Abstracts of Papers from Scientific Program of 1962 Meeting of Aerospace Medical Association, Atlantic City, April 9-12

Follow-up Studies of EEG in Relation to Aircraft Accidents and Flight Training Failure.

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A previous report on the relation of electroencephalographic changes to incidents of unconsciousness in aviators indicated that certain such changes correlate highly with a variety of unconscious incidents, including some actual seizures. Additional cases have confirmed, extended, and, to some extent refined the concept of the character of significant EEG changes. Accident report data from U. S. Naval Aviation Safety Center have included 203 aircraft accidents involving 184 aviators or trainees on whom baseline electroencephalograms were available. Of these, 20 were fatal accidents. The remainder include a range from slight damage to aircraft to strike damage, with independently varying degree of injury. Even with this variety, the pilots involved in the accidents include a disproportionately high percentage of those in the original baseline group who had suspicious to abnormal electroencephalograms. When the accidents are analyzed further, the trend toward EEG abnormality becomes more marked with increasing degree of severity of accident. Analysis of data on those who failed to complete training shows a disproportionately high incidence of EEG abnormality in certain categories of dropouts.

Implications of these observations will be discussed with respect to prediction and selection of aviators on the basis of electroencephalogram.

Distraction From Flashing Lights.

R. C. B. AITKEN, M.B., Ch.B., FLT. LT., RAF, HELEN M. FERRES, M.Sc., and J. L. GEDYE, M.B., B.Chir., FLT. LT., RAF, RAF Institute of Aviation Medicine, Farnborough, England.

When an aircraft, displaying a flashing light, flies in clouds, the crew may be distracted by reflection. In order to determine the frequency of flicker that would be likely to cause the least distraction, five frequencies, within the range 1.0 to 2.3 c.p.s., were presented in pairs for one minute to each subject. After exposure to each pair, subjects expressed their relative preference for each frequency on a continuous scale and also estimated the relative duration of presentation. Palmar conductance was measured in order to estimate change in arousal. It was shown that the slower frequencies were preferred, and that there were associated effects on time estimation and conductance level. It was concluded that the optimum frequency for a flashing warning light is the lowest compatible with adequate visibility.

Development of Space Cabin Tolerance Criteria to Trace Contaminants.

KENNETH C. BACK, Ph.D., Aerospace Medical Laboratory, Wright-Patterson AFB, Ohio.

These studies were performed in order to form a basic philosophy concerning long-term tolerance criteria in a situation where there is no time for physiological recovery from continuous exposure to trace noxious materials in the closed environment of advanced space vehicles. Monkey, rats, and mice were exposed continuously for 90 days to Threshold Limit Value (TLV) concentrations of toxic agents. The exposures were grouped as follows: (1) Carbon Tetrachloride; (2) Phenol; (3) Indole; (4) Skatole; (5) Hydrogen Sulfide; (6) Methylmercaptan; and (7) A mixture of (3) through (6). Clinical, physiological and pathological examinations were done on all animals. These experiments showed evidences that chemical or physical interactions between trace contaminants resulted in either additive, synergistic, or decreased physiological activity. It is evident that TLV cannot be used as the sole criterion for long-term exposure to trace contaminants.

Man's Visual Capabilities in Space: Perception of Movement in Depth.

CHARLES A. BAKER, M.A., and WILLIAM C. STEEDMAN, B.A., Behavioral Sciences Laboratory, Aeronautical Systems Division, Wright-Patterson AFB, Ohio.

In manned space flight, man will be required to perform certain visual tasks in the environment exterior to his space vehicle. Close inspection of other space vehicles, terminal guidance and rendezvous, and construction of satellites in space are examples. Much is known about the visual cues man utilizes to perform comparable tasks in his normal earth environment. The relatively unstructured visual environment of space, however, will deprive him of many familiar cues. This paper describes research findings on man's ability to perceive relative movement in depth of an object viewed in an otherwise unstructured visual field. Luminance, angular size, and rate of relative movement are varied. These data are useful in de-

scribing the capabilities of man to perform terminal rendezvous in space by direct visual sensing. In general, these data provide an improved basis for determining the optimal assignment of functions to man and to machine in manned space vehicles.

A New Approach to Nitrogen Elimination in Oxygen Rebreather Systems.

R. G. Bartlett, Jr., Ph.D., U. S. Naval School of Aviation Medicine, Pensacola, Fla.

The economical elimination of nitrogen from the lungs and body of an aviator on a closed circuit rebreather system has long been a perpelxing problem. To ask the aviator to purposely dump the first few exhalations outside the mask demands that he give attention to his oxygen apparatus at a time when his attention may well be committed to flying the aircraft. Following this (or perhaps as the only nitrogen purging technique) a portion of each breath may be trapped and then dumped. Early in the course of nitrogen elimination such a procedure is inadequate to purge the nitrogen rapidly evolving from the body. Later, when nitrogen is eliminated more slowly, this technique constitutes excessive purging. A more economical approach has been developed in which the aviator need give no attention to the oxygen apparatus. Greater purging is used early in the nitrogen elimination procedure and lesser purging is used later when nitrogen release rate from the body is less. The purging is periodic and nitrogen allowed to accumulate during rebreathing periods. An experimental apparatus has been developed which automatically cycles the aviator from open to closed circuit breathing. In the emergency of cabin pressure loss or with power failure the aviator is automatically cycled to open circuit breathing. However, manual over-rides give the aviator final control of the breath routing. The experimental studies of economical nitrogen elimination and their adaptation to a prototype operational device will be discussed.

The Maintenance of Correct Ejection Posture.

Gp. Capt. A. J. Barwood, O.B.E., M.R.C.P., L.R.C.P., D.P.H., D.I.H., RAF, RAF Institute of Aviation Medicine, Farnborough, England.

The high incidence of mild back injury during otherwise successful ejections, and the increasing incidence of such back injury with the improvement of ejection capability, prompted investigation into the probable cause of such injury. The geometry of harness systems was studied and the techniques for adjusting such harnesses were investigated. The typical back injury in the region of T-10—L-2 indicated that posture appeared to have a direct relation to such injury. Means of maintaining an acceptable posture were therefore investigated and ultimately modifications for all types of harnesses were proposed. Initially these were tried experimentally and have produced marked improvement in whole body restraint, and have, at the same time, made the harness system more comfortable. The moulding of the seat top and back to the mean anatomical profile of aircrew has also been attempted, resulting in the maintenance of an improved ejection posture and very considerable improvement in comfort and acceptability—a factor which might well be applied to conventional seat design.

Successful Prediction of Air Sickness in Aircrew Trainees.

Smiley Powell Beach and Fl. N. C. Russell, Canadian Joint Staff, Washington, D. C.

Work done in 1953 by one of the authors suggested that successful prediction of air sickness could be made by taking a careful history and subjecting the individual to square wave head movements while seated in a rotating chair. Starting in 1960 one hundred and fifty pilot trainees were assessed by this method and also given a psychiatric assessment before undergoing primary flight training. The failure rate in this primary training due to air sickness was seven per cent. The combined history assessment and rotation test predicted half of this number with no false predictions. The assessing psychiatrist predicted failure of half of the remainder because of poor motivation or anxiety. This threefold attack can be usefully employed to remove the incurably airsick individual before he attempts expensive flying training.

Bio-experiments in Extreme Magnetic Fields.

Dietrich E. Beischer, Ph.D., in collaboration with P. Close, D. C. McNutt and E. F. Miller, U. S. Naval School of Aviation Medicine, U. S. Naval Aviation Medical Center, Pensacola, Fla.

High intensity magnetic fields may be encountered during space flight in connection with magnetic shielding against cosmic radiation and around ion-propulsion devices. Near absence of a magnetic field will be experienced on the moon and in some distance from the vehicle during transit. Animal experiments above 100,000 gauss performed in Bitter magnets at the magnet facilities of the Naval Research Institute, Washington, will be described and conclusions drawn concerning the effects of these extremely high fields on man. Results of experiments in the near absence of a magnetic field (below 50 gamma) will also be described. The behavior of animals and men in a magnetically quiet environment is presently studied at the Naval Ordnance Laboratory, Washington, D. C.

Summary and Evaluation of Aircraft Accidents and Fatalities During the Past Five Years.

Lt. Colonel Horace S. Bell, USAF, MC, Office of the Assistant for Life Sciences, Deputy Inspector General for Safety, Norton AFB, California.

A summary and evaluation of all USAF aircraft accidents for five years are reviewed. In addition, aspects of these accidents will be analyzed in terms of the cause factor, fatalities, major injuries, escape and survival.

Ozone Contamination of High Altitude Aircraft Cabins.

G. BENNETT, M.D., Research Medical Officer, British Overseas Airways Corporation, London, England.

Experimental observations of the horizontal and vertical distribution of ozone in the atmosphere are briefly reviewed. Two series of observations have been made, correlating ozone concentrations in the cabins of passenger transport aircraft with outside atmospheric concentrations obtained by direct sampling or balloon ascent. The results are presented for aircraft types in which air for cabin pressurization is obtained (a) from direct engine tappings at high temperatures, (b) from engine driven turbo-compressors at lower temperatures. Extrapolation of these results has been attempted in order to predict conditions in the cabins of supersonic transport aircraft. Groups of volunteers have been exposed for three-month periods to the predicted ozone contamination levels to determine whether any chronic toxicity hazard existed, and the results are presented.

Aerospace Medical Aspects U.S. Navy Manned Balloon Flight of May 4, 1961, "Strato-Lab High No. 5".

VICTOR G. BENSON, CAPT., MC, USN, and R. D. SQUIRES, M.D., Aviation Medical Acceleration Laboratory, U. S. Naval Air Development Center, Johnsville, Pa.

Strato Lab High No. 5, a manned balloon flight, was launched at dawn 4 May 1961 from the flight deck of the *USS Antietam* 200 miles south of New Orleans. The flight was recovered at sea 8.9 hours later 164 miles east of the launch site. CDR Malcolm Ross, USNR, and LCDR Victor Prather (MC) USN, wearing Navy-Mercury full pressure suits and riding in an open gondola set a new world's record of 117,-733 feet for manned balloon flights. A complete system of biotelemetry was used on each subject and transmitted physiological data to a medical monitoring team on the *USS Antietam*. From the data received by biotelemetry and voice communications it can be concluded this flight demonstrated that the Navy-Mercury full pressure suit would function satisfactorily in an actual space equivalent environment and also that subjects wearing this suit could be exposed to the same environment and perform useful functions for a prolonged period of time with no major physiological impairments.

Heat Regulation in a Conflict: Warm Interior With Cold Skin.

T. H. BENZINGER, Naval Medical Research Institute, Bethesda, Md.

Thermoregulatory sweating in a warm environment —where no cold-reception on the skin takes place— was found in this laboratory to be independent of skin temperature over a wide range of conditions. Other laboratories had observed, however, under different conditions including chilling of the skin after warming the interior of the body, that certain correlations must exist between the temperature of the skin and the rate of thermoregulatory sweating. This seeming conflict has been clarified by quantitative observations under paradoxical conditions: Not infrequently man is exposed to cool environment which leads to cold-reception at the skin while lasting heat retention or strenuous muscular exertion keep the internal temperature of the body above the "setpoint of the human thermostat". Under these conditions the internal thermoreceptive system responds to warmth and calls for sweating while the *skin* in response to cold produces sensory nerve impulses that would call for shivering and increased heat production. These latter reactions do not take place because they are inhibited by the internal warm-reception. On the other hand, the sweating response to internal warm-reception is also reduced or abolished. The role of this peculiar mechanism and its practical importance for manned space flight will be briefly discussed with reference to the integrated function of the "human thermostat".

