigations of Armstrong. The first successful pressurized aircraft, Lockheed's XC-35, is described in detail. Further commercial and military developments here and abroad are presented. Finally, there is a brief discussion of the *Comet* accidents and the classic investigation which led to the solution of why these aircraft cabins failed in pressurized flight. A comprehensive search of the available literature suggests that this is the first effort at compiling a history of this type.

Neurohormonal Aspects of G Tolerance. CAPTAIN SANFORD I. COHEN, CAPTAIN ALBERT J. SILVERMAN, CAPTAIN GEORGE ZUIDEMA, USAF (MC), and ALICE CATON, B.S., Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

The threshold for blackout appears to be ultimately dependent on cardiovascular reflex activity. However, catechol amine production from the adrenal medulla and sympathetic neural endings seems to play an important role in determining the level of compensation possible. It was observed that under centrifugal stress a substantial production of noradrenaline occurred in subjects who withstood exposure to high G levels. Subjects blacking out at lower G levels secreted less noradrenaline and more adrenaline. Hypertensive responses to a hypotensive drug were associated with high noradrenaline levels and hypotensive responses with lower noradrenaline and higher adrenaline levels. The inter-relationship of emotional factors, catechol amine levels and G tolerance indicated that high levels of anxiety were associated with high levels of adrenaline and lower levels of noradrenaline and lowered G tolerance. Overt anger was associated with lower levels of adrenaline and high levels of noradrenaline and high G tolerance.

A Flight Simulator Incorporating Acceleration Forces. LT. CARTER C. COLLINS, USNR, JOHN L. BROWN, PH.D., and COMDR. C. FINK FISCHER, USN, U. S. Naval Aviation Medical Acceleration Laboratory and Aeronautical Computer Laboratory, Johnsville, Pa.

It is proposed to use the Johnsville centrifuge to add the forces of acceleration to flight simulation. This realism can be made possible by allowing the pilot to control his own acceleration through an analogue computer simulating aerodynamic performance on the centrifuge. Transfer functions have been developed which will enable the transformation of control stick displacements

into the appropriate centrifuge motions. The measured dynamic responses of the centrifuge will allow simulation of most high G aircraft maneuvers. This simulator will not only provide a facility for investigation which has heretofore been possible only in actual flight testing, but also will extend the measurements to the vital area not before realizable with safety, i.e., to the limits of both aircraft and human performance.

The Practical Application of Pulmonary Function Studies in Thoracic Surgery. WILLIAM B. CONDON, M.D., Department of Thoracic Surgery, University of Colorado, Denver, Colo.

The pulmonary function of more than one hundred patients was studied extensively prior to thoracic surgery. Many of these patients also were studied postoperatively. This presentation correlates such laboratory data with the clinical condition and postoperative course of the patient. Conclusions are drawn as to which tests are the more important from the surgical standpoint.

Electrophysiological Aspects of Personality and Behavior. R. COOPER, H. W. SHIPTON, J. SHIPTON, V. J. WALTER, and W. GRAY WALTER, Burden Neurological Insitute, Bristol, England.

Previous difficulties in relating physiologic and psycho-social variables are attributed to inadequate resolution in the electro-physiologic analyzing systems and over-simplification of the experimental conditions by isolation of physiologic variables. Study of the fine structure of the EEG and other variables during dynamic experiments has defined previously obscure patterns of mental physiology. Results obtained in preliminary experiments emphasize in detail the consistent individuality of the general response pattern in each subject, the multiplicity and autonomy of the brain mechanisms involved in adaptive behavior and the persisting discrepancies between individual ways of thinking. There is also evidence that certain physiologic mechanisms are associated with characteristic attitudes to risk and responsibility. The results are classified in terms of a set of arbitrary parameters in order to disclose associations between mutually independent physiologic and psycho-social estimations.

AntiFibrillary Effects of Glycine in Hypothermia. FIRST LT. BENJAMIN G. COVINO, USAF (MSC), and CAPTAIN WILLIAM R. BEAVERS, USAF (MC), Arctic Aeromedical Laboratory, Ladd Air Force Base, Alaska.

Ventricular fibrillation is the greatest hazard in accidental and/or surgical hypothermia. Numerous attempts have been made to uncover a means of preventing this lethal cardiac dysfunction. In this regard glycine has been used experimentally for cyclopropane-epinephrine arrhythmias. Thus the efficacy of glycine as an antifibrillary agent in hypothermia, with and without surgical insult, was studied. Thirty-five dogs were anesthetized with pentobarbital and subjected to immersion hypothermia. Thirty-four of the animals succumbed to ventricular fibrillation at a rectal temperature of from 25° to 20° C. Ten dogs were treated with intravenous glycine and all terminated in asystole at rectal temperatures of from 18.5° to 15° C. without exhibiting any cardiac arrhythmias. Similar results were obtained in dogs subjected to hypothermia plus cardiac surgery.

The Pilot's Compromise with His Personal Equipment. LT. MORRIS J. DAMATO, MSC, USN, Naval Auxiliary Air Station, El Centro, Calif.

Most ingenious efforts seem to be directed toward long-range planning with the infallible, integrated escape capsule anticipated as the ultimate solution to safety and survival problems in high altitude, high performance aircraft. Meanwhile, today's pilot, highly displeased with the added weight and bulk of his present operational equipment, is cynical and pessimistic toward, and invariably questions the need and the efficiency of, his accessory equipment. The need for a more clearly defined pilot-equipment compromise is discussed with the recommended program including: (1) extended research in anthropometric studies of aviation personnel; (2) continued improvement, integration, and standardization of the present safety and survival equipment; and (3) a more thorough education and indoctrination of the air crewman in the mission and use of his current equipment.

Acquired Myopia in Airline Pilots. STANLEY DIAMOND, M.D., Pan American World Airways, San Francisco, Calif.

Pre-employment refractions of sixty-seven pilots were studied. These men initially had 20/20 vision or better, and five to eighteen years of flight duty. Sixteen pilots who later acquired myopia had emmetropic or mild myopic pre-employment refractions. Fifty-one pilots who maintained normal vision had predominantly hyperopic pre-employment refractions. Thus 20/20 vision alone appears to be an insufficient ocular criterion for long-continued visual efficiency. Pilot candidates with emmetropia or mild myopia may progress toward greater myopia. Hyperopia appears to be a safeguard against later defective vision due to acquired myopia. The findings were of significance in regard to ocular criteria for high selectivity of pilots where long-term maintenance of normal visual efficiency is of prime importance.

The Regulation of Hemoglobin Concentration. D. B. DILL, PH.D., Directorate of Medical Research, Army Chemical Center, Md.

The blood of a healthy man at sea level can combine with 20±2.5 volumes per cent of oxygen. The mean values have been established in this country by Wintrobe and by Osgood, and a recent summary by Albritton defines the concentrations associated with age, sex, species, and altitude. In evaluating the changes in hemoglobin concentration that depend on the partial pressure of oxygen in the environment, account must be taken of many other factors. Among these are individual idiosyncrasy, exercise, water balance, diet, emotional state, and disease. Season and climate are popularly, though probably erroneously, thought to have direct influence on hemoglobin concentration. The interplay of some of the above factors is discussed.

The "Stress" Concept Applied to Flying. COL. THADDEUS J. DOMANSKI, USAF (MSC), School of Aviation Medicine, Randolph Air Force Base, Texas.

The human physiologic response to flying is visualized as being an outcome of the interaction of an inflight circumstance or condition (stress) and a susceptible individual. The demonstrable physiologic response (stress response; "strain") is described in terms of the laboratory test employed, e.g., blood eosinophil count, urinary steroids. The investigator's emphasis may be upon the further definition of a particular stress or upon the recognition of individual differences in the response pattern. The data presented are representative of both categories of flight-line problems studied in terms of blood eosinophil response.

A Comparison of Static and Dynamic Trainers in the Learning of Flight Procedures. DORA J. DOUGHERTY, PH.D., and DOUGLASS R. NICKLAS, M.S., University of Illinois, Urbana, Illinois.

The possibility of utilizing flight trainers, which are less complex than the currently accepted electronic simulators, is one which is worthy of investigation. This study tested the hypothesis that flight procedures could be learned in trainers which incorporated decreasing amounts of dynamic simulation and could subsequently be performed in the aircraft with no detriment in flight performance. Three trainers were used in testing this assumption: (1) the SNJ Link 1-CA-2, (2) an SNJ procedures trainer, and (3) a photo mock-up of the SNJ aircraft cockpit. Ten students at the private pilot level were trained in each trainer group and were tested in the SNJ aircraft. Performances of these students were compared with ten control group students who were trained in the SNJ aircraft itself. Objective measures of procedure and flight performances indicated that learning in the static trainer compared very favorably with learning in the fully dynamic trainer.

Blood Acid-Base and Sugar Variations in Jet Pilots. JAMES P. ELLIS, M.A., ROBERT T. CLARK, PH.D., J. GORDON WELLS, PH.D., and CAPTAIN CLYDE H. KRATOCHVIL, USAF (MC), School of Aviation Medicine, Randolph Field Air Force Base, Texas.

Previous studies of inflight P_ACO_2 variations have indicated that jet pilots may experience intervals of hyperventilation.

The present investigations represents an attempt to correlate inflight P_ACO_2 alterations with acid-base related components in the blood and urine of pilots after flights in jet aircraft. The degree of hypocapnia found was in excellent agreement with previous findings. A corresponding reduction in whole blood and plasma bicarbonate occurred in postflight blood samples. Urine pH values were elevated. The lesser degree of alkalosis' indicated by postflight P_ACO_2, P_vCO_2, and blood pH has been attributed to the near re-establishment of control values during the short postflight interval preceding collection of samples. Blood sugar level was found to be in the normal range.

Linear Distance Changes over Body Joints. IRVIN EMANUEL, M.A., and AIRMAN SECOND CLASS JAMES T. BARTER, USAF, Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Linear distance changes over the body surface resulting from various joint movements were studied in a series of thirty young men. The following joints and joint complexes were studied: head and neck, shoulder, elbow, wrist, fingers, trunk, hip, knee, and ankle. Summary statistics and design values are presented for forty-eight linear distance changes measured over these joints. While there are usually definite and significant changes in bodily dimensions resulting from joint movements, these changes are generally fairly constant in magnitude. At the same time, the changes are mostly unrelated to body size. These data are of importance to the clothing engineer and others faced with the problems of reducing restriction of motion at the joints caused by the wearing of skin-fitting physiologic garments. The easement factors to be incorporated into such garments for major joints are readily available from these data.

Potassium Changes in Dogs During Acute Decompression Stress. FREDERICK P. FERGUSON, PH.D., Department of Physiology, University of Maryland, Baltimore, Md.

Decompression of intact dogs to a simulated altitude of 30,000 feet for thirty to ninety minutes consistently results in a decrease in the plasma potassium concentration and an increased urinary excretion of potassium. In an attempt to determine whether the adrenal glands are essential for these responses, similar studies were carried out on adrenalectomized dogs maintained on cortisone or DCA, or in moderate adrenal insufficiency. These animals manifested potassium changes similar to those observed in intact dogs. It is therefore concluded that, in this species, the characteristic responses of plasma and urinary potassium to an altitude of 30,000 feet are not mediated by the adrenal glands. The possible relationship between these potassium changes and the development of respiratory alkalosis is discussed.

Effects of Altitude and Oxygen upon Taste Sensitivity. BEATRICE FINKELSTEIN, M.S., and SECOND LT. JOSEPH P. CASTELLI, USAF, Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

The effects of breathing 100 per cent oxygen at a simulated altitude of 25,000 feet upon the taste sensitivity of young adult males are presented. For each taste determination, a series of fourteen dilutions of one of the four primary tastes (salt, sour, bitter, sweet) are used. Each dilution is twice the strength of the preceding one. Sensitivity is measured in terms of the subject's ability to discriminate between the four primary tastes, and his estimate of the sensory reaction to each of the dilutions. Determinations are made at ground level, and after one and two hours of simulated flight. Results will be applied to foods for use aboard high performance aircraft.

The Choice of Subjects in Dial Legibility Experiments. JOHN GAITO, A.M., U. S. Naval Air Crew Equipment Laboratory, Philadelphia, Pa.

This study was concerned with investigating the validity of extrapolating to other populations the results based on the experimental population. A paper and pencil test on aircraft clock designs was administered to experienced naval pilots, to naval enlisted aircrew personnel, and to naval enlisted non-aircrew personnel. Using mean number of errors and mean time per

reading as criteria of legibility, the three samples differed in most of the analyses. However, in no case did the relative effectiveness of the various designs change from one sample to another. Thus, this investigation would indicate that generally the results obtained on one population may be extrapolated to another population.

Psychologic Analysis of Unintentional Wheels-Up Landings. FRANK P. GATLING, PH.D., U. S. Naval Aviation Safety Center, Norfolk, Va.