The Value of Indoctrination Flights in the Screening and Training of Naval Aviators.

JAMES R. BERKSHIRE, M.A. and ROSALIE K. AMBLER, M.S., U. S. Naval School of Aviation Medicine, Pensacola, Fla.

Four instructional hops were given to 196 students prior to their entry into naval air training. The purpose was to determine the effects of the flights upon subsequent student performance in training and to determine if evaluation during such flights could be used to augment existing selection procedures. The evidence was generally favorable toward the concept of indoctrination flights. Reduced attrition and enhancement of performance were demonstrated. These findings were interpreted with caution, however. The most significant results were that certain predictions and observations made by the instructors had high validity in predicting later failure and would significantly augment current selection procedures.

Peptic Ulcer in Aircrew: A Follow-up Study.

LT. COL. CHARLES A. BERRY, USAF, MC, MAJ. WILLARD R. HAWKINS, USAF, MC, and CAPT. MYRON R. SMITH, USAF, MC, Aerospace Medicine Division, Office of the Surgeon General, USAF, Washington, D. C.

There has long been concern about the complications of peptic ulcer disease in aircrew and the hazard that they might create. There has been conjecture about the importance of ulcer in flying personnel and the applicability of current medical literature statistics on recurrence rates. In an effort to shed light on this problem, some 359 aircrew with ulcer disease were selected at random and a questionnaire designed to obtain information from their current flight surgeon on the status of their disease. The results of this follow-up study are presented.

The SAM Decompression Sickness Management Team.

LT. COL. DAVID H. BEYER, USAF,

MC, School of Aerospace Medicine, Brooks Air Force Base, Texas.

Aviator's decompression sickness complicated by neurocirculatory collapse is a serious threat to life. Since the pathophysiology of this condition is inadequately understood, its treatment is not based on firm therapeutic rationale. To provide a special medical team for the study of this disease and for the gathering and dissemination of information about it, the School of Aerospace Medicine has established a Decompression Sickness Management Team. A team member is available at all times to provide medical consultative advice concerning afflicted patients and the team is prepared to rapidly deploy within the continental limits of the United States to aid in the evaluation and treatment of patients with neurocirculatory collapse. This paper discusses the general diagnostic and treatment guide lines used by the team and describes its composition and the method of operation. Early experiences will be presented.

Helicopter Versus Fixed Wing Crash Injuries, Army Experience.

CAPT. ANTHONY A. BEZREH, MC, F/S Human Factors Section, United States Army Board for Aviation, Accident Research.

A review of three years of Army aviation major accident data revealed more similarities than differences between crash injuries received in rotary wing and fixed wing types of aircraft. The same preponderance, namely 97% of the accidents in both types of aircraft were considered as survivable, although as many aviators were killed in survivable as in non-survivable accidents. There were twice as many injuries produced per accident in rotary wing crashes as there were in fixed wing crashes. When injury patterns were analyzed for injury location, injury type, and for the types of injuries causing death, it was found that rotary wing and fixed wing data paralleled each other remarkably closely. The same similarity appeared in the breakdown for agents of injury causation. The head and upper and lower extremities were the most frequent body areas involved. Wounds, fractures, and burns were the prevalent types of pathology produced. The most common causes of death were head injuries, multiple extreme injuries, and burns and complications, while the major agents of injury causation were cockpit agents, fire, and decelerative forces. The important cockpit agents of injury causation were the instrument panel, windshield or bubble, and the control column, cyclic or collective stick. Thus, Army crash injury patterns are typical of those found from other sources of light aircraft accident data, in spite of the fact that over 50% of the Army aircraft inventory is rotary wing in type. Further discussion will be devoted to the astounding implications of post-crash fire and to the differences in the injuries attributable to pure decelerative forces in rotary wing and fixed wing aircraft.

Modern Medical Management in Reserve Aerospace Forces.

MAJ. GEN. R. L. BOHANNON, USAF, MC, Headquarters USAF, Washington, D. C.

In the significant sixties we are faced with a multiplicity of vacillating values and prolix purposes. In the midst of this confusion we must assign relative weights to our individual goals and allocate priorities in the use of our group and national resources. Our democratic society assumes that ordinary citizens as well as policy makers are capable of making the necessary evaluations, and that we will do so not wholly on the basis of individual self-interest. Herein lies the challenge and the goal of the Air Reserve Forces program. This paper discusses the background and current concepts of the utilization of professional medical talents in the Reserve Aerospace Forces.

The Relationship of Conformance, Survival and Behavior of Modern Man: A Theory.

CAPT. ROLAND A. BOSEE, MSC, USN and CAPT. ROBERT L. BURDICK, MC, USN, Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

Throughout evolutionary history, physical survival of an individual animal has meant conformance to the physical principles governing the animal and its environment. Considering the characteristics most likely to produce physical survival of a species characterized by reproduction of one offspring at a time, it is reasoned that conformance to principles governing the behavior of men with respect to each other became as important to survival as conformance to physical principles. However, the application of these principles has become so complex that the relationship to physical survival has been lost. As a result man's behavior now serves conflicting purposes and becomes unpredictable. The recognition and understanding of these circumstances is vital to aero-space considerations.

Medical Aspects of Selected Toxic Propellants.

COL. JOHN E. BOYSEN, USAF, MC, Deputy Command Surgeon, Air Force Logistics Command, Washington, D. C.

Experimental and operational observations concerning the toxic properties of selected propellants and associated oxidizers are discussed. Based upon animal experimental work and limited clinical observations of personnel exposed during operational activities, including manufacture, an attempt is made to project and assess the problems which may present themselves on operational missile sites.

The Importance of Personal Habits in Operational Flying.

CAPTAIN SIDNEY I. BRODY, MC USN, U. S. Naval Air Station, Oceana, Va.

Flight regulations and flight surgeons attempt to influence personal habits of aviators which affect flight proficiency. Deviations from accepted procedures continue to occur. It is helpful to flight surgeons to know the extent and frequency of devia-

tions in order to estimate the relative importance of nonadherence to recommendations or regulations as applied to operational flying. A survey was conducted involving 542 naval aviators to elicit information regarding flight experience, breakfast habits, amount of sleep, drinking habits and past aircraft accident history. Because of their relative importance breakfast habits and alcoholic intake are discussed. It was concluded that among all naval aviators more than one-third ate little or no breakfast while engaged in flying. The absence of breakfast from the daily diet of operational pilots and its possible role in the production of functional hypoglycemia is not considered of significance. This practice is also not considered a potential accident producing factor. Approximately one-half of all naval aviators may be considered as having a moderate alcoholic intake; one-quarter, light drinkers; and one-quarter of the sampled population abstainers and heavy drinkers. There is a decided shift in drinking habits relating to weekday versus weekend drinking. In view of potential decrements in flight performance regarding the presence of very small amounts of alcohol in the blood, it is essential that flight surgeons continue to stress the need for reduction in alcoholic ingestion while engaged in flying.

Why Pilots Must Have Instrument Training.

HAROLD N. BROWN, M.D., Lombard, Ill.

Many private pilots are under the illusion that they can avoid clouds at their option. These same pilots are frequently under the impression that they can determine the earth's whereabouts by sensory mechanisms other than their eyes, should they be engulfed by clouds. The major cause of death in aviation is inadequate instrument training. It is the obligation of physicians, active in aviation medicine, to acquaint pilots and other physicians as to the limitations of depth perception while in flight as this limitation causes inadvertent cloud entry. Similarly, pilots and physicians must know why their proprioceptive and vestibular apparatus do more to confuse them, than to aid them in determining the earth's whereabouts. This presentation is an attempt to help solve this serious problem.

The Psychomotor Task as a Monitor of Subject Safety.

CAPTAIN ROBERT L. BURDICK, MC, USN, Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

In pursuing aerospace medical research, it is often necessary to expose subjects to hazards which could endanger the subject's life. When the effects of the physical hazard include disturbance of cerebral or motor function occurring before irreversible change, the subject's performance on a suitable psychomotor task is a sensitive and reliable measure of the subject's condition. The criteria establishing suitability of such tasks are discussed. The design philosophy, construction and performance of a particular psychomotor task used in hypoxia experiments are presented and discussed.

Evaluation of Flying Personnel With Persistent Hypertension.

EARL T. CARTER, M.D., Ph.D., JAMES C. HUNT, M.D. and JAN H. TILLISCH, M.D., Mayo Clinic and Mayo Foundation, Rochester, Minn.

Decision regarding the flying status of a pilot with elevation of blood pressure remains a difficult aeromedical problem. Our evaluation of such an individual is oriented toward the following questions: 1. Does the patient have true hypertensive disease or is he merely a vascular hyperreactor? 2. What associated pathologic and physiologic alterations can be demonstrated? 3. What is the etiology? 4. Is surgical relief possible? 5. Would nonsurgical treatment, if indicated, be compatible with flying duties from a flight safety standpoint? Such an approach necessarily involves a detailed history, careful physical examination and pertinent laboratory studies. We shall emphasize means of detecting reversible forms of hypertensive disease as exemplified by hypertension of renal origin. The case of renal artery disease in a 31-year-old airline pilot will illustrate the principles.

Coronary Artery Disease in Military Aircraft Accident Investigation.

CAPT. R. L. CATHERMAN, USAF, MC and COL. F. M. TOWNSEND, USAF, MC, Armed Forces Institute of Pathology, Washington, D. C.

Autopsy material received by the Aerospace Pathology Branch, Armed Forces Institute of Pathology, to date in military aircraft accidents has been reviewed. The relationship of incidence and severity of coronary artery disease to the accidents is noted. Comparison of the incidence will be made to that in military, non-flying personnel and the general population. Several recent cases correlating the finding of coronary artery disease and cause of the accident will be presented as well as several cases in which there was no relationship or only a possible causal relationship. Pathologic examination of whole hearts received by the Aerospace Pathology Branch, Armed Forces Institute of Pathology in military aircraft accident cases, with particular reference to the extent of coronary artery disease, is being carried out and a preliminary report of the findings will be given.

Miniature Tissue Equivalent Ionization Chambers and Their Use.

CAPTAIN F. W. CHAMBERS, JR., MSC, USN, Naval Medical Research Institute, Bethesda, Md.

Evaluating the biological effect of mixed ionizing radiations (gamma or X-rays, neutrons, beta rays, protons, etc.) requires a correlation of physical measurement with the biological effect. It is, therefore, desirable to be able to measure physically the absorbed dose at any point in biological or simulated biological material. Quoting from National Bureau of Standards Handbook 75, Measurement of Absorbed Dose of Neutrons, and of Mixtures of Neutrons and Gamma Rays: "The absorbed dose depends on geo-

metric and material configuration, and precise experimental determinations must usually be carried out either in a biological object or in a suitable phantom. The instruments employed must not appreciably disturb the radiation field and need therefore to be quite small or tissue equivalent in composition." Miniature tissue equivalent ionization chambers containing tissue equivalent gas are described and the method of using them for the measurement of absorbed dose at various points in both tissue equivalent phantoms and biological material is presented.

Effects of Positive Pressure Breathing on Performance and Physiology During Acceleration.

RANDALL M. CHAMBERS, PH.D., WILLIAM F. AUGERSON, CAPT., MC, USA, ROBERT KERR, B.S., and DONALD A. MORWAY, B.S., Aviation Medical Acceleration Laboratory, U. S. Naval Air Development Center, Johnsville, Pa., and National Aeronautics and Space Administration, Langley Field, Va.

Statistical analysis of results from two experiments indicated that breathing positive pressure oxygen facilitated performance during exposure to transverse ($+G_x$) and positive ($+G_z$) acceleration stress. In the first experiment, five test pilots were required to perform an orbital tracking task during steady-state accelerations ranging from 6 to 12 $+G_x$ while breathing 100% oxygen under pressure and under control conditions of normal breathing. In the second experiment, six other subjects were required to perform a visual brightness discrimination task during exposure to steady-state accelerations ranging from 1 to 7 $+G_x$ and from 1 to 5 $+G_z$. Effects on visual brightness discrimination were recorded under comparable breathing conditions. There were major individual differences in response to the effects of acceleration during pressure breathing. Analyses of the performance and piloting opinion data indicated beneficial effects on performance and pilot comfort from breathing 10% oxygen under pressure at the higher acceleration levels.

Perception of Angular Acceleration About the Yaw Axis of a Flight Simulator: Thresholds and Reaction Latency for Research Pilots.

BRANT CLARK, PH.D. and JOHN STEWART, M.S., San Jose State College, San Jose, Calif. and National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

Thresholds for the perception of angular acceleration and reaction latencies for accelerations in the region of the threshold were determined using the Ames Three-Degrees-of-Angular-Freedom Simulator. The simulator was controlled by an analog computer signal and each angular acceleration was measured throughout its ten second duration by an angular accelerometer. A forced choice procedure was used for angular acceleration and reaction latencies for angular accelerations from 0.06°/sec.^{2} to 10°/sec.^{2} will be reported and compared with earlier studies.

Glaucoma Screening in Aeromedical Examinations.

CAPT. WILLIAM B. CLARK, USAF, MC and LT. COL. JAMES F. CULVER, USAF, MC, Ophthalmology Branch, School of Aerospace Medicine, USAF Aerospace Medical Center, Brooks Air Force Base, Texas.

The USAF Surgeon General's Office, recognizing the economic and aeromedical significance of undetected glaucoma, now requires tonometry in the annual physical examination for aircrew members over 40 years of age. Many ophthalmologists feel that tonometry should be performed only by ophthalmologists. This would be impractical in the Air Force, and to omit tonometry because of lack of ophthalmologists would be a mistake. Experience in teaching tonometric technique to prospective aeromedical examiners indicates the safety and practicality of screening tonometry. The consultant's workup of "positive" cases must be extremely thorough and should be viewed critically by the aeromedical examiner.

Aeromedical Aspects of the B-58 Capsule Ejection Seat.

CAPT. NEVILLE P. CLARKE, USAF, VC and CHARLES R. FEELEY, B.S., Aerospace Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

The evolution of aircraft escape devices from the open ejection seat into the encapsulated seat system brought many critical and crucial human factor problems. Paramount of these problems was in the area of biodynamics, in which the establishment of the additional human tolerance data was required for making man compatible with this new concept of escape. This paper presents the aeromedical support provided to the B-58 escape capsule program under the leadership of the Aerospace Medical Laboratory, Wright-Patterson AFB. Details of the tests conducted and the highlights of the related biodynamic factors will be discussed. The critical portions of the animal and human testing conducted by the contractor and the Air Force to validate the design principles and establish command confidence in this new escape concept will be discussed.

The Flying Physicians Disaster Program in Action.

FRANK H. COBLE, M.D., Richmond, Indiana.

In any disaster of great magnitude it is reasonable to believe that a proportional part of medical facilities, hospitals, doctors and other medical personnel and supplies would also be casualties. Consequently any medical help to the area of devastation must come in from outside the area despite destruction of means of surface transportation and facilities for use of large aircraft. Realizing these possibilities the members of the Flying Physicians Association felt they had a service to offer that no other group could possibly duplicate. Their 2,000 members, piloting their own planes carrying medical supplies and additional medical personnel could converge on an area of disaster to land on segments of highways or

country lanes to bring some help and some degree of hope to survivors before facilities could be re-established for regular relief units to enter. The organization has developed definite plans to work with State Civil Defense and Public Health offices to this end. A conservative estimate indicates that it would cost our government in excess of $60,000,000 per year to duplicate and maintain aircraft and equipment and the stand-by medical personnel involved in this plan which is available at no cost to the government or to the tax payer. Since actual plans must vary in each state due to the difference in problems because of location, terrain, industry and population, a resume of some of the plans is given. We are thankful no occasion has yet arisen to test the efficiency of these plans but it is felt that definite plans are needed and, though perhaps inadequate, any plan would be better than no plan at all.

Decompression Collapse Syndrome: Report of Successful Treatment by Compression to Three Atmospheres Pressure.

LT. CMDR. KENNETH R. COBURN, MSC, USN, SURG. LT. T. R. GOULD, RN, SURG. LT. J. M. YOUNG, RN, SURG. LT. M. HATFIELD, RN, SURG. LT. CMDR. I. N. COLLEY, RN and SURG. CAPT. E. BOYD MARTIN, RN, Royal Navy Air Medical School, Seafield Park, Hampshire, England.

Following an exposure of one hours duration at a simulated altitude of 37,000 feet, a 47 year old RN pilot experienced a loss of motor function in his left lower leg. Over the next hour function returned slowly to the point where he could walk, although there remained a severe foot drop. Sensation in the affected limb was at all times normal, although it became progressively cooler than the unaffected limb. Approximately 75 minutes post-run his blood pressure fell from 120/80 to 70/50. Just prior to being placed in an ambulance for transfer to a recompression chamber at HMS Dolphin the blood pressure fell to 50/? with a pulse rate of 120. He appeared moribund. Upon arrival at the chamber he was compressed to a pressure depth of 66 feet and within three minutes blood pressure and pulse rate had returned to normal levels and he had regained almost 100% of the lost motor function. Decompression was carried out according to RN Decompression Table III. During the decompression blood pressure and pulse remained normal but there was a slight deterioration in left lower limb motor function. He was transferred to a hospital where he remained for about 60 hours. Upon admission an abnormal EEG was obtained. Repeat EEG two days later was normal and the patient was discharged. A discussion of the case and a rationale for treatment are presented.

Manipulation of Arousal and Its Effects on Human Vestibular Nystagmus Induced by Caloric Irrigation and Angular Accelerations.

WILLIAM E. COLLINS, PH.D., Psychology Branch, Civil Aeromedical Research Institute, Federal Aviation Agency, Oklahoma City, Okla.

Recordings of vestibular nystagmus were obtained from subjects in total darkness and in an illuminated room. Stimulation consisted of low-magnitude angular accelerations and aural irrigation. Sets of instructions and drugs designed to influence subjects' mental arousal were employed and EEG tracings were obtained. Results indicate that: (1) vestibular nystagmus is markedly affected by instructions which influence mental activity, (2) fixation distance exercises significant effects on the caloric response in illumination, (3) under certain conditions, eye-movement records may be more sensitive indicators of states of alertness than are EEG tracings, (4) interpretation of vestibular nystagmus in experiments pertinent to space flight must take into account the arousal level of the subject.

Thoughts on Interference with Gastric Activity During Prolonged Weightlessness.

LT. CMDR. NORRIS K. COMBS, MSC, USN, U. S. Naval Air Station, Norfolk, Va.

During prolonged weightlessness, it is believed that gastric action on food could be seriously impaired. A review of physiology texts reveals a disagreement on the role of gravity in stomach processing of food. The weight of food and liquids, it is felt, plays an important role in their passage from the fundus to the pylorus as peristalsis *per se* is not considered to take place in the upper stomach. In addition, it is difficult to see how the orderly exposure of food to gastric juices could take place if the food were without weight. Inasmuch as prolonged weightlessness cannot be simulated, we can only speculate on some of its effects. Gastric difficulties could pose a serious threat to man's well-being and performance. Until more information is obtained from early space ventures, providing personnel with parasympathomimetic or anticholinergic agents might be indicated.

Space Radiation Monitoring System.

MAJOR DE PAUL J. CORKHILL, USAF, VC, Aeromedical Field Laboratory, Holloman Air Force Base, N. Mex.

The Aeromedical Field Laboratory is procuring a radiation monitor for future satellite flights which will possess the following capabilities: 1. Differentiating between radiations of different types and determining the intensity of each type within a number of energy intervals. 2. Measuring the dose rate associated with each particle type in each energy interval, the overall dose rate from all particle types and energies, and the integrated dose. 3. Telemetering the information to ground receiving stations in a format compatible with reduction techniques at Air Force Missile Development Center. 4. Displaying overall dose rate and time integrated dose information to the vehicle passenger. 5. Capable of withstanding environmental conditions that are foreseen in satellite vehicles for the next eight years. A discussion will be

given covering the radiation detector functions and the ancillary electronic instrumentation.

Influence of Sustained Acceleration on Certain Pilot-Performance Capabilities.

BRENT Y. CREER, National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

The NASA has a continuing study of the effects of large acceleration forces on the pilot of a manned orbital or space vehicle. The objectives of these studies have been to investigate the effects of acceleration on the pilot's ability to perform the required tasks and on the effects of acceleration on the physiological processes of the pilot. These projects have been carried out using the Aviation Medical Acceleration Laboratory Centrifuge, U. S. Naval Air Development Center, Johnsville, Pa. The experimental setup consisted of a flight simulator with the centrifuge in the control loop. In previous Ames Research Center experiments, the influence of acceleration force fields up to 7 g on the pilot's ability to perform were investigated. In experiments which have recently been completed, the subject pilots have performed control tasks while being subjected to acceleration forces up to 14 g for the "eyeballs in" direction, 10 g for the "eyeballs out" direction, and 9 g for the "eyeballs down" g field direction. The following specific results obtained to date from these research investigations will be presented and discussed: 1. Time tolerance to acceleration boundaries which are believed to apply to the test pilot population will be presented. These boundaries were derived by measuring the longest periods of time a test pilot can manually control a given simulated vehicle, with no marked deterioration in his performance while immersed in a specified, nearly constant elevated g field. 2. In these centrifuge investigations, an index of pilot performance was obtained by having the pilot track a randomly driven target while flying the simulated vehicle. The effect of acceleration on the pilot's ability to track the target, as a function of the length of time, the magnitude and the direction of the applied g field, will be presented. Information will also be given on the maximum g beyond which the pilot could not be expected to manually control the simulated space vehicle. 3. Data have been obtained on the influence of rate-of-onset-of-acceleration on pilot performance, and on the pilot's time-tolerance-to-acceleration. These data will be presented and discussed in terms of the maximum rate-of-onset-of-acceleration which will be encountered by a vehicle entering the earth's atmosphere at parabolic velocities.

Circulatory Effects of Oxygen Breathing.

WALTER J. DALY, M.D. and STUART BONDURANT, M.D., Indiana University School of Medicine, Indianapolis, Ind.