Special interviews were conducted between flight surgeons and fifty-five pilots who made unintentional wheels-up landings. The psychologic items analyzed were: (1) training, such as hours in model and total hours flying; (2) type of maneuver, such as wave-off, preceding wheels-up landing, and its contribution to psychologic error; (3) pilots' actions during wheels-up landing sequence; and (4) the distractions present in the landing environment, such as other planes or tower communications. The results indicate a strong relationship between wheels-up landings and certain preceding maneuvers and distractions.

Pathology of Explosively Decompressed Rats Fixed at Altitude. CAPTAIN CHARLES F. GELL, MC, USN, LT. WILLIAM M. HALL, MC, USNR, and F. K. MOSTOFI, M.D., U. S. Naval Aeronautical Medical Equipment Laboratory, Philadelphia, Pa., and Armed Forces Institute of Pathology, Washington, D. C.

Investigators wearing the Navy's full pressure, B. F. Goodrich high altitude suit explosively decompressed rats from sea level pressure to a simulated 65,000 feet utilizing parasite chambers in a main low pressure chamber. The investigators then dissected and formalin-fixed the rats at 65,000 feet. Using another parasite chamber the rats were kept in a fixative at maximum altitude until total fixation occurred. A gross and microscopic pathologic evaluation of the effects of explosive decompression was conducted by the Armed Forces Institute of Pathology.

Experiments on the Labyrinthine Posture Reflex (Righting Reflex) of the Cat During Short Periods of Weightlessness. SIEGFRIED J. GERATHEWOHL, PH.D., School of Aviation Medicine, Randolph Air Force Base, Texas.

Experiments on the righting reflex were made using (1) four young cats with the reflex well developed (eight and twelve weeks old), and (2) four kittens before the reflex was developed (about three weeks old). The cats were held in upside-down position and dropped from an altitude of about 20 inches. The older animals turned upright immediately after release; the younger ones fell straight on their backs. Blindfolding did not affect the reflex once it was developed. The animals were then exposed to periods of about 20 to 30 seconds of practical weightlessness obtained by flying parabolic trajectories in T-33 and F-94 type aircraft. The cats were held upside-down while entering the parabola and released after 1, 5, and 10 seconds. The reflex was studied under both blindfold and nonblindfold conditions and recorded on 16 mm. film.

Some Physical Factors Affecting Gaseous Cavity Formation in Decompressed Animals. HERBERT R. GREIDER, B.S., and LOUIS J. SANTAMARIA, B.S., U. S. Naval Air Crew Equipment Laboratory, Philadelphia, Pa.

In previous work it had been clearly shown that gaseous cavities were formed at various loci in animals explosively decompressed to extreme altitude. Such work has not isolated the exact physical conditions necessary for the formation of gaseous cavities. The present study attempts to define some of these conditions, such as: (1) minimum altitude on which cavities form; (2) the effect of increased initial altitude in gaseous cavity formation; and (3) the effect of decompression rates on cavity formation. Rats, the experimental animals, were quick frozen at a specified time interval after decompression. Cross sections of the animals (half-inch thick) were made perpendicular to the long axis of the body. The sections were photographed in color and studied for pathologic changes. The results are discussed in detail.

Effect of Acceleration on Cerebellar Potentials in Birds and its Relation to the Sense of Direction. T. GUALTIEROTTI, M.D., and B. SCHREIBER, PH.D., Laboratorio di Fisiologia dell'Universita, Milan, Italy.

Migratory or sedentary birds show an increase in amplitude and decrease in frequency of the cerebellar electrical activity when subjected to acceleration between 2 and 1/50 G. Such changes can be recorded either directly from the cerebellar cortex or by external electrodes. Immediately after acceleration spindle-shaped discharges were observed in migratory species only; the electrical parameters of such after-discharges were similar to the ones observed during the acceleration itself. The results obtained are discussed, taking into account the Ising theory on the role of geodetic forces on the migratory direction sense of birds. The effect of acceleration and Coriolis force on cerebellar and extra-cerebellar potentials in birds and mammals is presented.

Influence of Cold Exposure on the Development of Thermal Burns in Rats. JAMES D. HARDY, PH.D., LESTER ZITOWITZ, B.A., and DAVID I. HILL, B.A., U. S. Naval Aviation Medical Acceleration Laboratory, Johnsville, Pa.

Second degree thermal burns were produced on shaved areas in rats by direct contact in a constant temperature water bath at 55° C. for an exposure time of twenty-five seconds. The burned animals were separated into two groups, one of which was kept at an environmental temperature of from 1° to 4° C. for five days and then removed to room temperature, while the second group was maintained at room temperature (21° to 26° C.). Measurements were made of skin temperatures at the site of the burn, the areas of the burns produced, and the areas of scars produced at the site of the burns. Results of these measurements showed that the skin temperature of the shaved areas in the rats exposed to cold averaged from 29° to 31° C. and in the control rats from 34° to 36° C. The severity of the burns is reduced in the animals maintained in the cold, as shown by a relative decreased area of burn and a decreased area of scab formation. The clinical implications of these observations is presented and discussed.

The Fatigue-Relieving Properties of Various Developmental Aircraft Seat Cushions. T. D. HANNA, B.S., and L. M. LIBBER, PH.D., U. S. Navy Air Crew Equipment Laboratory, Philadelphia, Pa.

The marked degree of pilot fatigue and discomfort incurred during prolonged flight in single seated aircraft accentuates the need for the development of improved seat cushions. Eight prototype seat cushion assemblies employing principles of vibration, pulsation, three dimensional fabrics (tri-lok), layered differential resiliency, and air inflation were evaluated in the present study. These seat cushions were first tested in the laboratory to determine which type of criterion could be used for evaluation. Physiologic and psychologic tests were insufficiently sensitive to differentiate one seat cushion from another. An operational evaluation using the only sensitive criterion, a questionnaire, showed that the pulsating seat with tri-lok possessed the best fatigue-relieving properties.

Noise Protection and Measurement. NELSON W. HARTZ, B.S., Mine Safety Appliance Co., Pittsburgh, Pa.

A discussion is presented of the design parameters and the engineering compromises affecting them, that were necessary to provide practical over-the-ear protectors. Similar considerations leading to the design of a composite, portable, sound level meter; octave band analyzer; narrow band analyzer; and field calibrator are reviewed.

Human Tolerance to Accelerations: A Practical Tool for the Engineer. JAMES F. HEGENWALD, JR., B.S., and SHIGERU OISHI, B.S., North American Aviation, Inc., Los Angeles, Calif.

A convenient method is developed for evaluation of human tolerance to simple and combined translational and rotational accelerations. Magnitudes from 2.5 to 150 G, time durations from 0.005 to 1000 seconds, rates of onset from 0.1 to 4000 G per second,

and various directions of resultant accelerative vectors are compared with levels of useful consciousness, voluntary tolerance, and permanent injury as criteria. The results of this study are applied to the current program of North American Aviation to attenuate acceleration hazards during emergency escape from high performance airplanes, including full scale rocket sled tests.

The Dissipation of Vibrational Energy in the Human Body. T. C. HELVEY, Glenn L. Martin Co., Baltimore, Md.

The major limitation for a human monitor in a man-machine system is caused by multiple stresses which are not additive parameters. In a broad program on stress physiology, studies were carried out with low frequency vibration with a range of three to thirty cps which is frequent in high performance airplanes. Longitudinal and transversal measurements were made on the extremities, chest and torso. Significant resonance frequencies have been found for various organs and parts of the body. Some of the transversal resonance energies must be considered as deleterious for pilot performance. The longitudinal dissipation of vibrational energy in the limbs is very favorable (except at frequencies below five cps with peak G values above 2.5), if only a vertical component with one degree of freedom is applied to the flexed limb. The measurements were made with small accelerometers placed on biokinematically significant points, and their outputs recorded with a multi-channel galvanometer.

Development Status of Supersonic Ejection Seat. R. R. HEPPE, Ae. E., and M. D. CASSIDY, M.S., Lockheed Aircraft Corp., Burbank, Calif.

Lockheed recently has been pursuing intensively the development of new concepts in ejection seat design to meet the immediate demand for escape systems in existing supersonic aircraft. This paper reviews the basic philosophy and concepts which led to the Model D seat design. The results of design development and full scale development tests are discussed to indicate the existing status of the supersonic downward ejection seat.

Measures of Behavior Following Repeated Exposure to Negative Acceleration Forces. ROBERT M. HERRICK, PH.D., JEROME L. MYERS, PH.D., and RICHARD E. BURKE, M.A., U. S. Naval Aviation Medical Acceleration Laboratory, Johnsville, Pa.

Rats were trained on a simple visual discrimination problem. They were then centrifuged daily for three minutes at a given negative G level. The G level was increased every five days until the lethal level was reached for all rats. Behavioral measures of the discrimination were taken daily one hour after the end of the centrifugation period.

Stereophotogrammetry As an Anthropometric Tool. H. T. E. HERTZBERG, C. W. DUPERTUIS, and I. EMANUEL, Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

This paper outlines the procedures used to draw body contours at one-half inch intervals of several male subjects, and compares the dimensions derived from plotted profiles with those of the subjects themselves. It discusses the utility of such data for special anthropometric purposes, and mentions further applications for other biologic specialties such as orthopedics, dentistry, and pathology.

Theoretical Investigation of the Dynamic Response of the Human Torso Under Large Vertical Acceleration. JOHN L. HESS, M.S., and C. F. LOMBARD, PH.D., Douglas Aircraft Co., El Segundo, Calif., and Protection, Inc., Los Angeles, Calif.

This paper attempts to investigate the dynamic response exhibited by the human torso when subjected to large, upward, short duration accelerations of the sort encountered in ejection from aircraft, by considering a simpler mechanical system. This, if successful, would permit the determination of spinal stresses. The simplest model, the elastic rod, is chosen as a first approximation. Its predictions agree fairly well with experiments on human subjects. Among these are the lack of physical significance of rate of rise of acceleration and the dependence of dynamic stress magnification on time of rise of acceleration. It is concluded that fixed stroke ejection systems can maximize safe ejection

velocity by raising the acceleration slowly to a relatively high maximum, while other systems can employ arbitrarily short times of rise if the acceleration does not exceed a value approximately half that which is safe in the case of slow rise.

The Physiologic Responses of Dogs to High Intrapulmonic Pressure When Protected by a Partial Pressure Suit. FRED HITCHCOCK, PH.D., and ALFRED FASOLA, PH.D., Laboratory of Aviation Physiology, Ohio State University, Columbus, Ohio.

Studies have been made of the physiologic responses of dogs, both at ground level and at a simulated altitude of 60,000 feet, when the animals were exposed to intrapulmonic pressure of +100 mm. Hg. and the same pressure applied to a partial pressure suit of the bladder type. Survival time averaged about two hours, ranging from 0 to 8 hours. Withdrawal of blood shortened the survival time and the administration of ACTH prolonged it. Cardiac output at 60,000 feet was decreased in one hour to a value of about one-third of the control value. X-ray studies showed the suit to be inadequate in preventing hyperinflation of the lungs. Blood gas analyses revealed a decrease in saturation at altitude, even though hyperventilation occurred as indicated by a drop in the pCO_2. Cardiovascular studies were also made.

Observation on Exposure to Anticholinesterase Agents. JOSEPH H. HOLMES, M.D., and MAURICE GAON, M.D., Department of Medicine, University of Colorado, and the Rocky Mountain Arsenal, Denver, Colo.

A total of over 600 cases of accidental exposure to anticholinesterase agents have been studied with respect to clinical findings, psychologic evaluation and laboratory abnormalities. These organic phosphorus compounds include parathion, TEPP, and nerve gas. The common symptoms observed were miosis, dimness of vision, rhinorrhea, chest constriction, cough, salivation, nausea, vomiting, and diarrhea. The changes demonstrated by psychologic testing and psychiatric interviews are presented. The relation of red cell and plasma cholinesterase to degree of exposure and symptomatology is discussed. Laboratory studies included changes in blood coagulation, electrolytes, urine, and EEG. Possible chronic effects resulting from multiple exposure is discussed. Consideration of treatment includes maintenance of a good airway, artificial respiration and administration of atropine.

Collapse During Rapid Decompression. CAPTAIN FRITZ M. G. HOLMSTROM and LT. COL. HENRY F. STEINBOCK, USAF (MC), Hq. Office of the Surgeon, Hq. U. S. Air Forces in Europe, APO 633, New York, N. Y.

Observations on two subjects who collapsed in an altitude chamber, while undergoing rapid decompression from 8,000 to 22,500 feet, are presented. One patient showed extensive transitory neurologic involvement evinced by loss of consciousness, paralysis, and residual headache. There was also a pneumomediastinum and an associated left pneumothorax. The other presented minimal transitory neurologic findings, loss of consciousness and change in deep reflexes, without demonstrable pulmonary pathology. Both patients recovered completely. It is suggested that increasing the intrapulmonary pressure beyond the parenchymal tolerance may result in (1) arteriolar aeroembolism, and (2) perivascular and peribronchiolar dissection of air to mediastinum. Collapse during rapid decompression must be differentiated from decompression sickness.

Training Naive Pilots on an Instrument Panel Homogenous with Respect to the Principle of the Moving Part. ROBERT C. HOUSTON, PH.D., University of Illinois, Urbana, Ill.

Research evaluations of individual instrument presentations have consistently favored the display of the aircraft symbol as the moving part rather than as a fixed index with a moving background. In this study, the "principle of the moving part" was applied to the whole panel and evaluated in the training of flight-naïve students to fly instrument landing system (ILS) approaches under simulated instrument conditions. Ten students were trained

on a conventional panel and ten on the experimental panel in a 1 CA 1 (C-8) Link. Six students in each group flew the Air Force Aero Medical Laboratory's experimentally instrumented C-47 on ILS approaches. Objective measures of performance generally favored the group trained on the experimental panel. Considering their limited training, performance for all students was remarkably good.

Jet Transitional Training. CAPTAIN CARROLL P. HUNGATE, MC, USNR, Naval Air Station, Olathe, Kan.

Older pilots of propeller aircraft experience a variety of difficulties in transitioning to high performance aircraft with high altitude capabilities. A reorientation of the older pilot's thinking is necessary and can be stimulated by jet operational experiences of the flight surgeon. The field observations of the jet squadron flight surgeon can lead to improvement in safety. All incidents and accidents should be carefully analyzed so that any new causative factors discovered can lead to improved safety regulations. Similar incidents of a recurring nature often happen at widely separated air facilities. When brought into focus through the alertness of the flight surgeon, the safety of jet flying is enhanced. Precision in jet flying can be impressed upon the aviator by the flight surgeon's explanation that the pilot's present transitioning is but the first step to flights at greater speeds at higher altitudes, the latter requiring yet greater skill and knowledge of survival experiment.

Helicopter Recovery of Survivors Afloat. LT. COMDR. ROGER G. IRELAND, MC, USN., Naval Air Facility, Elizabeth City, N. C.

The current status of operational problems encountered in effecting timely airborne helicopter recovery of survivors from the water is reviewed, and followed by a statement of general criteria to guide development of all accessory devices designed to solve these problems safely. The results of the author's experience during eighteen months of research and field testing of such devices in co-operation with U. S. Coast Guard Air-Sea Rescue Facilities is briefly summarized. A new all-purpose recovery device, designed and successfully tested by the author and constructively based upon this research experience, is described and illustrated by a short 16 mm. silent film.

Skin Resistance Changes During Acceleration. FIRST LT. GILBERT JOHNSON, USAF, CAPTAIN SANFORD I. COHEN, CAPTAIN ALBERT J. SILVERMAN and CAPTAIN GEORGE D. ZUIDEMA, USAF (MC), Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Changes in basal skin resistance have been reported in response to many types of stimuli and attributed to factors such as blood volume shifts and sympathetic nervous system discharges. Basal resistance shifts have also been noted in subjects exposed to centrifugal stress. Subjects exposed to high levels of rapid acceleration showed greater decreases in resistance levels than those exposed to gradual acceleration. To evaluate the relative role of blood volume shifts and sympathetic impulses in these changes, hemi-sympathectomized dogs were exposed to centrifugal stress. The non-sympathectomized side showed consistent changes in resistance level far in excess of the sympathectomized side. Thus it appears there is a promising measure, rather easily obtained in operational conditions, which may reflect central nervous activity associated with cardiovascular reflex response to acceleration stresses.

Relation of Preference to Performance in Naval Air Advanced Training. LT. H. PAUL KELLEY, MSC, USNR, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

Naval pilot training consists of a "common core" of basic training, followed by more specialized advance training. At the end of the "common core," each trainee officially states the type of advanced training he would prefer; these preferences are taken into consideration in making the assignments to advanced training. Because preliminary research suggested that men assigned to a preferred type of training performed better than did men assigned to a nonpreferred type, the following data have been collected for several thousand pilot trainees: type of advanced training pre-

ferred, type of advanced training to which assigned, performance in basic training, and performance in advanced training. These data have been analyzed to determine the importance of preference to performance.

Need for Simplified Methodology for Determination of Exposure to Toxic Chemicals: Carbon Monoxide. GEORGE KITZES, PH.D., and MAJOR JACK MAYER, FIRST LT. PETER E. STURROCK, and FIRST LT. NORMAN B. FURLONG, JR., USAF, Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Early detection of health hazards due to exposure to chemical materials will protect Air Force personnel and maintain their efficiency in performing their duties and mission. Carbon monoxide continues to be a problem in the Air Force and is still incriminated as a cause of aircraft accidents and pilot illness, although adequate proof has been lacking. Not infrequently, laboratory reports contain high blood carbon monoxide values inconsistent with symptomatology and associated circumstances. Experience has proven that erroneous analyses can be obtained if experienced and trained personnel are not available, or if faulty methodology is employed. Costly surveys and research effort can be obviated by the employment of simple but accurate methodology and techniques and easy to use instrumentation. Several methods meeting these criteria have been developed for the measurement of blood carbon monoxide.

Aviation Human Engineering Is a Scientific Specialty! SHERWIN J. KLEIN, PH.D., and CAPTAIN CHARLES F. GELL, MC, USN, U. S. Naval Air Crew Equipment Laboratory, Philadelphia, Pa.

The operational demands of current aircraft are rapidly outstripping the capabilities of human operators. Future aircraft are expected to make such extreme demands upon the organism that personal safety equipment as now conceived may be totally inadequate to provide minimum protection for survival. This problem is further complicated by the impact of stress—resulting from the incumbrances of personal safety equipment, high speeds, and a variety of environmental and psychological stressors—upon pilot performance. Human engineering has been growing as an engineering subspecialty. To intrust the resolution of such a complicated problem to an engineer who may be a biological novice is inviting disaster. The human engineer must be a highly trained medical, physiologic, or behavioral scientist who can translate human requirements and limitations for the design engineer. Examples of human engineering problems are discussed and a well-rounded human engineering program outlined.

An Approach to the Physiological Simulation of the Null-Gravity State. MAJOR LEON A. KNIGHT, USAF (MC), School of Aviation Medicine, Randolph Air Force Base, Texas.

The null-gravity state is discussed, the observation being made that the condition of "weightlessness" exists whenever the only mechanical forces acting on a body are "field" phenomena. The importance of the problem in space medicine is considered to reside in the absence of the normal physiologic adjustments which a body makes to the forces of deformation opposing the "field" forces. The similarities and differences are considered between the state of a body floating in space and that of a body floating in water. A preliminary study is described in which static equilibrium functions were observed under water, with interest concentrated in the function of the otolith mechanism, particularly its socalled "blind spot."

Physiological Factors in U. S. Air Force Aircraft Accidents. EUGENE B. KONECCI, PH.D., Human Factors Group, Douglas Aircraft Co., Tulsa, Okla.

An analysis of aircraft accident records in the Air Force was made while the author was assigned to the Directorate of Flight Safety Research, Norton Air Force Base, California, to determine the role that physical and physiologic stresses play in aircraft accidents. Some of the factors taken into consideration were hypoxia, vertigo (spatial disorientation), hampered or restricted vision, black-out (white-out or red-out), fatigue, G forces, air sickness, carbon monoxide poisoning, other toxic agents (hydrocarbons), physical disturbances (cold, sort throat, sinus, et cetera),

thermal conditions (too cold, too hot, hypochloremia), hyperventilation or hypoexcitability, hypoglycemia, vibration, noise, decompression sickness, substandard visual acuity, and cardiovascular irregularity. The results of the analysis are discussed.

Prevention of Back Injuries Resulting from the Crash Landings of F7U-3 Aircraft. CHRIS T. KOOCHEMBERE, U. S. Naval Air Crew Equipment Laboratory, Philadelphia, Pa.

The Air Crew Equipment Laboratory has recently completed a project involving investigation of vertebral injuries of pilots encountered as a result of nose wheel failure type crashes aboard carriers and in land operations, and the subsequent solution of this problem. The system of an energy absorption cushion, which also eliminates the necessity of foot stirrups, and a fully annealed, stainless steel strap which elongates under a predetermined load allowing the seat and pilot to displace downward in the ejection rails, is presented. Data concerning the basic accelerations and loadings endured on the aircraft, seat, and pilot were obtained by crashing a full scale airplane. This information was then utilized in designing the energy absorption system.

G Tolerance in Primates. I. Unconsciousness End Point. GEORGE H. KYDD, PH.D., and ALICE M. STOLL, M.S., U. S. Naval Aviation Medical Acceleration Laboratory, Johnsville, Pa.

Because of the hazards involved, investigations of many physiologic functions in human beings during acceleration have been unfeasible. Since no direct relationship has been established between results from animal exprimentation and those found with human subjects, it has not been possible to apply information obtained on animals to the prediction of loss of function in human beings under accelerative stress. To establish such a relationship, unanesthetized primates, preferably chimpanzees, must be subjected to experimental conditions identical with those used in establishing the human tolerance curve. Monkeys were used in the present preliminary study. From photographic observations strength-duration curves were obtained using certain head and eye movements and straining as end points. The curve for straining appears to closely approximate the human curve for unconsciousness, while the head and eye movement end points occur later.

Relationship Between Electroencephalographic and Psychological Findings in 800 Candidates for Aeronautic Pilots. P. LABOUREUR, M.D., H. GASTAUT, M.D., P. NAVARRANNE, M.D., and C. JEST, M.D., Department of Medicine, University of Marseille, and the Marine Hospital, Marseille, France.

The relationship between the results of EEG examination (character of various grapho-elements both spontaneous and provoked) and of psychologic examination (maturity of effect, self-control, emotional responses, anxiety, and dynamic and aggressive traits), have been studied in a population of candidates for naval aeronautic pilots, with an average age of 20.5 years. From the psychologic point of view, this population is characterized by immaturity of effect, aggressiveness, and lack of anxiety. From the EEG point of view, it is characterized by an alpha rhythm of from 9 to 10 cps (average 9.57), often associated with slower elements: theta rhythms in 50 per cent of the cases, delta waves posteriorly in 30 per cent, and bursts of slow waves on hyperventilation in 25 per cent. The records are flat in 15 per cent of the cases, with a so-called "rolandic" rhythm (beta waves of high amplitude, or rhythm "en arceau") in 16 per cent of the cases. The significance of these findings is discussed.

Effects on Cerebral Circulation and Cerebral Oxygen Consumption of Hypoxia, Hypocapnia and Combined Hypoxia and Hypocapnia. C. J. LAMBERTSEN, S. G. OWEN, H. P. CHIODI, H. WENDEL, J. E. TURNER, P. G. LINAWEAVER, and R. GELFAND, Department of Pharmacology, University of Pennsylvania, Philadelphia, Pa.

Administration of 8 per cent oxygen at 1.0 atmosphere to normal young men maintained at their normal arterial pCO_2 of 43 mm. Hg. increased cerebral circulation 50 per cent, reduced brain oxygen consumption 7 per cent, and lowered mean brain capillary pO_2 to 31 mm. Hg. without pro-

ducing unconsciousness. When 8 per cent oxygen administration was combined with assisted ventilation to lower arterial pCO_2 to 23 mm. Hg., cerebral circulation and oxygen consumption were reduced 10 and 15 per cent below control air breathing levels, mean cerebral capillary pO_2 was lowered to 23 mm. Hg., and 50 per cent of subjects became unconscious. The same degree of hypocapnia without anoxemia decreased cerebral circulation 44 per cent without lowering brain oxygen uptake or producing unconsciousness.

Arterial Blood Pressure Responses to Positive G Forces in Monkeys. LT. COMDR. R. W. LAWTON, MC, USNR, L. GREENE, M.S., G. KYDD, PH.D., R. CROSBIE, M.S., and L. PETERSON, M.D., U. S. Naval Aviation Medical Acceleration Laboratory, Johnsville, Pa., and Department of Physiology, University of Pennsylvania, Philadelphia, Pa.

The automatic control features of the human centrifuge make possible the application of G forces of precise configurations. Arterial blood pressure responses of monkeys accelerated with short duration positive G patterns have been studied at various intra-arterial locations. The instantaneous value of the arterial blood pressure during centrifugation is a function of the length of the blood column in the G axis, the distensibility of the arterial walls and the volume of blood contained therein. The volume of blood in the arterial tree is determined by the dynamic equilibrium between inflow and outflow. Blood pressure records during centrifugation are presented to illustrate the interplay of these factors in the monkey.