While oxygen breathing is often used in operational and investigative problems of aerospace medicine, the circulatory effects of hyperoxia have not been completely defined. These effects would be expected to modify the physiologic responses to the rigors of aerospace and should be considered in interpreting the physiologic data obtained under certain space equivalent or actual space conditions. Fifteen normal male subjects breathed 100% O_2 or air in random sequence in such a way that the gas composition was unknown to the subject. Cardiac index (Indocyanine green dilution) decreased (3.01 ± 0.053 to 2.67 ± 0.46 L/min/m^2 $p = 0.001$) during O_2 breathing. Heart rate decreased proportionately and stroke index was unaffected. Mean brachial blood pressure increased (93 ± 9 to 94 ± 8 mm Hg $p = 0.05$), and systemic resistance increased (16.7 ± 3.1 to 18.1 ± 3.1 units $p = 0.001$). After atropinization, cardiac index, heart rate, and total systemic resistance were unaffected by hyperoxic breathing. The same variables were measured before and during the phase of reactive hyperemia following release of arterial thigh tourniquets. Hyperemia increased cardiac index to 4.59 L/min/m^2 during air breathing but only to 3.74 L/min/m^2 during O_2 breathing ($p = 0.01$). The level of inspired O_2 concentration at which these changes occur was investigated in 9 normal subjects breathing 7 concentrations of O_2 from 15 to 100% in random sequence. Increasing concentrations of O_2 produced proportionately decreasing heart rates over the entire range. (Heart rate = 71.5-0.1075 x O_2 concentration). Thus, evidence is presented that the upper limit of oxygen sensitive chemoreceptor activity extends at least to 100% O_2 inspired; that breathing increased oxygen tensions produces a vagus dependent decrease in heart rate and rate related decrease in cardiac output; that this effect persists in situations of altered circulatory demands such as reactive hyperemia. While these circulatory effects of O_2 breathing are small, they are consistent and should be considered in interpreting the circulatory behavior of persons breathing O_2.

Effects of Chlorinated Hydrocarbons on Active Transport by Mammalian Membranes.

JACK W. DAUGHERTY, Ph.D., Civil Aeromedical Research Institute, Norman, Okla.

Early studies have shown that a condition similar to that described as hydropic degeneration may be produced in the tissues of mammals exposed to various chlorinated hydrocarbons used in aerial application. Recent investigations pertaining to the effects of insecticides on applicator personnel (1) have indicated that interference with the oxidative esterification of inorganic phosphate is involved and (2) suggest that one mechanism of the toxic effects and the resultant pathological findings may be attributed to alterations in the active transport of water and other metabolites by cell and cell compartment membranes.

The Effects of Environmental Stress Interactions on Performance.

ROBERT D. DEAN, PH.D., and CARL L. MCGLOTHLEN, B.S., Bioastronautics Section, The Boeing Company, Seattle, Wash.

Previously reported research with rats indicated that severe heat and vibration had an interactive ef-

fect on the physiology of these animals. The purpose of the present study was to determine if moderate environmental stresses have an interactive effect on human physiology and performance. The performance of sixteen subjects was measured under all possible combinations of two levels of altitude (sea level; 12,000 feet), temperature (70°F; 95°F) and noise (70 db; 95 db). Humidity was held constant at 40% R.H. Physiological data (EKG, EEG, GSR, respiration and axillary temperature) were obtained simultaneously during the runs. The performance measured, as a combined task, was (1) two-dimensional tracking; (2) radar warning; and (3) meter monitoring. The data were analyzed by testing the interaction terms in analysis of variance for statistical significance.

Contact Lenses in Aviation.

STANLEY DIAMOND, M.D., Pan American Airways, Overseas Division, San Francisco, Calif.

In the present state of the art, corneal contact lenses for aircrew personnel have great limitations. There are certain situations, however, where they may prove useful for greater visual efficiency: (1) to obviate the need for spectacles and visual field restriction from rims and temples; unhampered use of oxygen masks; (2) the correction of unilateral ametropias or unilateral aphakia, for the preservation of binocularity and normal depth perception. Handicaps during flight or important maneuvers would be: (1) the threat of loss of one or both lenses through windblast, vibration, buffetting, or ditching; (2) symptoms of intolerance (photophobia, lacrimation, or blepharospasm), fogging, and spectacle blur when shifting to regular glasses; (3) high altitude or depressurization effects of low barometric pressure forming bubbles under lenses; (4) limitation to pre-presbyopic age group; (5) the threat of sudden incapacity due to corneal abrasion, ulceration or lid edema with symptoms of blepharospasm, photophobia and lacrimation, involving one or both eyes. This may occur with ill-fitting lenses, a foreign body trapped under the lens, or from overwear; (6) lenses cannot be worn in the presence of conjunctival or corneal inflammation or infection due to the threat of corneal ulceration; (7) probably contra-indicated in bilateral high ametropia due to (a) the threat of loss of one or both lenses, either of which might produce great visual confusion, fusion intolerance, loss of depth perception, or loss of useful vision at a crucial time or (b) the possibility of inadvertent switching of right and left lenses with resulting visual confusion or eye discomfort.

The Effects of Simulated Altitude on Penetrating Eye Injuries.

J. ROBERT DILLE, M.D., CAPT. NORRIS L. NEWTON, MC, USAF and MAJ. JAMES F. CULVER, MC, USAF, Civil Aeromedical Research Institute, Norman, Okla. and Ophthalmology Branch, Department of Clinical Medicine, School of Aerospace Medicine, Brooks Air Force Base, Texas.

Penetrating eye injuries demand prompt highly specialized care by trained personnel. When the victim lives in a remote area, an unpressurized aircraft may be available as an alternate means, or as the only means, of transporting him to a treatment center. Little is known of the effects of altitude, rate of ascent, and rapid decompression upon these injuries, particularly when bubbles of air are present along the tract of penetration. Since intraocular air is injected in several diagnostic and surgical procedures of the eye, questions have also arisen concerning the safety of air transportation for these patients. In this experiment, rabbits with penetrating ocular injuries, one-half of the eyes containing 0.1 cc of air and one-half of the eyes containing no air, were subjected to both slow and rapid simulated ascents. The findings will be discussed. An equation is given which appears to represent the volume of the expected loss of intraocular contents from any eye with a penetrating injury through either the cornea or the sclera.

Officer Peer Rating as a Predictor of Flight Training Failure.

LIEUT. (jg) RICHARD E. DOLL, MSC, USNR and LIEUT. (jg) LEE R. BEACH, MSC, USNR, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

Peer ratings have demonstrated substantial validity in predicting performance in various military training and post-training situations. However, to date, such ratings have typically been limited to cadets, officer candidates, and other military personnel who live under conditions of close association. This study investigates the validity of such rating procedures when applied to 700 commissioned officer flight trainees, who do not have as much opportunity to observe their classmates behavior outside the classroom.

Studies on the Toxicity of Hydrazine: Correlation of Morphological Changes with Metabolic Activities.

CAPT. A. M. DOMINGUEZ, USAF, MSC, CAPT. J. S. AMENTA, MC, USAF, and 1/LT. C. S. HILL, USAF, MSC, Armed Forces Institute of Pathology, Washington, D. C.

The administration of hydrazine produces characteristic pathological lesions in the liver and kidney of experimental animals. In this study an attempt has been made to correlate hydrazine-induced morphological changes with the effects of this agent upon normal cellular function. In order to examine kidney function at the cellular level, the capacity of the renal tubular cell to actively transport chemical agents was explored. The movement of a chemical substance across the cellular membrane against a concentration gradient requires the expenditure of energy which is potentially existent within the cell in the form of metabolic reactions. Hydrazine (2mM/Kgm) was administered subcutaneously to adult male rats, and at varying periods of time thereafter the kidneys were removed and the capacity of the renal cortical slice to accumulate PAH was determined. There was marked increase in the ability of the renal cortical slice to accumulate PAH in the fasted hydrazine-treated animals. A similar increase was observed

in vitro when the kidney slice was incubated in a medium containing $1x10^{-3}$M hydrazine. These findings are discussed along with the observations on carbohydrate and fat metabolism as they are related to the morphological changes seen in the liver of hydrazine-treated animals.

The Experimental Comparison of Three Dynamic Map Display Configurations in a Simulated Steep Gradient Vehicle Environment.

D. J. Dougherty, Ph.D., B. A. Abbott, B.S., W. G. Matheny, Ph.D., and J. M. Willis, B.S., Bell Helicopter Company, Fort Worth, Texas.

This paper discusses special problems in the display of movement on attitudinal and positional displays for use with rotary-wing aircraft. Research results are reported for an experimental study which evaluated three configurations of pictorial position displays (moving map, moving vehicle symbol and a combination of these). The study included an examination of the up-scope vs. down-scope problem and of the vectored vs. non-vectored problems.

Medical Problems of a Tactical Air Force in an Overseas Theater.

Colonel Fratis L. Duff, USAF, MC, and Lt. Colonel Stanley Lutz, Jr., USAF, MC, Hq. USAFE (Surgeon), APO 633, New York, N. Y.

A Tactical Air Force in an overseas theater is faced with the same basic aeromedical problems as a Tactical Air Force in CONUS. This paper intends to discuss special problems of such an Air Force. Providing complete medical care to dependents is required. Obtaining off-base sites for dispersal of medical facilities is often difficult. The aeromedical evacuation mission must be supported within the capabilities of the command. Medical support is often required for government agencies not possessing their own integral medical services, such as State Department Agencies, MAAG's, etc. Special problems are inherent in working with NATO. Special missions, operational in nature, are carried out to support national policy.

Physiology of the Labyrinth: Quantitative Studies on the Effects of Angular Acceleration in Experimental Animals.

C. B. S. Evans, M.D., E. B. Konecci, Ph.D., and H. Glassner, Douglas Aircraft Company, Santa Monica, California.

The purpose of this presentation is two-fold: (1) to report briefly our findings from experimental investigations of the labyrinth physiology in vertebrates under rotational accelerations and (2) to exhibit a motion picture incorporating the synchronous display, during rotation, of the (a) labyrinthine cupula motions, (b) the vestibular nerve action potentials as translated on the oscillograph accompanied by its sound recording, (c) view of the attached accelerometer and chronometer and (d) nystagmus movements of the eyes.

These studies are being conducted to determine *quantitatively* the reactions of the labyrinth's sensory components and their specific innervations to the effects of varying degrees of rotary acceleration and g-forces, and the presence (or absence) of the nystagmus reactions in terms of amplitude, frequency, duration and direction.

Habituation of Nystagmus.

Cesar Fernandez, M.D., and Robert Schmidt, Ph.D., The University of Chicago, Chicago, Illinois.

Habituation of nystagmus elicited by repetitive caloric or rotatory stimulation was studied in cats with lesions in the central nervous system. Normal animals served as controls. Eye-movements were recorded by electro-nystagmography. Animals with ablation of either neocortex or anterior cerebellar lobe and animals with extensive damage to midbrain tegmentum exhibited habituation of nystagmus similar to that obtained in controls. Ablation of the cerebellar nodulus prevented acquisition of habituation until the cat compensates from cerebellar deficiency. Rate and extent of habituation varied from one parameter of nystagmus to another. Usually, but not always, amplitude and duration of the reflex were little modified while response decline was observed consistently in total number of jerks, frequency and velocity of both slow and fast component.

A Report of Operational Experience with the Navy Mark IV Mod II Full Pressure Suit.

Lieut. E. J. Filson, MC, USN, Naval Air Station, Oceana, Va.

The results of eighteen months of operational and training flights in the Navy Mark IV MOD II full pressure suit are discussed. This experience was obtained during the course of replacement air group training of Naval Air Forces Atlantic Fleet Squadrons. The emphasis is placed on training and use of the full pressure suit during operational missions while these squadrons were transitioning to the two-place, all-weather F4H-1 aircraft. Air crew indoctrination, pilot and radar intercept operator preferences and acceptance of the suit, cooling system requirements, fatigue factors, survival training and mission completion factors are presented.

Fatigue.

W. R. Franks, M.D., R.C.A.F., Institute of Aviation Medicine, Toronto, Canada.

Fatigue may be defined as a reduced capacity to perform resulting from previous functioning. It is the converse of training but both processes may operate concurrently. Fatigue may be regional or generalized and is a parameter of the units of function, i.e., cell, organs, or systems. Fatigue in one function may arise from diminished performance in another on which it is dependent. The prime example of this is the brain which is highly parasitic on other body functionings. Thus muscular exhaustion may result in diminished brain glucose supply. Fatigue may be sensed in some organs but not in others. The treatment of fatigue

involves removal of end product of functioning and anabolic replacement of reserves. Parasitic organs like the brain may thus be relieved by further functioning of non-fatigued contributing system, e.g., increased circulation from exercise or "play."

Studies in Orbital Rendezvous Simulation.

PAUL R. FULLER, Ph.D., Space Systems Department, Martin-Denver, Denver, Colo.

The purpose of the study was to investigate the feasibility of manual rendezvous of space vehicles. REAC analogue computers were programmed with the dynamics of a specific space vehicle. Six degrees of freedom with their cross-coupling effects were included. These were: roll, pitch, yaw, crossrange, elevation and downrange. Studies were conducted with experienced jet pilots, light plane pilots and non-pilots. Manual rendezvous proved feasible starting from a distance of miles through to actual vehicle contact.

The Effect of Prolonged Intermittent Exposure to Supplemental Oxygen on Lung Morphology.

LT. CDR. WALTER D. GABLE, MC, USN and COL. FRANK M. TOWNSEND, USAF, MC, Armed Forces Institute of Pathology, Washington, D. C.

Prolonged exposure to 100% oxygen, or short exposure to 100% oxygen combined with high G forces produce symptoms of respiratory difficulty in certain individuals. This suggests that morphological alterations might occur in the lungs of persons subjected to supplemental oxygen over a long period of time. To evaluate this hypothesis, sections of lung from cases of aircraft accident fatalities accessioned at the Armed Forces Institute of Pathology, who had over 500 hours of jet aircraft flight time, were examined by routine histologic and special stain methods. The results of this study are presented and discussed.

Long Term Weightlessness: Its Possible Effect On Cellular Metabolism.

CHARLES F. GELL, M.D., D.Sc., Vought Astronautics, Division Ling-Temco-Vought, Inc., Dallas, Texas.

The effect of long-term weightlessness on the metabolic function of cell structures in man have been discussed by physiologists in a casual vein since the early concept of manned space flight. The major interest has been directed to the systemic effects of this stressor as related to its effect on the labyrinth, cardiovascular and skeletal systems. The author believes that there is a possibility of more subtle effects at the cell level which may result in cumulative damage to man in long-term weightlessness. He also believes that observing cells in a weightless state throughout their life cycle of 36 to 72 hours may reveal conclusively whether occult cell physiologic disturbance exists. Knowledge of the effect of weightlessness at the cell level will, if negative, render assurance of the ability of man to withstand long-term weightlessness. Positive evidence of disturbed cellular metabolic processes will influence space ship design. The author discusses methods of accomplishing this type of study and believes it is necessary to avoid mistakes in related design concepts that may prove extremely expensive in the future.

Radar Target Detection Under White Collimated Lighting.

EDMUND C. GIFFORD, B.A. and JOHN LAZO, Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

In order to provide an optimal lighting system for CIC compartments, a comparative evaluation of different lighting systems is currently being performed. The present study concerns the effect on radar operator performance of collimated white lighting. The variables in this study include (1) light level, (2) ratio of target brightness to background brightness, (3) number of targets presented at one time, and (4) presence or absence of console lighting. The results indicate that of the variables studied, target brightness and lighting level are the most important. The whole problem of CIC illumination is thoroughly discussed and plans for future lighting evaluations are presented.

Status of Medical Facilities at United States Civil Airports.

JAMES L. GODDARD, M.D., Civil Air Surgeon, Aviation Medical Service, Federal Aviation Agency, Washington, D. C.

This paper will show the results of a survey by the Aviation Medical Service of the Federal Aviation Agency of medical and related facilities at 110 major civil airports in the United States. Highlights and deficiencies are presented and a comparison made between growth in the aviation industry and related progress in the medical support capability at civil airports. Planning for medical support at airports is discussed as well as the important role of local medical authorities in this airport planning.

Toxic Material Guidelines for Range Operation.

SIDNEY GOREN, CAPTAIN, MSC, USN, Bio-Science Office, Pacific Missile Range, Point Mugu, Calif.

For the man engaged in missile and satellite operations and development on the Range, experience with toxic materials will come in prelaunch handling and launch phases, in static tests and in the event of accidental failures or aborts. In routine prelaunch phases where environment can be controlled there is little need to deviate from presently established limits of exposure. In the matter of static testing of developmental projects we are groping in a rather grey area of toxicological effects. In the area of accidental aborts and failures we are working in total darkness as regards contact and exposures to possibly toxic components. The latter two phases require the development and adoption of a practical philosophy based on common sense to guide our range operations.

Maintenance of Cardiovascular Adaptability During Prolonged Weightlessness.

DUANE E. GRAVELINE, CAPT., USAF, MC, Biomedical Labora-

tory, Aerospace Medical Laboratory, Wright-Patterson AFB, Ohio.

It is expected that during prolonged zero gravity because of the absence of hydrostatic pressure influences, special techniques will be necessary to maintain cardiovascular adaptability and provide the orbiting astronaut with optimum tolerance for re-entry stresses. The author has devised a multiple tourniquet approach to intermittently obstruct venous return from the periphery, simulating the hydrostatic pressure effects of standing and thereby "triggering" compensatory cardiovascular reflexes. Following 6-hour periods of water immersion with tourniquet protection, the orthostatic tolerance of 5 subjects was determined and compared with that obtained following previous 6-hour immersion tests with no protection. The results are presented and discussed.

Nystagmus and Disorientation Reduction in Human Subjects.

F. E. Guedry, Jr., Ph.D., Capt. Ashton Graybiel, MC, USN, and W. E. Collins, Ph.D., U. S. Naval School of Aviation Medicine, Pensacola, Fla., and Federal Aviation Agency, Oklahoma City, Okla.

Nystagmus, disorientation and nausea were reduced in most subjects living and moving about for several days in a slowly rotating room. The reduced nystagmus was not reinstated by assigning "arousal-tasks" which are ordinarily effective in this respect. After rotation was stopped, residual effects were noted for several hours. These included compensatory nystagmus, compensatory illusory reactions and some motion sickness. Other subjects were exposed to similar circumstances for shorter periods wherein only restricted head movements in a particular plane were permitted. Nystagmus, illusory phenomena and nausea were reduced by this procedure. However the habituation did not transfer to forms of vestibular stimulation including head movements in an "unpracticed quadrant" which produce reactions similar in direction and plane to those repeatedly experienced during the habituation period. Residual effects from this shorter more restricted exposure were slight.

Head Mounted Electrocular Display: A New Display Concept for Specialized Environments.

Robert J. Hall, M.A. and James W. Miller, Ph.D., Hughes Aircraft Company, Fullerton, Calif.

The Electrocular Display is a lightweight optical device which consists essentially of a small cathode ray tube (CRT), a front surface mirror, a single lens and semi-reflecting eyepieces. The general purpose of this display is to permit an individual to receive a wide variety of information originating from any of several sources such as processed computer data, raw video, television, etc. Since the orientation of the display remains fixed with respect to the observer regardless of his position, it removes the postural constraints of conventional displays. When vibration or disorientation are present as in the case of low altitude, high speed flights or weightlessness, the displayed information remains stable and appropriately oriented with respect to the observer's visual system. The present prototype has been developed and evaluated through a series of human factors studies. The current research program includes three dimensional display and tracking applications, and monitoring and multiple task studies.

A Practical Issue in the Administration of a Motion Sickness Questionnaire to Flight Students.

Ens. L. E. Hardacre, MSC, USNR and Lt. jg. R. S. Kennedy, MSC, USNR, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

A motion sickness questionnaire was developed and validated on 100 subjects who had been exposed to a reliable test for measuring susceptibility to "canal sickness" on the Pensacola Slow Rotation Room. The reliability of the questionnaire was then ascertained under three conditions. Three forms of the questionnaire were administered to three groups. Forms differed in the kind of assurance given that this questionnaire would influence subsequent career possibilities. The results will be discussed not only in terms of the above variables but also in terms of the reliability of the test items.

Behavioral and Physiological Responses to Varying Periods of Sensory Deprivation.

Thomas D. Hanna, B.S., Neal M. Burns, Ph.D. and Perry R. Tiller, M.S., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa., and The Decker Corporation, Bala-Cynwyd, Pa.

The effects of 4, 8, 12, and 24 hours of reduced sensory stimulation on heart rate, electrical skin conductance, time estimation, digit span, sentence completion, draw-a-person, and visually presented amorphous figures were investigated using human subjects. Data analyses indicate (1) significant sources of variance attributed to personality differences among subjects, (2) lack of emergence of length of deprivation period as an overall dominant source of variance, and (3) certain response systems were more sensitive to deprivation than others.

Performance Effects in 17-Day Simulated Space Flights.

Bryce Hartman, R. E. McKenzie and B. E. Welch, School of Aerospace Medicine, Brooks AFB, Texas.

Eight subjects participated in pairs in 4 simulated space flights of 17 days' duration in the SAM Two-man Space Cabin Simulator. The flights were made at pressure equivalents of 33,500 feet altitude and 96% $+O_2$ levels. In addition to the management of logistical and environmental aspects of the flights, subjects were required to perform a psychomotor task consisting of several systems-type subtasks. Duty tours were either 2 or 5 hours long. Work rates

varied from very low (approximately 40 signals per hour) to high speed (more than 400 signals per hour). The day-vs-night dimension was also varied. The results did not demonstrate significant effects for length of duty period, day-vs-night, or duration of the flight. Significant differences in performance were obtained for signal rates, with marked decrement occurring at the very low work rates. These findings confirm tentative conclusions reported a year ago.

Evacuation Pattern Analysis of a Survivable Commercial Aircraft Crash.

A. HOWARD HASBROOK, J. D. GARNER, CLYDE C. SNOW, and VERLON HEAD, Civil Aeromedical Research Institute, Norman, Okla.

On July 11, 1961 a DC-8 with 122 passengers and crewmen aboard crashed and burned at Stapleton Field, Denver, Colorado. Impact forces were not sufficient to cause major structural damage or physically incapacitate persons aboard. Sixteen passengers were overcome by smoke and, unable to evacuate the aircraft, died in the ensuing fire. An analysis, based on statements of survivors, an on-scene investigation, and other sources, was performed in order to determine factors controlling the rate and flow of evacuation.

Relationships Between Operator Proficiency and Effected Changes in Biological Circadian Periodicity.

GEORGE T. HAUTY, PH.D., Civil Aeromedical Research Institute, Norman, Okla.