The Otolaryngologist's Approach to Passenger Comfort in Air Transport. BRUCE V. LEAMER, M.D., Department of Otolaryngology, University of California, Los Angeles, Calif.

Barotrauma, from the passenger standpoint, is becoming relatively infrequent due to improvements in cabin construction and pressurization. It is still of sufficient frequency, however, to cause discomfort to a limited number and of sufficient importance to warrant consideration. From the otolaryngologist's point of view, barotitis and barosinusitis should be recognized by air crews, especially stewards and stewardesses. They should be instructed in etiology and simple methods of inflight treatment to relieve passenger discomfort, and should advise passengers to seek medical advice at destination. Passengers suffering from acute upper respiratory infections, acute or chronic sinusitis, or otitis media who are about to go on flights which cannot be postponed, should be advised concerning the possible occurrence of barotitis or barosinusitis and should be instructed as to simple methods of prevention and treatment.

A Study of Drowsiness Following Administration of Motion Sickness Remedies Bonamine® and Marezine.® LUDWIG G. LEDERER, M.D., PH.D., Capital Airlines and Department of Medicine, George Washington University, Washington, D. C.

Two of the most popular drugs now in use for airsickness were tested on human subjects to study the occurrence of drowsiness. For technical reasons and in order to obtain more valid data, the author decided to conduct this study away from the aircraft on normal, intelligent, young adults. Approximately 100 medical students served as subjects for this study. The medications used were Marezine® in doses of 50 mg. and Bonamine® in doses of 25 mg. and 50 mg., and a placebo. The experimental group was divided into four equal parts, each one receiving one of the above trial samples. Criteria for drowsiness were, (1) no effect; (2) slightly sleepy; (3) sleepy, but able to carry on school work; (4) too sleepy to carry on school work or unable to attend social functions. The results of this study are of interest.

EEG and Military Service Performance. MARGARET LENNOX, M.D., and FRITZ BUCHTHAL, M.D., Institute of Neurophysiology, University of Copenhagen, and the Institute of Air Medicine, Military Hospital, Copenhagen, Denmark.

A followup of 682 pilot applicants investigated electroencephalographically in 1950 and 1951 has shown a correlation of military service performance with markedly abnormal (including paroxysmal) EEGs. The EEG findings were not considered in

decisions of rejection or dismissal. The incidence of these abnormalities was highest in those rejected for military service (13.4 per cent) and lowest in those still in service (4.9 per cent). It was 8.6 per cent in trainees dismissed from service. Of applicants or trainees with a markedly abnormal EEG in 1951, 20 per cent are still in service; 40 per cent of those with a normal or slightly abnormal EEG. The aircraft accident incidence was more than twice as high in pilots with markedly abnormal EEGs than in those with normal or slightly abnormal tracings.

Standardization of Human Centrifuge Techniques. CAPTAIN SIDNEY D. LEVERETT, JR., USAF, and CAPTAIN GEORGE D. ZUIDEMA, USAF (MC), Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

There are eight centers in the world actively reporting studies on the human centrifuge and several others are either under construction or being planned. With increased speed and altitude of aircraft, the problem of human tolerance and reaction to acceleration becomes more complex. Although many centrifuges have been in operation as long as fifteen years, there has been no standardization of operation. This tends to make results reported by one group invalid for another group using a different set of operating criteria. These criteria include the type of lights used for subject response, central observer, closed-circuit TV monitor, end-point criteria, maximum time at peak G during a rapid-onset run, rate of acceleration to peak G, type of lights in room, and distance between subject's eyes and signal lights. A standard run based on the above criteria is suggested.

Human Tolerance to Safety Belt Restraint. FIRST LT. SIDNEY T. LEWIS, USAF, and LT. COL. JOHN P. STAPP, USAF (MC), Aero Medical Field Laboratory, Holloman Air Force Base, N. M.

Human volunteers were decelerated while restrained by lap belts of either 1¾ inches or 3 inches wide while seated forward-facing in three experimental devices: (1) an aircraft seat hanging by cables forming a swing-pendulum, which could be raised and dropped through a measured vertical component and arrested by a steel cable; (2) a rubber shock cord catapult capable of 17 G at 400 G per second for 80 milliseconds when decelerated from eighteen miles an hour to a stop in twelve inches by friction brakes; and (3) a 120-foot track with sled propelled by ejection seat catapult and decelerated by water inertia brake. Rate of onset, magnitude and duration of forces are tabulated for twenty human volunteers for each lap belt width. Air transport crash protection is discussed.

The Effects of Moderate Heat Stress, Altitude and Time on the Dehydration Rate of Subjects Wearing the Ventilated Full Pressure Suit. LEONARD M. LIBBER, PH.D., HERBERT R. GREIDER, B.S., and LOUIS J. SANTAMARIA, B.S., U. S. Naval Air Crew Equipment Laboratory, Philadelphia, Pa.

Design difficulties in high performance aircraft may force pilots to operate at comfortably warm temperatures while wearing a ventilated full pressure suit. Although this is quite bearable, the pilot may be evaporating a considerable amount of moisture which may lead in time to a physiologically detrimental state of dehydration. The effects of altitude, time and a subjectively designated comfortably warm state on various measures of water loss were studied. Results showed that there was as much as 1,044 grams total weight loss during a four-hour test period. The rate of total weight loss, however, decreased with time. Altitude had little effect on any of the dependent variables.

Studies of Babies Born at a High Altitude. JOHN A. LICHTY, M.D., ROBERT C. HOWARD, M.D., and PAUL D. BRUNS, M.D,. Department of Obstetrics, University of Colorado, and the Colorado State Department of Public Health, Denver, Colo.

The incidence of prematurity for a county in Colorado at high altitude was found to be three times the state average. The weight distribution curves indicated that these infants were one-half to three-quarters of a pound lighter than babies born in Denver. Preliminary studies did not explain this discrepancy on the basis of racial

or dietary factors. The possibility that altitude might influence birth weight was considered. When head size dimensions and length of the infants born at high altitude were plotted, confirmation of the reduced size of the babies was obtained. This could not be related to prematurity. No reduction of blood oxygen saturation was found in the mothers, and the values for the babies rose promptly to normal saturation during the first twenty minutes following delivery.

Liljencrantz and Boynton: A Study in Heroism. MAE M. LINK, PH.D., Office of the Surgeon General, Department of the Air Force, Washington, D. C.

Two flight surgeons who sacrificed their lives to advance aeromedical research are Commander Eric Liljencrantz, in 1942, and Lt. Col. Melbourne W. Boynton, in 1944. Liljencrantz was making studies in gravity stress encountered in dive bombing when the wings of his plane collapsed. Boynton, continuing the earlier experiments of Lovelace in delayed parachute opening, jumped from the bomb bay of a B-17 aircraft at 43,000 feet. He had hoped to establish the characteristics of free fall, and to determine the rate of deceleration and the path of fall. His parachute failed to open. This paper pays tribute to these two heroes, with major emphasis upon Liljencrantz, and assesses their contributions.

Can Change of Position Improve Ejection Tolerance? C. F. LOMBARD, PH.D., Protection, Inc., Los Angeles, Calif.

The recommended position during ejection has been to have the spine oriented in the line of thrust of the ejection gun. Limits have been set upon the tolerance of the lumbar spine to take the load of the upper portion of the body under the G force imposed by ejection. This "ideal" position is not always achieved during escape with the use of the ejection seat. In certain instances successful escapes at high speed have been made when the occupant was bent forward so that the upper torso flexed downward to rest upon the legs. This suggests that an increased G load could be applied during the ejection stroke with the individual in this position. Such a position could result in higher velocities attained at the end of the stroke, resulting in better clearance of the tail of the aircraft, and permit at the same time a smaller configuration resulting in lower air drag.

Physical Competence of Men from 20 to 45 Years of Age. ULRICH C. LUFT, M.D., and ELIZABETH H. ROORBACH, M.S., The Lovelace Foundation, Albuquerque, N. M.

A group of eighty men of predominantly sedentary habits was subjected to a graded work load on a bicycle ergometer starting at 300 mkg. per minute and increasing by 75 mkg. per minute each minute. Heart rate, blood pressure, ventilation, and gas exchange were measured at regular intervals. Work was continued until the heart rate of approximately 180 (range 172-188) was attained. The oxygen uptake during the final minutes of the test was calculated per square meter of body surface area. The oxygen pulse which represents the oxygen uptake per heart beat was also used as a general criterion of circulatory efficiency because it is mainly determined by the stroke volume of the heart. Range and age distribution of physical competence in this group of untrained men is presented, and the use of this type of test for the selection of personnel for special tasks is discussed.

What Makes a Flyer Ill? H. M. C. LUYKX, D.Sc., Office of the Surgeon General, Department of the Air Force, Washington, D. C.

For the first time the Air Force has data available to show the difference in morbidity patterns resulting from different definitions of illness, i.e., when comparing groundings of fliers with excusals from duty, as defined in the military services. For example, during 1955 there were about 410 groundings per thousand fliers, as opposed to 270 excusals from duty; and 11.2 fliers per thousand were not available for flying duty on an average day, compared with 6.3 fliers per thousand excused from all military duty. Groundings of fliers occur with three or four times the frequency of excusals from duty for such diseases as respiratory infections, trauma, and disorders of the nervous system and sense organs. In many other categories, groundings are no more frequent than excusals from duty,

among fliers. The flight surgeon's attention, therefore, is focused in a different direction from that of the general medical officer.

Avoidance of Acceleration Forces in the Animal by Immersion in Water. R. MARGARIA, PH.D., and T. GUALTIEROTTI, M.D., Laboratorie di Fisiologia dell'Universita, Milan, Italy.

A body immersed in a liquid of the same density is not subjected to acceleration forces. The specific weight of the single components of the animal body is not the same; therefore, the consequences of the immersion in a liquid of the same density of the animal as a whole, when subjected to acceleration forces, ought to be limited to the differences of density of the single organs. This is expected to be a minor effect. Fishes subjected to centrifugation at 1500 G for up to ten minutes survived over twenty-four hours having only the otholitic system destroyed. Frogs, centrifuged when immersed in water, survived when exposed to several hundred G for some minutes. Mice contained in a missile in free fall for nine minutes and decelerated to stop in 1 cm. were killed instantly, but they survived a number of successive such falls when immersed in water.

The Effects of Hypoxia, Hypoglycemia, and Aging on Light Sensitivity. Ross A. MCFARLAND, PH.D., Harvard School of Public Health, Boston, Mass.

Measurement of the light threshold of the dark adapted eye was used as a sensitive index of changes in the internal environment. Lowering the partial pressure of oxygen impaired visual sensitivity at about 7,000 feet. Reducing blood sugar by insulin also produced a loss in sensitivity. Effects similar to those obtained at high altitudes were found with carbon monoxide. Because changes in oxygen transport and cerebral circulation may be characteristic of aging, dark adaptation curves were taken on 200 subjects ranging from twenty to sixty years of age. The correlation between age and final threshold was 0.895, and a doubling of the threshold intensity of illumination was required for each increase of thirteen years in age. The experiment was repeated with 240 subjects ranging from sixteen to ninety years of age. Similar results were obtained. The changes in visual sensitivity with age are believed related to basic physiologic functions in the cells of the retina and brain.

Human Variation to Cardiovascular Stress. CAPTAIN TERENCE F. MCGUIRE and CAPTAIN FRANK J. LEARY, USAF (MC), Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

On rapid ascent to 10,000 feet without oxygen or to 40,000 feet on 100 per cent oxygen, a series of cardiovascular changes are noted. These changes are intimately related to the individual's ability to compensate for other stresses of flying, such as pressure breathing or G stress. This ability to compensate cardiovascularly has great person-to-person variability and should have weight in the selection of personnel for special missions. Simple physical means of determining this ability are discussed.

Mercy Flights in the Northwest. J. L. MCMILLAN, M.D., Vancouver, Canada.

Injuries commonly received by loggers of the British Columbia coast are discussed, and the organization established by both the Royal Canadian Air Force and civilians to transfer patients to larger centers is described. First aid equipment carried in the planes and interesting cases described to illustrate use of particular apparatus are presented. The paper discusses the use of parachutists by the RCAF and of small seaplanes by civilians in search and rescue operations following air disasters in the mountains.

The Contributions the Industrial Hygiene Engineer Can Make to Aviation Medicine. LT. COL. ALVIN F. MEYER, JR., USAF (MSC), Office of the Surgeon, Strategic Air Command, Offutt Air Force Base, Nebr.