In a series of investigations designed to appraise modifiability of biological rhythms and corresponding changes in operator integrity, subjects were confined within the SAM one-man space cabin simulator for a period of 168 hours and, throughout this period, were committed to an 8-hour day of work and rest in place of the biological 24-hour day. The critical characteristics provided by such an environment consisted of a drastic reduction of physical and social circadian cues, and the critical characteristics of work in this case consisted of objective appraisals of the proficiency with which different functional operator tasks were executed. A full treatment of the psychological and physiological data to autocorrelation, power spectrum, and periodogram analyses provided mathematical expressions of the periodicities inherent in these data. These expressions, in turn, reveal intra- and inter-individual differences of significant magnitude. A given subject, for example, would evidence pronounced desynchronization, i.e., the different psychological and physiological functions were found to have differentially adjusted to the imposed 8-hour day. The differences between individuals were equally extreme. As would be predicted, circadian components were more pronounced when adaptation to the 8-hour day was more difficult as judged by the investigators and reported by the subject.

Dynamic Biomedical Monitoring.

W. M. HELVEY, M.D., G. A. ALBRIGHT, M.D., and I. AXELROD, A.E., Life Sciences, Republic Aviation Corp., Farmingdale, Long Island, N. Y.

The design and use of a lightweight solid state 15-channel PAM/FM biomedical telemetry system is described in which 14 channels have a frequency response of 0-100 cps and one channel 0-1000 cps for phonocardiography. The signal conditioning unit is designed in a modular concept to permit transmitting various physiological channels (e.i., EEG, EMG, EKG, GSR, Temperature and Respiratory Rate) on any channel by interchanging a series of 1/4 oz. modules. When operated with its own receiver, two-way communications, remote turn "on" or "off" and 7 channels of return stimuli are possible. Previous work with EKG telemetry in Republic's supersonic F-105 during maximal stress maneuvers is discussed along with the present multichanneled system under a variety of dynamic physiological states.

Concepts in Operational Support of Extreme High Altitude Flying.

MAJOR HARVEY W. HERTZ, USAF, MC, and MAJ. HENRY C. MORITZ, USAF, MC, School of Aerospace Medicine, Brooks AFB, Texas and San Pablo AFB, Spain.

Operational transition to aircraft capable of flight above fifty thousand feet has developed critical support requirement problems for many medical and line unit commanders. Increased physiological hazards are present in the aerospace environment, and pressure suits and other more complex equipment is required for protection. The ground and air abort rate for these missions might therefore be expected to be higher than for flight with conventional equipment at lower altitudes. Varied support measures have been developed to reduce mission failures from these factors. Those methods of sufficient value to be retained after the first three years' experience in an extreme high altitude flying program at Laughlin Air Force Base, Texas, are detailed in this report. Service statistics are summarized for medical and protective equipment problems occurring in more than 1600 weather reconnaissance training flights conducted in U-2 aircraft at altitudes requiring partial pressure suits. Less than 1½% of the scheduled missions were aborted because of problems in the man or his equipment. The incidence of dysbarism was extremely low, and all decompressions were successful. The interrelation of methods and results is discussed, stressing such factor as preflight fatigue, nutrition, integrated equipment checks, investigation of malfunctions, manpower requirements and medical treatment of routine illnesses. Emphasis is placed on the rationale of the methods employed to meet operational objectives.

Radiation Measurements Obtained From High Altitude Balloon Flights.

CAPTAIN RUDOLF A. HOFFMAN, USAF, VC, Aeromedical Field Laboratory Holloman AFB, N. M.

A series of high altitude balloon flights was conducted from bases in Northern Minnesota to measure the intensities and energies of solar-produced ionizing radiations. Measurements were made of protons and alpha particles, gamma radiation, and neutrons. The

radiation detection system was flown to altitudes of 130,000-137,000 feet and the data were telemetered and stored on magnetic tape for further data processing, reduction and analysis.

Respiratory Response to Whole-Body Vertical Vibration.

GEORGE N. HOOVER, PH.D. and W. F. ASHE, M.D., Department of Preventive Medicine, The Ohio State University, Columbus, Ohio.

Human subjects were exposed to whole-body vertical vibration in the seated position. The vibration frequencies were 2, 4, 6, 8, 11 and 15 cps at amplitudes of .0625 and .125 inch. The peak accelerations of vibration were from ± 0.03 to ± 2.88 G. Respiratory frequency was not altered significantly by these levels of vibration. Tidal volumes were increased in all but the three lowest vibration intensities. At the lower amplitude respiratory minute volume was not drastically altered. At 8, 11 and 15 cps in the higher amplitude vibrations considerable increase in $\dot{V}$ was noted. The greatest increase in $\dot{V}$ was seen at 11 cps, the postulated resonant frequency of the lung-thorax system. Oscillations of pneumotachograph tracings were found to coincide with the vibration frequency and in the higher frequencies appear to be greater than the amplitude of the respiratory flow itself. It is suggested that much of the increase in ventilation is a result of a forced hyperventilation and is most significant at the resonant frequencies of the chest-lung system.

Effects of Space Vehicle Vibration Upon Human Occupants.

RICHARD J. HORNICK, PH.D. and ROBERT W. COSTIN, B.S., Bostrom Research Laboratories, Division of Bostrom Corporation, Milwaukee, Wis.

It is known that various space vehicles vibrate, especially during periods of launch and re-entry. The characteristics of such vibration are mentioned. Possible effects of this vibration on man's performance and physiological functions are discussed based upon research conducted on humans. Effects on performance include those of compensatory tracking ability, vision, reaction time, and body equilibrium. Physiological measures include oxygen consumption, breathing rate, and total ventilation. Attention is also given to combinations of motion, body support positions, and the relationships of performance, physiological responses, and mechanical response of the human body.

The Effects of Gas Composition and Acceleration Vector Upon Lung Volumes.

ALVIN S. HYDE, Ph.D., M.D., CAPT. JOSEPH PINES, USAF, MC and MAJ. ICHIRO SAITO, JASDF, MC, Aerospace Medical Laboratory, Wright-Patterson AFB, Ohio, and Aeromedical Laboratory, Tachikawa, Japan.

The effect on lung volumes of breathing air versus breathing 100% O_2 was investigated at ambient pressures on the human centrifuge facility of the Aerospace Medical Laboratory. The vectors of acceleration of interest were "positive G" ($+3.0$ -3.5 G_z) and "forward acceleration" ($+6.0$ G_x), each for three minutes. The combinations of these events and of the use of anti-G-suits upon lung volumes are discussed in terms of weighted causality with regard to the severe (greater than 50%) reductions in vital capacity noted after accelerations when anti-G-suits, 100% O_2 and acceleration were present.

Implications of Cellular Biology to Space Travel and Industrial Medicine.

JAMES P. ISAACS, M.D., JOHN C. LAMB, M.D., and WILLIAM R. BREWSTER, JR., M.D., The Johns Hopkins University School of Medicine and the Johns Hopkins Hospital, Baltimore, Md.

A brief outline is presented of a cell as an energy transducer with the electron and proton as signal carriers. The relationship of cellular organelles, membranes, and water in a series of working systems will be sketched. The special roles of vitamins, trace metals, and hormones in the establishment and control of a balanced enzymatic circuitry will be commented upon. The periodic table of elements will be briefly discussed as the background for cellular biology. An attempt will be made to relate the especial properties of carbon and of water and its components to cell structure and function. The implications of a number of influences upon the cell, including radiant energy, electromagnetic, electrostatic, and gravitational fields, catalytic inhibitors and carcinogenic stimulators from space travel and industry will be considered.

One Hundred Years of Hypoxia.

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Since 1862 when Glaisher and Coxwell first reported their experience during a balloon ascent, aeromedical literature has contained numerous reports of deaths due to hypoxia. In spite of continued investigation and extensive indoctrination of aviators by Aviation Medical Personnel, this insidious killer has continued to claim the lives of a few of those who fly at high altitude. Details of several recent episodes of hypoxia in military aviation, together with a recording of the actual radio transmissions which demonstrate the onset of hypoxia, will be presented. The role of personal oxygen equipment, aircraft oxygen systems, and human engineering as factors in these episodes will be discussed. The need for the development of adequate hypoxia warning devices is stressed and recommendations for the prevention of similar episodes are made.

Abolition of Effective Temperature Regulation in Cats by Preoptic Lesions.

F. H. JACOBSON, Ph.D. and R. D. SQUIRES, M.D., Aviation Medical Acceleration Laboratory, U. S. Naval Air Development Center, Johnsville, Pa.

Electrolytic destruction of the medio-caudal preoptic region abolished effective temperature regulation

in 11 cats until the animals died or were sacrificed as long as seven months after operation. Eight animals not housed in an incubator reached mean colonic temperatures 3-10 standard deviations below the mean of 12 unoperated cats. At ordinary room temperatures ten animals exhibited day-to-day variance of colonic temperature 5-39 times the mean variance of the unoperated animals. The eleventh cat reached a colonic temperature of 22.5 deg C the day after operation and died after being rewarmed. All animals tested at extreme ambient temperatures showed impairment in the responses to both heat and cold. Two cats with anterior hypothalamic lesions, two with medio-rostral preoptic lesions, and one latero-caudal preoptic lesion, were unimpaired in their ability to regulate at normal or extreme ambient temperatures.

The Effect of Training Plane Type on Jet Pilot Performance.

LIEUTENANT (JG) J. H. JOHNSON, MSC, USNR, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

Six experimental sequences and combinations of training in propellor aircraft and in jet aircraft were compared. The measure of their effectiveness is the relative performance of matched groups of students in advanced jet aircraft training subsequent to the experimental syllabi. The evidence generally supports the notion that the performance of students who received jet training relatively early tends to be superior later.

The Effect of Decreased Barometric Pressure on Oxygen Consumption.

LOUIS F. JOHNSON, JR., LT. COL., USAF, MC, J. RYAN NEVILLE, Ph.D., and RICHARD W. BANCROFT, Ph.D., Physiology-Biophysics Branch, USAF School of Aerospace Medicine, Brooks AFB, Texas.

There have been conflicting reports in the literature concerning the effect of decreased barometric pressure on oxygen consumption, some reports citing a decrease in consumption, others citing no change in consumption. The oxygen consumption of healthy males was measured at several different barometric pressures in an altitude chamber. Preliminary data suggest that if there is a change in oxygen consumption at decreased barometric pressure, it is an increase in consumption. The findings will be discussed in regard to possible and probable causes of any differences in oxygen consumption due to decreased barometric pressures.

Some Effects in Monkeys of Exposure to a High-Intensity Noise Field.

W. H. JOHNSON, RCAF Station Downsview, Toronto, Canada.

One death and a few instances of dangerous confusion (disorientation) have been reported among ground-crew exposed to high-intensity noise. In order to determine whether or not noise was a contributing factor, some experimental animals have been tested in jet engine test cells to determine the possibility of functional or anatomical damage involving the auditory and non-auditory labyrinths. Eight monkeys were exposed to two types of jet engines used by RCAF aircraft (CF-100 and CF-104). The animals were observed and photographed during the exposures, and histological sections made of the temporal bones postmortem. Although additional work must be done before conclusions can be drawn clinical evidence of disorientation and nausea has been obtained, as well as evidence of temporary and permanent damage to hearing.

Objective and Subjective Manifestations of Coriolis Acceleration on a Slowly Rotating Room.