There is an increasing area of aviation medicine in which engineers with biotechnical training may make a major contribution. Sanitary and industrial hygiene engineers have special training and interest which fit them for work in aeromedical problems with little or no additional education. Industrial hygiene engineers generally are well

oriented in problems of noise and ionizing radiation, control of other physical agents of disease such as abnormalities of temperature, illumination and pressure; are versed in problems of ventilation and air conditioning; and possess high technical skill in the analysis and control of exposure to hazardous chemicals. Many industrial hygiene engineers possess the "know how" to deal with human factors and human engineering design problems. These engineers are well qualified for collection of and examination of atmospheric samples. In the Air Force there has been an increasing utilization of such skills to support and assist flight surgeons.

Determination of the Effective External Dead Air Space Limitations at Altitude. EDWARD L. MICHEL, M.S., and HERBERT R. GREIDER, B.S., U. S. Naval Air Crew Equipment Laboratory, Philadelphia, Pa.

A knowledge of the physiologic limitations of dead air space is important in the design of respiratory equipment. Physical measurements of the dead air space volumes inherent in respiratory apparatus cannot at all times provide a true, complete indication of the resultant physiologic effect on an individual using the equipment. Pneumotachographic studies involving physiologic measurements were conducted at altitude for purposes of determining the allowable limits of effective external dead air space. The CO_2 concentrations in the respiratory gases were used as the criterion of the "critical" volume when subjects were exposed to various external dead space volumes.

Lipoproteins and Cardiovascular Disease in the Pilot-Executive; A Three-Year Study. LT. COL. LAWRENCE J. MILCH, USAF, COL. MARSHALL E. GROOVER, and CAPTAIN NORMAN WEINER, USAF (MC), and FIRST LT. BERNARD S. SCHLESINGER, USAF (MSC), School of Aviation Medicine, Randolph Air Force Base, Texas and Office of the Flight Surgeon, The Pentagon, Washington, D. C.

A large group of Air Force pilots and aircrew members, assigned since late 1953 to executive type duties, was studied along with nonflying officers and civilians in executive jobs at the same installation. The experiment was organized in conjunction with a care-of-the-executive program to include comprehensive physical examinations at intervals dictated by medical history, medical status, age and, in certain cases, sensitivity of position. In each physical examination blood samples were taken and the sera analyzed for ultracentrifugal lipoproteins, cholesterol, and lipid phosphorus. Whenever diet or drug therapy was indicated, it was instituted and recorded. Included in the initial history were details of: (1) the family history of cardiovascular disease; (2) personal cardiovascular history; (3) history of traumatic injury; (4) electrocardiogram; (5) eyegrounds; (6) peripheral arteries; and (7) emotional tension. These items were studied with reference to the observed blood lipid and liproprotein concentrations.

A Practical Evaluation of Supplementary Oxygen Masks. ARTHUR E. MILLER, B.S., Scott Aviation Corp., Lancaster, N. Y.

The author calls attention to the similarities and differences in purpose, function, and evaluation criteria of therapeutic oxygen equipment versus supplementary oxygen equipment. The specific requirements of supplementary oxygen masks for aviation are briefly discussed, and the various types of masks used in the past are illustrated and described. Tentative specifications are proposed for supplementary oxygen masks designed especially for new high altitude commercial transports. Test procedures in evaluation of several new types of masks are described, and test results reported. Practical applications are suggested for the data obtained.

Stresses Affecting the Pilot During Post-Stall Maneuvers of High Performance Aircraft. C. O. MILLER, B.S., and J. D. HORGAN, M.D., Chance Vought Aircraft, Dallas, Texas.

Supersonic aircraft operating at high altitude have produced erratic post-stall characteristics approaching, if not surpassing, the limit of a pilot's ability to apply proper corrective action. Subjective and empirical data have been obtained through flight test and accident analyses which suggest an

urgent need for more research in the areas of pilot disorientation and physical tolerances to gyrations lasting for extended periods of time. Improved design safety criteria can then be established, particularly in the field of emergency escape.

Evaluation of a "Moving Airplane" Attitude Indicator. ENS. ELMO E. MILLER and LT. JOHN A. CREELMAN, MSC, USNR, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

Under controlled field conditions the rates of student learning on two types of attitude gyro were compared. These were: (1) an indicator in which the miniature airplane was the moving element, and (2) an indicator in which the artificial horizon moved. The results indicated that there was only one significant difference of measures of student learning, and this was on later trials while the students were relearning on their second instrument. The direction of this difference indicated that it was easier for the student to relearn when this relearning took place on the standard attitude gyro. The other small differences which did exist tended to favor the standard attitude gyro.

Flight Safety Through Proper Nutrition. CAPTAIN JEROME A. MOORE, MC, USN Naval Air Station, Cecil Field, Fla.

Today's pilot must strive for peak physical fitness. Re-education in eating habits is one of the most important factors in this direction, based on our knowledge of the relationship of faulty diet and obesity to incidence of coronary disease and hypertension. Stimulated by recent revolutionary observations in the field of nutrition, a weight control program conducted at a master jet base during the past two years shows over 1,000 persons including pilots, ground personnel and their dependents losing more than 12,000 pounds. Besides almost universal decrease in blood pressure, the subjects experienced a greater feeling of well-being, ambition, energy, alertness, and efficiency. Because the average layman is unaware of the danger of improper nutrition, the medical profession must "re-educate" and inspire him in this phase of preventive medicine.

Aircraft Accident Injuries; A Review of over 2,000 Cases. COL. HARRY G. MOSELEY, USAF (MC), Directorate of Flight Safety Research, Norton Air Force Base, Calif.

The injuries incurred by all occupants of Air Force aircraft involved in accidents during calendar years 1953 and 1955 have been reviewed. All traumatic lesions, both fatal and nonfatal, have been analyzed as to type, location, aspect and frequency. Insofar as possible, the injuries have been related to identifiable causes such as force of deceleration, body position and objects inflicting injury. The role of protective equipment and factors bearing on the prevention of such injuries have been explored.

Depressor Effect of Moderate Respiratory Acidosis on Cardiac Activity in the Dog. GABRIEL G. NAHAS, M.D., and H. MEAD CAVERT, M.D., Department of Physiology, University of Minnesota, Minneapolis, Minn.

In the intact curarized dog, an increase in pCO_2 of 30 mm. Hg. is consistently accompanied by a fall in heart rate, which occurs after a period of ninety seconds of "apneic oxygenation." This bradycardia persists after bilateral cervical vagotomy and when apnea is associated with moderate hypoxia. In the heart lung preparation, mixtures of 5 to 30 per cent CO_2 in O_2 were used to ventilate the lungs. Cardiac output heart rate, coronary sinus flow, cardiac work and pH were measured. An increase in pCO_2 was accompanied by a negative inotropic and chronotropic effect on the heart. Complete heart failure occurred when pCO_2 in the arterial blood was 100 mm. Hg. and pH 7.2. This failure was reversible provided pCO_2 was brought down rapidly to its normal value, and it was prevented by pressor amines. Possible mechanisms are discussed.

Investigations of the Optimal Characteristics of Visual Light Indicator Systems. ROSALIE NOBLE, B.A., and JOHN LAZO, U. S. Naval Air Crew Equipment Laboratory, Philadelphia, Pa.

A series of factorially designed experiments was performed to determine the optimal characteristics of a visual warning and caution system for aircraft. The results

indicate the superiority of flashing or alternating lights, as opposed to a steady light, as an attention-getting device. It is also shown that the brightness of a steady light must be many times above the brightness of either the flashing or alternating lights in order that its effectiveness be equal as an attention-getter; the inadequacy of the steady light under both day and night conditions is shown.

Aviation Medicine in the Royal Canadian Navy. SURGEON LT. COMDR. H. D. OLIVER, RCN, Shearwater Air Station, N. S., Canada.

The size and role of the Royal Canadian Navy and the relationship of the air component to the remainder of the Navy is briefly discussed. The training of flight surgeons and the nature of their duties are described. The advantages and disadvantages of practicing aviation medicine in a small service are also discussed. The future aims for expansion and development and current problems are outlined. This paper is of interest in that it shows how the size and role of a service can affect the nature of aviation medicine practice. The aviation medical activities of the Royal Canadian Navy are described for the first time for the Aero Medical Association.

A Study of Manifest Anxiety as Related to Pilot Training. MAJOR HERMAN S. PARISH, JR., USAF (MC), U. S. Air Force Tactical Hospital, Manston Air Base, England.

A group of 131 students in primary pilot training was studied during the first forty hours of flight training. A psychologic test battery, selected as being most stressful for the students, was administered on six occasions to determine the levels of anxiety present and the changes in the levels of anxiety as related to progress in training. The group was divided into thirteen subgroups based on social status, marital status, flight experience, pass-fail, and the type of failure. The results supported the hypothesis that anxiety is related to social status, marital status, previous flight experience and psychologic failure. The test battery used is an excellent instrument for measurement of anxiety, but has limitations in defining the source and type of anxiety.

Multiple Psycho-Psychologic Measures During Gradual Onset Acceleration. JULIA A. PETTITT, CAPTAIN SANFORD I. COHEN, CAPTAIN ALBERT J. SILVERMAN and CAPTAIN GEORGE D. ZUIDEMA, USAF, (MC), Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Previous studies suggested that multiple cardiovascular and neurophysiologic changes occur when subjects are exposed to various G loads. Further information was obtained in this study concerning cardiovascular, bioelectric, biochemical and psychologic responses before, during, and after G stress. Gradual onset acceleration was utilized rather than rapid onset because (1) more time was available for measurements during the stress period, and (2) gradual onset acceleration permitted maximal degree of physiologic compensation. Results indicated that all subjects did not show uniform changes in the various psychologic and physiologic parameters as their blackout level was approached. Some showed marked decrease in psychomotor performance while others showed changes in central nervous system level of arousal. A third group responded maximally with cardiovascular changes without marked alteration of the other parameters. Some showed gradual deterioration under progressive G stress, while others maintained performance and physiologic functioning until total decompensation occurred.

Airsickness in Early Flight Training—Motion or Emotion? CAPTAIN PHILIP B. PHILLIPS, MC, USN, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

Flight students experiencing repeated airsickness in early flight were studied by means of caloric tests of labyrinthine function, cupolometric tests in the manner of van Egmond, and a battery of clinical psychologic tests. Subjects were then given a comprehensive psychiatric interview and evaluated as to the relative amount of anxiety manifested in their life adjustment. From this interview subjects were classified as to whether their airsickness was thought due to physiologic hypersensitivity, psychologic hypersensitivity, or both. All were grounded and given chlorpromazine (or a placebo) according to a standardized rou-

tine. All then resumed flight training. The results from the use of this ataraxic drug (or placebo) are shown and its relative effectiveness in the three categories of airsickness described.

Hormonal Factors in the Resistance to Acceleration Stress. B. DAVID POLIS, PH.D., ANNE ZELLA, B.A., and JAMES D. HARDY, PH.D., U. S. Naval Aviation Medical Acceleration Laboratory, Johnsville, Pa.

Experimentation was inaugurated to determine the hormonal factors implicated in the anoxic-fatigue syndrome operative in acceleration stress. Adrenal medullectomy performed on rats showed a small but significant decrease in the resistance to acceleration stress. This difference disappeared with time and the apparent regeneration of medullary tissue. A pronounced loss of resistance to acceleration stress as well as a disappearance in ability to adapt to acceleration stress was found in hypophysectomized rats compared to sham operated controls and normal control rats. From these data and current concepts of pituitary function in stress states it is proposed that the hypophysectomized rat offers a new and unique approach to the study of physiologic and biochemical factors in acceleration stress, and that replacement studies with whole pituitary extract and isolated pituitary hormones should reveal the relative importance of known pituitary factors and the probable existence of unrecognized pituitary factors operative in resistance to the anoxic-fatigue stress of acceleration.

The Need for Support of the Upper Part of the Body. JOHN R. POPPEN, M.D., Douglas Aircraft Co., El Segundo, Calif.

A study has been made of the mechanical characteristics of the structural members and the mass distribution of the upper part of the body. This has been related to the need for vertical support of this part of the body to obviate injuries resulting from increasingly high vertical components in the force diagrams appearing in current aircraft configurations. This study shows conclusively the need for support and suggests feasible means of accomplishing this by relatively simple modifications of existing equipment.

Etiology of Post-Decompression Shock. WING COMDR. W. LOCKHART RAIT, Royal Australian Air Force School of Aviation Medicine, Point Cook, Australia.

A new hypothesis of the etiology of post-decompression shock is presented. This is postulated from a consideration of the post-mortem findings in known fatalities and on certain experimental findings in animals and in one human case. It is suggested that potentially pathogenic fat embolizes from the liver under conditions of decompression, passing to the lungs and or the brain via the various routes, including a patent foramen ovale. Support is advanced for the belief that the pathologic effects of such emboli are two fold, being both mechanical and chemical. The hypothesis seeks to explain the origin of the fat emboli recorded by previous investigators.