W. H. JOHNSON, PH.D., CAPT. ASHTON GRAYBIEL, MC, USN and LIEUT. J. C. MEEK, MC, USNR, Defence Research Medical Laboratories, Toronto, Canada, and U. S. Naval School of Aviation Medicine, Pensacola, Fla.

The Slow Rotation Room at Pensacola (Aerospace Med., 32:321-327, 1961) has been used to determine reactions associated with stimulation of the human non-auditory labyrinth. A head-mounted camera has been used to obtain records of eye movements during the vestibular stimulation. These records will be discussed together with other techniques for determining changes in thresholds of vestibular sensitivity. Application to aerospace medicine will be discussed.

Vestibular and Optokinetic Factors in the Perception of Rolling Maneuvers.

G. MELVILL JONES, Aviation Medical Research Unit, McGill University, Montreal, Canada.

Pilots have complained of experiencing disorientation whilst flying on instruments, due to recurrent illusions of turning and banking which are always manifest in the same direction. Normal clinical examination of one of these pilots revealed no causal pathology. Laboratory examination of the nystagmus and duration of turning sensations resulting from rotational stimuli in "horizontal" and "rolling" planes revealed asymmetric responses which could well account for the in-flight illusions. In addition, this pilot was aware of marked generalized muscular tension when experiencing the illusion in flight and in this connection it was interesting to find unusually high levels of muscular activity when performing a simple control task in the laboratory. The causes and interactions of the illusion and muscular tension will be discussed in relation to the difficulty of the task.

Fatigue in Intercontinental Jet Service Crews.

GÉRARD JUIN, M.D., and PIERRE PINEAU, M.D., Paris, France.

Because of the noticeable increase in fatigue seen and described among commercial aviation crewmembers since the start of intercontinental, four-engine jet service, the authors, together with a team of specialists from the hospitals in Paris, undertook a medical inquiry for the purpose of rendering this abnormal fatigue, in personnel aboard these four-engine jet planes, more objective, more quantitative, and more precise. The authors describe this investigation which delves

into the clinical, biological, physiological, and ophthalmological areas. The authors report on the general results of investigations made on blood pressure. They show the variations in blood pressure recorded on 11 crews of jet aircraft and on 2 crews of conventional aircraft, or a total of 136 subjects. Three hundred and sixteen pressure measurements have been taken on jet-propelled planes, 42 on the conventional type. Although for the latter no significant variations are present, in jet planes there appears a decrease in maximum pressure and an increase in minimum pressure. This assumes particular importance when considered with the biological, bio-hormonal, and ophthalmological changes also recorded. The authors also report the results of the ophthalmological studies bearing on the variations in heterophorias during jet flights and comparing them with changes brought about in conventional planes. They also point out the condition and variations in strength of convergence and divergence in crewmen of the same aircraft. In addition, the authors, in the name of their team of investigators, point out the results obtained during the same study which deal with the endocrine and metabolic conditions, carried out in jet aircraft as well as in the conventional type. In conclusion, during these concise analyses, the authors try to formulate a policy as to the supervision of crew personnel and to locate sources of difficulty in commercial jet aircraft. This medical investigation, which has been followed for several months in France, as far as is known seems to be the only one of its type carried out anywhere, up until now, in commercial aviation.

Analyses of Human Motions in Orbital Space.

DUANE F. KASTEN, Ph.D., Behavioral Sciences Laboratory, Aeronautical Systems Division, Wright-Patterson AFB, Ohio.

A qualitative review is made of some seldom considered human factors problems which may confront a weightless worker in a space environment. Discussions are based on inflight zero gravity research, mathematical analyses of human motion in earth orbits, and computer simulation studies of orbital rendezvous. Topics covered include: human locomotion and rotation in a weightless, frictionless environment; human factors and engineering considerations for the design of rotating space stations; problems involved in tethering a space worker to his vehicle; and some misconceptions about the weightless state. Some implications are suggested for future space efforts.

Studies of Skin Temperature Responses to Simulated Thermonuclear Flash.

W. C. KAUFMAN, CAPT., USAF, H. T. DAVIS, LIEUT., USAF and A. G. SWAN, MAJ., USAF, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

The tolerance of a subject in a tactical aircraft exposed to a thermal energy flash characteristic of thermonuclear weapons has been determined. During a 3.5 second pulse of 3.0 cal/cm^2, simulating the flash of a 5 megaton device, forehead skin temperature reached 126° F. These studies have been extended with four subjects exposed to thermal energy produced by a programmed 6000 kilowatt source powering 900 lamps. The thermal yields of 1 to 5 megaton weapons have been simulated by pulses of 3 to 7 seconds duration with energy peaks at 1 to 3 seconds. Skin temperature of forehead and hand, and subjective pain response determined limits of tolerance.

The Validity of Tests of Canal Sickness in Predicting Susceptibility to Air Sickness and Sea Sickness.

LIEUT. (jg) R. S. KENNEDY, MSC, USNR and CAPT. ASHTON GRAYBIEL, MC, USN, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

A test for measuring susceptibility to canal sickness has been developed under controlled conditions utilizing the Pensacola Slow Rotation Room. The purpose of the present investigation was to compare the susceptibility to symptoms in the Slow Rotation Room with the susceptibility to air sickness and sea sickness. The findings are discussed in terms of these relationships and in terms of thresholds of sensitivity of the semicircular to caloric stimulation.

The Bear as an Experimental Animal.

CAPT. FRANK W. KIEL, MC, USA, MAJ. J. R. HALSTEAD, USAF, VC and COL. F. M. TOWNSEND, USAF, MC, Armed Forces Institute of Pathology, Washington, D. C.

The bear was chosen as the test animal in the development phase of the B-58 escape capsule. This animal was selected because of the essential similarities to man, namely, spinal characteristics, erect posture, and large size. The Armed Forces Institute of Pathlogy provided the pathology support for this endeavor. Eight bears were used in this series of tests and were exposed to various attitudes and decelerative forces. Five of the bears came through the tests well, two had traumatic lesions, and one bear was unsuitable, having congenital hydrocephalus. Complete autopsies were done on all animals, and no difficulty was encountered in interpretation of anatomy or lesions. It appears the bear would be a suitable test subject in lieu of man in a variety of mechanical and safety experiments.

Environmental Problems of an Air Force Missile Test Facility.

CAPT. OWEN H. KITTILSTAD, USAF, MSC, Edwards AFB, Calif.

The use of large quantities of extremely toxic, corrosive, explosive, and flammable propellants in rocket propulsion systems presents many potentially hazardous conditions in their use and handling. This is particularly true at a rocket test facility when very often there is not sufficient information available to describe the hazard potential of new research and development propellants. Also, to be feasible as rocket propellants, methods must be developed for handling them safely. This paper describes environmental problems encount-

ered at a facility engaged in the development and testing of high energy rocket propulsion systems. Experimental programs to obtain necessary hazards data for developing design and handling criteria are discused.

Oxygen Recovery by the Catalytic Dissociation of Carbon Dioxide.

J. J. KONIKOFF, B.S., General Electric Space Technology Center, Philadelphia, Pa.

The continued investigation of physico-chemical methods for the recovery of oxygen from carbon dioxide has revealed a problem arising from the application of a previously selected ranking approach, the Fischer-Tropsch synthesis. The difficulty stems from the second by-product of this reaction, methane. In order for the synthesis to result in a truly regenerative oxygen recovery system, a suitable reaction must be found which will strip the hydrogen from the methane in order that a sufficient quality of H_2 is made available for the basic reaction with CO_2. Unfortunately, a straight forward method has not been found. Consequently another technique has been selected for additional investigation, and found to be clearly superior in meeting the overall requirements of an oxygen recovery system for manned space flight. The approach is based upon the catalytic dissociation of carbon dioxide at reduced pressures and is noteworthy in that it: (a) requires 1/3 less energy input, (b) utilizes space vacuum, (c) is less complex than the hydrogenations reactions, (d) does not require additional reactants. This paper describes in greater detail the reaction, the utilization of all by-products thus forming a closed cycle, and its applicability to space flight.

The Carotid Pulse Wave Response to Compression of the Carotid Artery In Patients With and Without Coronary Artery Disease.

LOUIS R. KRASNO, M.D. and GEORGE J. KIDERA, M.D., United Air Lines Medical Department, San Francisco, Calif.

Upon manual compression of the carotid artery, patients with coronary artery disease show an improvement in the carotid pulse trace whereas those without coronary artery disease show decremental changes. However, in certain instances, the "coronary" response is obtained in the absence of clinical coronary artery disease. The question arises whether this latter response is due to subclinical atherogenic pathology and whether this procedure has possible merit in the identification of "coronary-prone" individuals. All normal individuals with "abnormal" responses are being followed on a long term basis and other measures of coronary artery disease will be correlated with this procedure to provide an answer to this question.

Medical Problems of a Composite Air Strike Force.

LT. COLONEL MARSHALL Y. KREMERS, USAF, MC, Seymour Johnson AFB, N. C.

Medical problems of this Force are peculiar to a rapidly moving group of combat air units of various types which form a part of a larger task force. In addition to the usual problems of combat forces deployed to any theater of operations are those of long over-water flights in single seater, high performance aircraft, aeromedical evacuation from combat areas and cooperation of the medical units of the uniformed armed services. Consideration must be given to operations in primitive areas where the best preventive medicine must be practiced to ensure successful completion of the mission. Mobility places a premium on constant preparedness of personnel and on a minimum of light weight medical equipment. Collection and compilation of medical intelligence is necessary for plans and operations in any geographical area.

Observations on the Relationships Between Human Acceleration End Points and the Centrifuge Acceleration Pattern.

G. H. KYDD, Ph.D., R. L. FENICHEL, Ph.D. and R. J. CROSBIE, M.S., Aviation Medical Acceleration Laboratory, U. S. Naval Air Development Center, Johnsville, Pa.

Nine human subjects were centrifuged on the 50-foot centrifuge according to a pattern used previously with monkeys. A total of 141 runs was made yielding 15 end points for peripheral light loss and unconsciousness. Analysis of the records showed that only one of the end points occurred later than 15 seconds, and a cinematographic record made during the runs showed that the subjects strained hardest during the initial period of the run whether or not an end point was reached. Accordingly, the hypothesis is advanced that the occurrence of an end point is dependent upon the time derivative of the onset acceleration.

Prolonged Ozone Inhalation and its Effects on Visual Parameters.

JOHN M. LAGERWERFF, M.D., Bioastronautics Department, The Marquardt Corporation, Van Nuys, Calif.

Supersonic commercial aircraft of the near future will be flying at altitudes well within the Ozonosphere. The outside atmosphere will remain the agency of choice for cabin pressurization and ventilation. It is expected that even after having been compressed, this air will contain a significant concentration of unchanged ozone. In order to determine if prolonged exposure to such ozone concentrations has any effects on the visual parameters of flight personnel, twenty-eight volunteers were exposed to ozone concentrations of 33, 58 and 83 parts per hundred million, by weight, in three and six hour periods, for a gross total of 709.75 hours. Comparison of pre and post exposure data obtained from three hundred and two vision test batteries, comprising a total of 3,426 separate tests, indicated significant changes in lateral phoria, divergence, convergence, peripheral vision and night vision in the majority of subjects. These effects are considered to constitute a possible safety hazard for future commercial aviation.

An Examination of Certain Aircrew Selection Standards in NATO Nations.