The Biologic Response to Overpressure. DONALD R. RICHMOND, PH.D., MEAD B. WETHERBE, M.S., RINALDO V. TABORELLI, M.S., THOMAS L. CHIFFELLE, M.D., and CLAYTON S. WHITE, M.D., The Lovelace Foundation, Albuquerque, N. M.

A modified blow-down wind tunnel, employed as a blast tube, was used to expose dogs to long duration overpressure rising to a maximum in from sixty to one hundred and fifty milliseconds. Environmental pressure variations up to 170 psi, enduring for over 20 seconds were employed with and without a baffle to minimize wind loading. Mortality was limited to animals displaced by high velocity winds. Survivors exhibited tympanic membrane rupture, paranasal sinus hemorrhage, and unique hemorrhagic lesions of the lungs due to the rapid "squeeze" applied to the body wall. The characteristic lung lesion involved the anterior, lateral and posterior basilar portions of the lung pinched in the costal angle between the rising diaphragm and the inward moving thoracic wall.

The Effect of Increased G on the Relation Between Illumination and Dial Reading. MITCHELL B. RILEY and WILLIAM J. WHITE, Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

This experiment was designed to determine possible impairment of a pilot's ability

to read aircraft instrument dials at various levels of illumination because of application of positive G forces below blackout levels. Twelve dials were presented simultaneously to an individual subject and performance in reading the dials was scored in terms of errors and average time. From a maximum brightness of 42 ml, the brightness of the dial marking was decreased in four equal logarithmic steps. G forces were produced on the human centrifuge and were increased in unit steps from 1 to 4 G. It was found that (1) at the three highest brightness levels errors were minimum and no systematic increase in total error was found for values up to 3 G; (2) at the two lower brightness levels, the total error increased directly as a function of G and inversely as a function of brightness; (3) at all brightness levels, the 4 G condition yielded a systematic increase in total error with decrease in brightness and; (4) total error and reading time vary as a function of brightness level and G value

Human Factors in Weapons System Development. COL. CHARLES H. ROADMAN, USAF (MC), and CHARLES C. LIMBURG, PH.D., Human Factors Division, Directorate of Research and Development, Department of the Air Force, Washington, D. C.

A weapons system is an assembly of materiel, personnel, and management techniques in an operational environment to produce a combat capability. Human contributions to weapons system performance must be identified and controlled to optimize weapons system combat capability. Increasing firepower, speed, range and altitude of modern weapons systems have greatly increased the requirement for reliable performance on the part of all personnel operating or maintaining the weapons system. Examples of the relation of human unreliability to weapons system unreliability are presented. The implications for human factors research and development are are discussed.

Concept of the Strato-Lab Balloon System for High Altitude Research. LT. COMDR. MALCOLM D. ROSS, USNR, and LT. COMDR. M. LEE LEWIS, USN, Office of Naval Research, and Bureau of Aeronautics, Department of the Navy, Washington, D. C.

The broad concept of the strato-lab program is briefly presented. Also included are some aspects of the system development, personnel safety considerations, results of important preflight tests and physical characteristics of the system.

Experimentation in the Space Cabin Simulator. CAPTAIN EMANUEL M. ROTH, USAF (MC), and JAMES G. GAUME, M.D., School of Aviation Medicine, Randolph Air Force Base, Texas.

Experimentation in the space cabin simulator (a closed system of 100 cu. ft. in volume) has been carried out during the past year at the Air Force School of Aviation Medicine. Those studies included the changes in the atmosphere of the cabin caused by the presence of a human occupant, the physiologic effects of these changes, and the methods of controlling them. A series of experiments was made, culminating in a twenty-four-hour test. Problems involving oxygen, carbon dioxide, temperature, humidity, odor and noise were studied. The space cabin simulator was then modified to include an air conditioning unit to control temperature and humidity, and to recover water for re-use. An odor removal unit was installed, and a unit was devised for recovery of water from urine. Electronic controls for the cabin atmosphere were devised. This instrumentation allows continuous experimentation for periods of days, or even weeks.

Bioelectric Measures During Flight. CAPTAIN JOHN ROTH, CAPTAIN SANFORD I. COHEN, and CAPTAIN ALBERT J. SILVERMAN, USAF (MC), and EDWARD G. CORRELL, Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Assessment of the stresses to which Air Force flight personnel are exposed suggests that laboratory stresses imposed on volunteers may leave many questions unanswered. The need to appraise physiologic states during operational conditions required that objective techniques perfected in the laboratory be used during flight. Bioelectric measures such as the skin resistance and electroencephalogram afford the opportunity for

continual monitoring of the state of the subject. The techniques utilized with these instruments are discussed. The problems of installation and artifact prevention in the use of these bioelectric instruments in flight are described. The sensitivity and reliability of the aeromedical instrumentation to standard flight stresses are demonstrated. The relationship of these measures to other parameters of behavioral and physiologic functioning is presented.

A Physiological Comparison of Personnel Wearing Ventilated and Non-Ventilated Anti-Exposure Suits Under Simulated Cockpit Conditions. LOUIS J. SANTAMARIA, B.S., and PERRY R. TILLER, B.S., U. S. Naval Air crew Equipment Laboratory, Philadelphia, Pa.

With current emphasis on shifting from a vapor-permeable, water-impermeable anti-exposure suit to a completely impermeable suit, the problem of ventilating personnel is a prime consideration. This investigation embraces physiologic evaluation of (1) both suits without ventilation and (2) the impermeable suit with ventilation. Ambient temperatures ranging from 60° F. to 110° F. were selected as representative of cockpit environment. Ventilating temperatures were identical to ambient temperatures. Ventilating air flow was maintained at 140 LPM/STP at 18,000 feet. The following dependent variables were statistically analyzed: total body and evaporative weight losses, mean skin temperatures (measured by thermocouples attached to the body at various loci), rectal temperatures, and mean body temperatures. Physical conditions effecting a relative state of thermal comfort were evolved for a ventilated impermeable anti-exposure suit.

A New Look at Aviation Physiology. HARVEY E. SAVELY, PH.D., and JAMES P. HENRY, M.D., Air Force Office of Scientific Research, Washington, D. C.

Research in aviation physiology is now undergoing a change in emphasis. Advances in aircraft design are making less critical the traditional physiologic problems in environmental protection. New environmental factors are presented by radiation and unusual patterns of acceleration. New demands are being made on man's endurance and performance under a wide variety of complex situations. The aircraft industry and Air Force operations, particularly in selection, training and management, are becoming increasingly dependent on the applied aspects of psychology and physiology, often referred to as human engineering. These important applications indicate that research in aviation physiology will be characterized increasingly by emphasis on the nervous system and on the biochemical and biophysical aspects of regulatory biology that relate to human effectiveness. Continuation of an effective applied science of human engineering will require a broadened scope in the traditional research areas of both aviation psychology and physiology to include the study of fundamental biologic mechanisms underlying human behavior and performance.

A Technique for Instrumenting Subgravity Flights. CAPTAIN GROVER J. D. SCHACK, USAF, and MAJOR DAVID G. SIMONS, USAF (MC), Aero Medical Field Laboratory, Holloman Air Force Base, N. M.

One method of producing subgravity and weightless states for medical research purposes employs jet aircraft flying ballistic trajectories. It is theoretically possible to realize uninterrupted weightlessness for periods of approximately thirty seconds, depending on angle of entry and speed of the aircraft upon entering the parabola, and the minimum allowable speed of the aircraft at apogee. Experience has shown that individual pilots vary in their skill in achieving the maximum duration of the weightless state. A sensitive G meter can be very helpful to the pilot. Measurement of G experienced by the subject will permit evaluation of the borderline between subgravity effects and effects associated with complete weightlessness. The instrumentation described was designed to record quantitatively the effective G measured in two axes on the subject and on the aircraft frame. A sensitivity of 1/500 G-unit was obtained. As an aid to the pilot in realizing minimum G trajectories for a maximum length of time, he was provided a direct reading meter indicating G vertical to the flight path.

Cosmic Ray Dosage During the Giant Solar Flare of February 23, 1956. HERMANN J. SCHAEFER, PH.D., U. S. Naval School of Aviation Medicine, Pensacola, Fla.

Cosmic ray intensity shows continuous irregular fluctuations. They seldom exceed the seven per cent level. Solar activity is known to be correlated to them. At the onset of the giant solar flare under discussion cosmic ray intensity abruptly increased thirty-five-fold and returned gradually to normal within about one day. The integral transitory "flare dose" is considerable. Data on the energy spectrum of the temporal addition indicate that it contains relatively many more low energy particles than the normal cosmic ray beam. This circumstance emphasizes the radiobiologic importance of the phenomenon. For a complete account further data to be collected during the IGY are needed before an approximate appraisal of the biologic implications can be given.

Visibility of the Man-Made Satellite of the Planet Earth. INGEBORG SCHMIDT, Indiana University, Bloomington, Ind.

The topic discussed concerns the visibility for the unaided eye of the satellite which will be launched from the southeast coast of Florida sometime during the International Geophysical Year. A method for calculating the possible location of the satellite in space is presented.

Subjective Flight Grades: An Attempt to Maximize Their Validity. LT. LEONARD M. SEALE, MSC, USNR, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

This study summarizes recent research attempts to maximize the validity of subjective grades in present use in the Naval Air Training Command. The research indicates that, through the use of multiple correlation and other statistical techniques, the validity of subjective grades can be increased. This paper describes the success of the research in increasing the validity of student flight grades given in field carrier landing practice and in carrier qualifications. The implications of the findings in aviation training are discussed.

Development of a New High Altitude Oxygen Pressure Breathing Mask with Manual and Altitude Controlled Suspension Adjustment. HENRY W. SEELER, Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

The development of a new, small, light weight and comfortable anti-freezing nasal-oral oxygen mask, usable during many hours of pressure breathing up to 45,000 feet in altitude, has been needed for many years. The development of this mask involved a thorough search for different face shapes with the intention of having only one mask size, only one built-in combined and pressure compensated inhalation-exhalation valve, and one noise-cancelling microphone. For a comfortable mask seal at any altitude and at any breathing pressure, a manually adjusted mask harness was developed, as well as an altitude-controlled harness tension-compensating system, which compensates the face mask gas pressure with the mechanical harness pressure against the occipital area of the wearer's head.

Correlates of Manifest Anxiety in Beginning Pilot Trainees. S. B. SELLS, PH.D., D. K. TRITES, PH.D., and MAJOR H. S. PARISH, USAF (MC), School of Aviation Medicine, Randolph Air Force Base, Texas.

Two hundred sixty-two students beginning pilot training at two primary flying schools were administered a brief test battery for manifest anxiety at the flight line on six selected occasions. These were before and after the first and seventh flights (occasions 1, 2, 3, 4), and after solo and the forty-hour check flight (occasions 5 and 6). Although the anxiety level was associated generally with adjustment to flight training, significant differences were found between what was interpreted as security anxiety and aspects of achievement anxiety. These differences are related to expressed preference for jet versus multi-engine training, students' estimates of their eventual class standing, and ratings by classmates.

Recording of Emotional Stress. CARL WILHELM SEM-JACOBSEN, Gaustad Mental Hospital, Oslo, Norway.

Rapidly mounting emotional stress or sudden fear encountered by most people

may in some instances leave the person "stiff" for a short period, during which he is not able to react or respond to outside stimuli in a rational way. It has long been a challenge to record these experiences with physiologic equipment. In the course of intracerebral recordings the author has been fortunate to record short periods of flattening of the depth tracings, indicating a blocking of the brain activity in response to frightening of the patient by a sudden sharp noise. There has also been some speculation regarding the possibilities of extreme emotional stress or sudden fear being responsible for some of the fatal accidents of low flying jet planes. Examples from unexplained jet accidents are presented.

Psychologic Factors in G Tolerance. CAPTAIN ALBERT J. SILVERMAN and CAPTAIN SANFORD I. COHEN, USAF (MC), and CECILE LAZAR, B.S., Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Anecdotal material collected from pilots and centrifuge subjects indicated that G tolerance was related to the level of anxiety and the presence of aggressive feelings. A projective psychologic test was devised to evaluate the subject's method of dealing with aggressive feelings. It enabled identification of persons with high and low G tolerance. Such classification was enhanced when measures of anxiety were included in the test battery. Measures such as the Taylor anxiety scale, Hippuric acid levels, and nonvascular stress levels of adrenaline were utilized. The intra-individual variations in G tolerance, and the inter-individual variations could be detected with a high degree of accuracy by focused interview techniques in which specific factors were evaluated, such as (1) level of anxiety; (2) level of anger or aggressive feelings; and (3) feeling of mastery and control.

Asthma and Altitude. S. WILLIAM SIMON, M.D., Department of Medicine, Ohio State University, Columbus, Ohio, and Allergy Clinic, Veterans Administration Center, Dayton, Ohio.

This paper is a summary of the answers with notations received from 961 flight surgeons and 290 allergists who returned completed questionnaires to the author. Opinions were asked relative to patients with asthma flying in pressurized and unpressurized planes, effect of pollen at altitude, and those chronic chest diseases in which flight is contraindicated. Criteria for making a decision prior to takeoff, including dyspnea, wheezing and vital capacity, are considered. The choice of drugs and their availability are explored. History, differential diagnosis and physical findings are weighed. In the discussion the scant literature on the subject is reviewed as well as the opinions expressed by the different groups. Finally, the conclusions are summarized from this study which may help the examiner make a decision as to the safety of flying for each patient with asthma.

Selection of a Sealed Cabin Atmosphere. MAJOR DAVID G. SIMONS, USAF (MC), and FIRST LT. DRUEY P. PARKS, USAF, Aero Medical Field Laboratory, Holloman Air Force Base, N. M.

The concept of escape capsules and the development of aircraft designed to fly above 80,000 feet indicate an increasing trend toward sealed cabins. The choice of total cabin pressure, the percentage of oxygen, and the percentage and kind of inert gas involve conflicting requirements. Sealed cabins introduce the requirement for scrubbing gaseous metabolic products. The relative advantages of different systems are discussed with respect to the critical weight and space limitations imposed on airborne systems.

The Relationship Between Meal Times and Landing Accidents. FLIGHT LT. J. R. SMILEY, Royal Canadian Air Force Institute of Aviation Medicine, Toronto, Canada.

The relationship between time of last meal and that of a landing accident has been investigated from the records of an RCAF flying training station. The problem arose as a result of the question whether hypoglycemia had any possible influence on the occurrence of aircraft accidents. Landing accidents were selected because the exposure to associated risk could be more easily measured. The data were confined to one year and to one type of aircraft at

a single flying training school. Analysis of the data shows that accident experience did not correlate significantly with exposure to risk, that peak experience occurred three to four hours after each of the three meal hours, and that minimal incidents occurred immediately after the noon and evening meals. There is evidence that food and rest markedly reduce the rate of accidents for short time intervals but the data need extension and confirmation before firm conclusions can be drawn.

The Helicopter in Air-Sea Rescue. Lt. Wallace B. Smith, MC, USNR, Naval Air Station, Norfolk, Va.

The Korean conflict proved the value of the helicopter in air-sea rescue operations. With the rapid advance of aircraft performance and capabilities, however, there is a pressing need for constant revision of our knowledge of rescue techniques. It is necessary that all interested personnel be thoroughly familiar with both the capabilities and limitations of helicopters as they relate to rescue work. Helicopters must operate according to the laws of aerodynamics in their rescue missions. In the thin air of mountain slopes or in humid jungles, the air density is such that power-weight ratios become critical. The amount of fuel aboard greatly affects lifting ability. There is a need for constant improvement in rescue methods so that the rescue mission can be carried out with the greatest facility and highest recovery rate.

Prevention of Vertebral Fractures in Aircraft Crashes. A. Benjamin Sorin, B.M.E., Bureau of Aeronautics, Washington, D. C.

This paper discusses aircraft accidents in which nose wheel collapse was the contributing factor in causing vertebral fractures, and the action taken to eliminate this problem. Various solutions that were considered and the system selected are discussed. The paper discusses in detail the final design of the energy absorbing system which consists of a stainless steel strap as the primary, and a frangible seat cushion as the secondary, means of absorbing the energy of vertical loads in crashes beyond physiologic tolerance limits. Methods and results of a laboratory evaluation and two full scale, completely instrumented, aircraft crashes are also discussed. The paper is supplemented by films and slides which graphically outline both problem and solution.

Unusual Pulmonary Lesions in Flying Personnel. Captain Robert J. Solomon, Major Edward P. Smith, and Lt. Col. Philip G. Keil, USAF (MC), Lackland Air Force Base, Texas.

Cases of unusual pulmonary lesions occurring in flyers are presented. These include cavitary disease due to congenital cysts and coccidiomycosis, metastatic pulmonary lesions, pericardial cyst, pectys excavatum and recurrent pulmonary infarcts. The aeromedical implications of pulmonary lesions are considered.

Variations of Spinal Reflexes in Some Stress Inducing Conditions. N. Spinelli, T. Gualtierotti, M.D., and R. Margaria, Ph.D., Laboratorio di Fisiologia dell'Universita, Milan, Italy.

An accurate method of measuring conduction speed in sensory and motor fibers, spinal and end-plate delays in intact men is described. Such parameters have been determined in spinal reflexes evoked by electrical stimulation in man and animals in condition of hypoxia, hypoglycemia and muscular fatigue. During hypoxia all four variables generally decreased. During insulin hypoglycemia (blood sugar: 0.045 per cent), sensory conduction speed after a transitory increase is decreased by 30 per cent, while motor fiber conduction speed increased by 15 per cent. Central delay also decreases roughly parallel to sensory conduction speed. The end-plate delay also changes in the same direction as motor conduction speed. After muscular exercise sensory conduction speed increases and motor conduction speed decreases about 12 per cent. Muscular and central delays decrease. The effect of other possible components of fatigue, such as cold, heat, mental fatigue, psychologic stress and some effects of neurotropic drugs, are also discussed.

Effect of Mechanical Force on Living Tissues. IV. Parameters of Injurious and Lethal Force. LT. COL. JOHN P. STAPP, USAF (MC), and GEORGE F. NICHOLS, B.S., Aero Medical Field Laboratory, Holloman Air Force Base, N. M., and Northrop Aircraft, Inc., Hawthorne, Calif.

Anesthetized chimpanzee subjects were exposed to increased durations of linear deceleration for magnitudes between 40 and 120 G, made possible by lengthening the 3500 foot track to 5000 feet and permitting entry velocities exceeding Mach 1 with the 2000 pound deceleration sled. Results of twenty experiments are described, ranging in effects from minimal reversible to lethal injuries. Relation of rate of onset, magnitude, duration, and body orientation are discussed and correlated with human deceleration experiments, human aircraft accident data, and supersonic ejection injuries. Comparison is made of human and chimpanzee value for injurious and lethal effects.

The Effects of Various Intraluminal Gas Mixtures on Colonic Motility and Flatus Volume. FREDERICK R. STEGGERDA, PH.D., Department of Physiology, University of Illinois, Urbana, Ill.

When known volumes of room air, mixtures of 40 per cent carbon dioxide and 60 per cent nitrogen, 100 per cent carbon dioxide, or 100 per cent nitrogen are injected into the lower colon of dogs, a marked difference in colonic activity is observed over a period of fifty minutes in each experiment. The collectible flatus available at the end of the experiments is likewise different. The greatest depression occurred with 100 per cent carbon dioxide and the least with 100 per cent nitrogen. Experiments at simulated altitudes up to 25,000 feet showed the same trend as did the ground level experiments. That the depression with carbon dioxide is related to an active inhibition of the colonic musculature and not a rapid absorption of carbon dioxide is demonstrated by further experiments on the dog and man.

Analysis of 289 Gross Autopsies on Aircraft Accident Fatalities. CAPTAIN VERNIE A. STEMBRIDGE and COL. HARRY G. MOSELEY, USAF (MC), Armed Forces Institute of Pathology, Washington, D. C., and Directorate of Flight Safety Research, Norton Air Force Base, Calif.

A review of the aircraft accident reports on file at the Air Force's Directorate of Flight Safety Research for the years 1953 and 1955 showed that a total of 1724 fatalities were recorded, and in 289 instances an autopsy had been performed. All traumatic and nontraumatic lesions noted grossly have been studied with respect to type, location, frequency and significance. Conclusions from the above data reflect trends and suggest methods for future approach of aviation pathology and flight safety.

A Description of the Acoustic Properties of a New Type of Portable Sound Proof Audiometric Testing Room Produced for the Royal Canadian Air Force by the Canadian Johns Manville Company. JOSEPH A. SULLIVAN, M.B., F.R.S.M. (Eng.) and W. E. HODGES, M.S., Canadian Forces Medical Council, Toronto, Canada.

This paper describes in detail the acoustic properties of a new type of entirely portable sound proof room designed by the authors initially for the Royal Canadian Air Force to provide the greatest possible control of the acoustic ambient about the head of the candidate being examined audiometrically. The sound isolation and internal acoustic absorption coefficients are reported. Slides illustrating the construction and use of the room are shown together with a motion picture depicting the assembly of the components of the room at the site where it is to be used, and their disassembly for shipment to another center.

Preventive Aspects of Flight Feeding. LT. COL. ALBERT A. TAYLOR, USAF (VC), Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

The preventive medicine aspects of flight feeding are examined and two new means of meeting needs are described. Inadequate feeding leads to adverse physiologic effects. The compact box lunch for use in combat jet aircraft, and the foil pack inflight feeding system of providing freshly cooked, hot meals to passengers and crews in transport and cargo aircraft have been developed to meet flight feeding needs. Both have been

tested extensively during flight in suitable aircraft. It is concluded these two new meal systems provide adequate means of flight feeding in the situations for which they were developed.

Effects of Activity on Metabolic Rates of Subjects Wearing the Full Pressure Suit. PERRY R. TILLER, B.S., and HERBERT R. GREIDER, B.S., U. S. Naval Air Crew Equipment Laboratory, Philadelphia, Pa.

With the advent of the full pressure suit the problems of increased workload on the pilot's metabolic rate becomes important. Since a flight simulator or a jet plane was not readily available, a pilot's simple task was chosen. Activity involving the Navy's ejection seat face curtain was considered a task sufficient to impose a workload. The metabolic rates were obtained while the subjects were wearing the full pressure suit unpressurized, the full pressure suit pressurized to 2 psi and 3.5 psi, and compared to a subject wearing a summer flight suit. The expired gases were collected in a Douglas bag and analyzed in the Scholander gas analyzer. The results are discussed in detail.

A Progress Report on Aviation Pathology. COLONEL FRANK M. TOWNSEND, USAF (MC), Armed Forces Institute of Pathology, Washington, D. C.

During the past year there has been an increasing trend to utilize the pathologist as an adjunct in aircraft accident investigation, particularly those involving fatalities. Interest in aviation pathology has been stimulated through various media, including the Joint Committee on Aviation Pathology, and military regulations have been implemented, outlining the procedures in the medical investigation of aircraft accident fatalities. Programs have been advanced to acquire and train personnel in both routine and experimental approaches to the problems of aviation pathology.

Landings vs. Hours as Indices of Hazard Exposure. D. K. TRITES, PH.D., and A. L. KUBALA, PH.D., School of Aviation Medicine, Randolph Air Force Base, Texas.

Accidents and flying experience records of 968 pilots were analyzed for relationships between landings, hours flown and hazard exposure (accident risk). From previous studies differential hazard risk was associated with three hazard classifications of aircraft (1-high, 2-moderate, 3-low) and three flight conditions (day VFR, night VFR, and weather). Correlations between landings and hours were .99, .84, and .71, respectively, for the three aircraft hazard groups. A weighted index of hazard exposure using hours correlated .96 with the index using landings. It is concluded that: landings, weighted by accident risk (aircraft group), produce an effective index of hazard exposure.

The Influence of Ocular Refractive State on Vision in Space. FLIGHT LT. N. C. TURNOUR, and GROUP CAPTAIN CLEMENT MCCULLOCH, Royal Canadian Air Force Institute of Aviation Medicine, Toronto, Canada.

This experiment investigated the state of accommodation of hyperopic, myopic and emmetropic persons when presented with an empty visual space. Under the test conditions, accommodation was apparent in each group but the tendency was significantly less for the myopic group. The experiment demonstrated certain factors which influence accommodation. In addition to these factors there are others which must be considered, particularly during search. These cannot be properly assessed in the laboratory. It is recommended that a study be made under actual flying conditions to determine the problem of accommodation as it affects visual search at altitude.

A Method for Calculating the Center of Gravity of the Human Body for the Development of Stabilized Escape Systems. CAPTAIN FRANKLIN D. VAN WART, USAF and AIRMAN SECOND CLASS JAMES T. BARTER, USAF, Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

New information is presented on a method of computing the center of gravity of the human body, which is directly applicable to a number of simulated flight positions. Anthropometric measurements used are presented, as well as regression equations for estimating the mass of the segments of

the human body from total weight. A method of utilizing these data in calculating the center of gravity of individuals of known height and weight is described. This method of determining the center of gravity of the human body is directly applicable to a number of human factors design problems which face the designer of stabilized escape systems.

Some Variables Affecting Physiological Response to Thermal Stress. FIRST LT. JAMES H. VEGHTE, USAF, Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

To predict human tolerance to thermal stress, several series of experiments with and without ventilation have been conducted in the Aero Medical Laboratory. In non-ventilated exposures, a study was made on the effect of various types of clothing (light, heavy, permeable and impermeable) on thermal stress. The vapor pressure gradient was found to be important in this type of experiment despite very low permeability of some clothing assemblies. In the ventilated exposures, the ventilating air temperatures and flows were widely varied to determine the optimal value for thermal tolerance. The effect of reduced barometric pressure on thermal stress was significant, and experimental evidence indicates a definite increase in thermal tolerance due to altitude.

Psychologic and Bioelectric Assessment of G Suit Protection. FIRST LT. LARRION L. VICKERY, USAF, and CAPTAIN ALBERT J. SILVERMAN, CAPTAIN GEORGE D. ZUIDEMA, and CAPTAIN SANFORD I. COHEN, USAF (MC), Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Anti-gravity protective suits have been used for many years. Much anecdotal evidence is available to suggest that these devices tend to decrease fatigue. This study was undertaken to attempt objective validation of this idea. Ten persons were subjected to ten rides on the human centrifuge at 3 G for thirty seconds, both while protected and unprotected with a G suit. Measures taken were: (1) performance, dual pursuit tracking task; (2) subjective reports; (3) bioelectric recordings, galvanic skin responses (GSR) and basal resistance shifts. Results indicate that subjects performed the tracking task better during the series of rides while protected against G force. GSR findings indicated greater progressive decrements in basal resistance while unprotected. Protected subjects did not show a downward drift in basal resistance. Combined psychologic and physiologic measures suggest that measurable decrements of functions may be prevented or alleviated by the anti-G suit.

To Fly or Not to Fly: The Decision and the Factors Which Affect it. LT. ROBERT B. VOAS, MSC, USNR, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

This report attempts to summarize the results of recent research on the problem of voluntary withdrawal from naval aviation training. These studies indicate that for the majority of students the decision to fly is a recent rather than long term one, and is based on little knowledge of what flying entails. Under these circumstances, the decision to enter training tends to be strongly influenced by factors peripheral to interest in flying. While new leads for selection tests and recruiting measures have been uncovered, the primary emphasis in meeting this problem must be made in the training program itself. Recent research has helped to discover the critical factors within the program which reduce the desire to fly and indicated methods of minimizing them.

Aviation Medicine in Naval Anti-Submarine Warfare. CAPTAIN H. G. WAGNER, MC, USN, Naval Medical Research Institute, Bethesda, Md.

Because a substantial part of the naval effort is engaged in anti-submarine warfare, interest is invited to the aviation medical aspects of this important military operation. The author reviews in detail certain problems observed during a recent tour aboard an aircraft carrier employed in anti-submarine warfare tactics. Visual problems in particular are discussed which are concerned with air operations at night, presentation of information to the aircrewmen in search aircraft, and the screening and training of aircrewmen for this work.

Temperament and G Tolerance. NEIL D. WARREN, PH.D., University of Southern California, Los Angeles, Calif.

The possibility that basic temperament variables, such as aggressiveness, nervousness and masculinity, may influence tolerance for positive G has been explored. Temperament traits were measured by the self-inventory technique and G tolerance was determined on the human centrifuge. Relationships to greyout, blackout, and unconsciousness were studied. In general few significant correlations were found, and these were low. Comparisons are made with other studies on the problem in which different techniques have been used. The theoretical implications of relationships between temperament variables and G tolerance are discussed.

Aeromedical Problems of Logistic Air Operations in South America. LT. COL. HAMILTON B. WEBB, USAF (MC), Office of the Surgeon, Caribbean Air Command, Albrook Air Force Base, C. Z.

The Caribbean Air Command provides logistic and staff support to Air Force missions, and to other categories of Army and Air Force personnel, in all the capitols of South America. This operation provides a series of aeromedical problems, which requires the continuing surveillance of a staff of flight surgeons. The equipment operated is obsolete. The routes are long, some are at very high altitudes, and the navigational aids are few. Alternate destinations are often impracticable. Stopovers are made in variably hygienic circumstances. En route medical support is difficult to provide or obtain. Pilots and navigators are not assigned as principal duty, but are staff officers who fly in addition to regular duties. Types of missions vary widely, from air evacuation to hauling cargo. The types of problems encountered are presented. Solutions are attained by sending flight surgeons out on frequent flights, by forwarding of medical supplies, varying minimum crew requirements, by suiting overnight stops and rest points to the medical stresses of different routes and missions, and by other methods.

Further Attempts at Coding Aircraft Accidents Into Psychologic Categories. WILSE B. WEBB, PH.D., U. S. Naval School of Aviation Medicine, Pensacola, Fla.

There have been a number of attempts to derive psychologic categories for the reliable cause coding of aircraft accidents. These attempts have been unsuccessful. It was hypothesized that part of the difficulty resulted from attempts to apply a generalized code to too great a variety of accidents. In this study the coding was restricted to one accident "area" — carrier landings. From a series of interviews with pilots who had recently experienced a carrier accident, categories were derived. Three psychologists independently applied this code to thirty randomly selected carrier accidents that occurred during training. The results and their implications for aircraft accident coding are discussed.

Comparison of Experiences and Reactions of Air Force and Other Military Prisoners of War of Chinese Communists. LOUIS J. WEST, M.D., and I. E. FARBER, PH.D., Oklahoma Medical Research Foundation, Oklahoma City, Okla.

In order to interpret any differences in the reactions of U.S. Air Force personnel and those of other members of the U. S. Armed Forces imprisoned by Chinese Communists during the Korean War, it is necessary to consider three classes of variables: (1) the general physical and social conditions of imprisonment; (2) the particular methods of interrogation, indoctrination, and pressures exerted by the enemy to secure collaboration; and (3) personal characteristics of the prisoners, including rank, intelligence and education, technical information and proficiency, et cetera. Data is presented concerning the role of some of these factors in determining the behavior of Air Force personnel as compared with other U. S. military prisoners.

Emission Spectroscopy in Analysis of Respiratory Gases. IV. The Calibration Characteristics of Oxygen Emission in the Near Infrared. CLAYTON S. WHITE, M.D., LOREN C. WATKINS, JR., B.S., and EDWARD E. FLETCHER, The Lovelace Foundation, Albuquerque, N. M.

Previous studies involving the spectral characteristics of small-volume discharge tubes excited with rf have been extended using "dry" gas mixtures containing oxygen, carbon dioxide and nitrogen. Emission near 7772-75 and 8446 Å, attributable to oxygen, was utilized to quantitatively determine the oxygen content. Data documenting the calibration and operating characteristics of the discharge tube, the influence of the nitrogen-carbon dioxide ratio, and the employment of the emission method for oxygen determinations in respired air is described.

The Effects of Exposure to Ultraviolet Light on Subsequent Dark Adaptation. WILLIAM J. WHITE, MEYER WEINSTEIN, and DOMINIC MORRIS, Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

The purpose of this investigation was to determine the effects of ultraviolet radiation on subsequent dark adaptation. The observers were preadapted to a field which was evenly illuminated by the radiation from a high pressure mercury vapor lamp. The observer viewed the pre-adapting field for a period of ten minutes, after which dark adaptation was measured using the Hecht-Schlaer adaptometer. When the ultraviolet component of the source was filtered out, absolute threshold (thirty minutes after exposure) was approximately .2 log unit lower than the threshold obtained thirty minutes after exposure to the unfiltered light. There was no difference between the initial portion of the cone segment of the dark adaptation curves obtained for both conditions. However, after exposure to the unfiltered light the rod-cone break was delayed from one to two minutes and the rate of rod adaptation was slower. After twenty minutes, twice as much light was still needed for threshold recognition in the ultraviolet condition.

Human Vertebral Column Alignment Under Physical Loads. C. M. WHITLOCK, JR., M.D., Convair, San Diego, Calif.

The normal human vertebral column is oriented in a somewhat buckled position. Determination of optimum vertebral column positions for various load applications to the human being is a complex human engineering problem in which a number of parameters must be balanced to get the best position for any given loading. The analysis of optimum vertebral column loading, for at least one type of load condition, is reported. This will include description of structural intricacies, the types of failures possible with them, results of x-ray analysis and design recommendations therefrom.

The Flight Surgeon and Aviation Safety. CAPT. CARL E. WILBUR, MC, USN, Aviation Safety Division, Office of the Chief of Naval Operations, Washington, D. C.

The development of the aviation safety program in the U. S. Navy is briefly reviewed. Current procedures leading to the analysis of each aircraft accident are outlined and the complexity of this safety review is emphasized. The duties of the flight surgeon are shown as natural outgrowths of traditional concepts applicable to the general practitioner of medicine. Two currently all-important, yet little understood, tasks highlight the role of the flight surgeon in aviation safety. These are: (1) the analysis of pilot-error accidents; and (2) the supervision of the individual pilot's flight readiness. The importance of each of these tasks is documented. It is concluded that the professionally trained flight surgeon is indispensable to the ultimate objective of training accident-free, professional pilots.

Recent Studies in Pressure Breathing. SYRREL S. WILKS, PH.D., and BRUNO BALKE, M.D., School of Aviation Medicine, Randolph Air Force Base, Texas.

Emergency descent from extreme altitudes following loss of cabin pressure necessitates breathing oxygen under pressure. The feasibility of pressure breathing without mechanical counter-pressure has been demonstrated by two well trained (physically), altitude acclimatized subjects. With the two subjects a positive tracheal pressure of 30 mm. Hg. was tolerated for more than thirty minutes. Maximum altitude attained was 58,000 feet for periods of five minutes. Recordings were made of: (1) heart rate, (2) pulse pressure, (3) ventilation, (4) tidal

and minute volume, (5) vital capacity, (6) blood "pooling" and (7) EKG. It is necessary to maintain abdominal tension at all times, as "relaxation" leads to dizziness within two or three respirations. There is a great difference between the "positive pressure tolerance" of trained and untrained subjects.

Air Transportation of 193 Respirator Patients. HAL T. WILSON, M.D., San Bernardino, Calif.

The air transportation of patients in full body respirators is a routine procedure in the U. S. Air Force. The Air Force School of Aviation Medicine established a program for proper selection of cases for air transport, for care of the patient during flight, and for postflight observation of the patient. This program has materially reduced the hazards of transporting respirator patients by air. Indications are that inflight and postflight complications have been reduced approximately from 41 to 13 per cent.

Effect of Valsalva Maneuver on Aortic Blood Flow in Man. EARL H. WOOD, M.D., WILLIAM P. CROWLEY, JR., M.D., NEWTON C. BIRKHEAD, M.D., IRWIN J. FOX, M.D., and H. J. C. SWAN, PH.D., Section of Physiology, Mayo Clinic, Rochester, Minn.

Variations of the Valsalva maneuver, such as the "M-1" and "M-2" maneuvers, profoundly affect tolerance of man to positive acceleration when performed with or without an anti-blackout suit. To elucidate some of these mechanisms, blood flow in the thoracic aorta has been recorded continuously by a constant rate indicator infusion technique in ten normal subjects before, during and after maintenance of an airway pressure of 40 mm. Hg. for fifteen seconds. Mean control thoracic-aortic flow was 4.2 (3.0-6.5) and at termination of the Valsalva maneuver fell to 1.9 (1.3-3.9) liters per minute. Inflation of a G-3A anti-blackout suit to 150 mm. Hg. greatly reduced, while tetraethylammonium chloride increased and a 10° head-down tilt decreased, the effects of the maneuver on blood flow. Close correlation was obtained between beat-to-beat changes in total cardiac output calculated from aortic pressure pulses and the thoracic-aortic flow by the dye method.

Microcirculatory Effects of Acceleration. PAUL L. YUDKOFSKY and RITA M. RAPP, Aero Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

Changes occurring in a morphologically typical vascular bed under various types of accelerative stress are shown in a 16 mm. color motion picture taken on the Air Force human centrifuge. Using the transparent cheek pouch of the golden hamster *(Mesocricetus auratus)* as the microcirculatory site, changes in small blood vessel diameter and in blood flow are shown under various types of G force applied at varying rates. Vascular responses to rapidly and gradually applied positive acceleration are compared with responses to rapidly and gradually applied negative acceleration.

Human Factors in Multi-Jet Accidents. ANCHARD F. ZELLER, PH.D., Directorate of Flight Safety Research, Norton Air Force Base, Calif.

Consideration of 257 selected multi-jet aircraft accidents indicates a marked similarity between the factors associated with these and those associated with comparable non-jet, multi-engine aircraft accidents. In both types, the predominate cause was error on the part of the pilot, and landing was the most critical phase of flight. An evaluation was made of the specific causes, associated conditions, and results in terms of injuries and aircraft damage. Types of errors were examined and related factors, such as the pilot's age and various types of flying experience, were considered. The findings emphasize the necessity for continued care in transitioning to multi-jet aircraft.