COLONEL (MC) ERWIN A. LAUSCHNER, German Air Force, Chief, Medical Advisory Staff, Headquarters Allied Air Forces Central Europe (AIRCENT), FONTAINEBLEAU, France.

The role of Headquarters AIRCENT in the chain of NATO Commands and the terms of reference of its Medical Advisory Staff are briefly outlined. The main items of this year's Annual Medical Conference have been studies of the Aircrew Selection Standards of the nations having aircrew assigned to AIRCENT. This comparative study not only considered the standards actually in use, but also, and in particular, recent or intended changes as well as the main reasons for these changes. The study was limited to four aspects: (a) Vision, (b) Otorhinolaryngology, (c) Some main subjects of general physical conditions and internal medicine, (d) The often controversial specialties of psychiatry and psychology. Three or four speakers of different nationality presented papers in each of the first three categories, one of them being asked to co-ordinate all papers in his specialty and to lead the open discussion. For the session dealing with the approach to Aircrew Selection by the psychiatrist or psychologist only two speakers read papers. The co-ordination, rather difficult but very important, was presented in a third paper by an experienced flight surgeon and was followed by a very intense discussion from the floor. The main results of the foregoing study are discussed separately for each category. Highly qualified speakers from USAF, USN, French AF, R-Neth. AF, Belgian AF, R.A.F., and German AF have contributed to produce useful results. Some differences still exist in details but there is a remarkable degree of accord in the basic principles, in particular where changes are considered necessary by the introduction of new types of aircraft. The results of the psychiatric/psychological session reveal a particular interest, as this broad and very important field is very often controversial. The limitations and the principles of a sound application of both specialties for the benefit of aircrew selection have been fully discussed. The intention of this paper is not only to give a summary report on the Conference but to come to a synthesis of some problems considered to be important, in order to provide general advice and guidance.

On Synchrony of the Alpha Rhythms.

RAPHAEL B. LEVINE, Ph.D. and RICHARD P. SMITH, Ph.D., Human Factors Research Laboratory, Lockheed-Georgia Company, Marietta, Ga.

Speculations on alpha rhythm function concern their origin (whether in individual neurones or in alpha centers), their possible control of neural "tone", and their co-ordination of vigilance and information-handling processes. The synchrony exhibited by these rhythms is important to all such speculations, and other investigators have shown that synchrony exists to a significant degree. This study was designed to yield quantitative information on the degree of synchrony, and a new instrument, the "Vector Electroencephalograph" was used. This instrument presents, in a single pattern, the total electrical activity of the brain, referred to an equivalent central dipolar source. Patterns indicating an astonishingly high degree of synchrony throughout the brain have been obtained. During such alpha "bursts," intrabrain phase shifts were about 5 milliseconds per second, or less.

The Appraisal of Fearfulness.

LIEUT. (jg) A. A. LONGO, MSC, USNR and LIEUT. (jg) R. E. DOLL, MSC, USNR, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

Changes in two presumed indicants of emotional stress, pulse and eye-blink rate, were measured on 225 aviation cadets in three different, physically threatening situations. The three threatening situations were: just prior to the taking of the blood sample, to being fastened into the Dilbert Dunker (a training device for underwater aircraft escape), and to entering the low pressure chamber (which simulates altitude at 20,000 feet). Peer ratings on anxiety proneness were obtained after 7 weeks of close association in the pre-flight program. Intercorrelations among pulse change, blink change, and the peer rating scores indicate: significant consistency in pulse change, but not blink change, in two out of three threatening situations; and a significant relationship between blink rate change and peer ratings of anxiety proneness in one situation.

Optimization of Space-Vehicle Design with Respect to Artificial Gravity.

BENJAMIN J. LORET, M.S., Major, USAF, Aerospace Medical Laboratory, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

A design envelope and the optimum vehicle configuration are established through a human-factors analysis of the artificial gravity environment peculiar to rotating space vehicles. The envelope is prescribed by: an upper limit on vehicle angular velocity of 0.4 radians/sec to minimize occurrence of "canal sickness"; an upper limit of one "g", and a lower limit of 0.2 g to permit unaided walking, both limits modified to compensate for Coriolis effects; and a practical upper limit on vehicle radius of 180 feet. The optimum configuration is characterized by a single cylindrical crew compartment oriented parallel to the spin axis, counterbalanced by other vehicle components. The configuration is illustrated in the conceptual Pseudo-Geogravitational Vehicle of 180-foot radius, rotated at 0.4 radians/sec to produce 0.9 g in the crew compartment.

Machine Models of Man: Review and Implications for Aerospace Technology.

LT. BERTRAM, H. LOWI, MSC, USN, and CAPT. ROBERT L. BURDICK, MC, USN, Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

Extensive parallels have been drawn between the behavior of man and the automated action of machines man has created. Should these models of man prove to be valid, some interesting implications follow. Man, as a viable and self-programming computer is ultimately susceptible to the random inputs of his environment. In a long duration space vehicle, isolated from the usual consensus of his native surroundings (environmental and social), man's behavior may be expected to evolve into patterns altogether different from those upon which the man-machine system was predicated. A general review of machine models of man now in vogue is presented, from which the authors speculate uninhibitedly.

A Lead System and Electrode Design for a Dynamic ECG.

GEORGE G. LUCCHINA, M.D., MS and CLIFFORD G. PHIPPS, Bio-Medical Division, U. S. Naval Missile Center, Point Mugu, Calif.

Demands have come, in recent years, from both military and civilian spheres for an accurate system of monitoring ECG's with the subject in a dynamic state. This paper presents a lead and electrode system that is being utilized with telemetry and magnetic tape recording system to achieve this end. The authors propose a torso lead system involving the common terminal concept, which is relatively free of muscle artifacts and gives accurate orthogonal representation of electrocardiac activity in the three major axes. In addition, the common terminal allows unipolar exploration and monitoring from any area of the torso including representations of the conventional unipolar chest leads, if desired, in the dynamic state. Also presented is a new physiologic electrode relatively free of movement and pressure artifact, which is not impeding to the activity of the subjects. These electrodes may be left in place continuously over extended periods of several days without special attention to maintain performance and without decay of characteristics or undue discomfort to the subject. This system has been thoroughly tested and successfully used in inflight monitoring of the ECG of pilots and radar operators flying high-performance Navy aircraft. It is suggested that the above system may be used in performance of exercise tolerance tests and prolonged monitoring of cardiac patients as well.

Dysbarism: A Review of 35 Cases With Suggestion for Therapy.

CAPT. WILLIAM G. MALETTE, USAF, MC, JOHN B. FITZGERALD, M.D., and CAPT. ABRAHAM T. K. COCKETT, USAF, MC, School of Aerospace Medicine, Brooks Air Force Base and USAF Hospital Lackland, Lackland AFB, Texas.

This study was undertaken in response to the demand for a clearer treatment regimen in cerebrovascular collapse at altitude. Thirty-five serious cases were reviewed. The pathologic physiology on the basis of clinical findings is reviewed. It was found that the mortality was 45%, an excessive mortality possibly due to misdirected therapy. A large primary plasma deficit was seen in all cases. A working hypothesis and rationale for treatment will be outlined.

Disposition of the Flyer Who Faints.

COLONEL WILLIAM C. MARETT, USAF, MC, Aerospace Medicine Division, Office of the Surgeon General, Washington, D. C.

Flight Surgeons have traditionally regarded fainting in a flyer as a serious matter. In the USAF only three causes have been allowed as far as continuing flying is concerned: 1. Pain following a severe injury, 2. During convalescence from an acute infection or serious illness, and 3. Severe blood loss. Recent work has shown that fainting especially in young flyers is more common than suspected, that it is usually due to multiple stress factors and that one or two isolated episodes of syncope do not necessarily denote syncope proneness. The methods of evaluation and disposition of USAF flyers who faint are discussed. The mechanisms of the production of syncope and means of preventing it are also discussed.

Relative Motion of Elements in Information Displays.

W. G. MATHENY, PH.D., D. J. DOUGHERTY, PH.D., and J. M. WILLIS, B.S., Bell Helicopter Company, Fort Worth, Texas.

This paper summarizes the present thinking and conclusions on the problem of motion relationships among elements of visual displays for closed loop control systems. Results of recent experiments on the effect on display interpretation of the addition of body motion cues are presented and the importance of such kinesthetic cues in evaluation of display designs is discussed. The "outside-in" versus "inside-out" display controversy is examined in the light of findings from experiments in the dynamic (cockpit motion) simulator.

Aeromedical Aspects of Supersonic Pilot Training.

LT. COL. JOHN P. McCANN, USAF, MC and CAPT. CLIFFORD L. MAYHEW, USAF, MC, Office of the Surgeon, Headquarters ATC, Randolph Air Force Base, Texas.

The history of Pilot Training in the United States is traced from the inception of flight in heavier-than-air craft. Included is the preliminary experience in the Northrup T-38 which was designed to provide the Air Training Command with a lightweight, economical, basic trainer capable of training pilots in the operation of a supersonic aircraft. From March, 1961, through March, 1962, a special Test Force of pilots and support personnel at Randolph AFB, Texas, determined the operational capability and suitability of the T-38 for this purpose. A portion of this program was the initial USAF basic pilot training of a test class of twenty-six student pilots who had just completed their primary training in the Cessna T-37 at Webb AFB, Texas. Observations were made on the aeromedical aspects of this program, with special reference to human factors items in a supersonic aircraft and to the adaptability of such an aircraft to the training of relatively inexperienced student pilots.

Appropriate conclusions and recommendations are made as a result of these observations.

An Evaluation of the Electroencephalograph During Acrobatic Flight.

SURG. LIEUT. CDR. D. C. MCNUTT, Royal Navy, HARLOW W. ADES, Ph.D., S. N. MORRILL, Electronics Scientist, LIEUT. A. B. HEADLEY, USN, U. S. Naval School of Aviation Medicine, U. S. Naval Aviation Medical Center, Pensacola, Fla.

Three groups of subjects were exposed to a standard acrobatic sequence in an attempt to evaluate the electroencephalogram during an "activating" procedure such as flight. The groups compared were inexperienced, and experienced aircrew, and aircrew who had been referred for evaluation after incidents such as loss of consciousness in the air. It was found in this latter group that a higher percentage of abnormalities were produced in the electroencephalogram during flight than on the ground. Typical tracings taken from subjects during the flight sequence will be discussed.

Effect of Altitude Upon Tolerance to Vibration Stress.

H. MEGEL, Ph.D., H. WOZNIAK, B.S., E. L. FRAZIER, B.S., and H. C. MASON, Ph.D., Bioastronautics Section, The Boeing Company, Seattle, Wash.

Restrained adult male rats of a Sprague-Dawley strain were exposed to a constant vibration stress (60 cps-15 g) at varying altitudes. Using lethality as an index of tolerance, exposure of animals to vibration and altitudes less than 10,000 feet resulted in an incidence of lethality which did not differ from that observed for vibration alone. Above 10,000 feet, the per cent mortality increased as a function of altitude even though exposure to these altitudes *per se* were sub-lethal. It was demonstrated also that the increased lethality resulting from simultaneous exposure to the combined environments was caused by the reduced partial pressure of oxygen rather than the reduction in barometric pressure. Massive lung hemorrhage and severe intestinal damage were found in those animals succumbing to the combined environments. The possible causes for the enhanced mortality will be discussed.

Noise Exposure and Individual Alterations in Middle Ear Muscle Reflex Activity.

EMANUEL S. MENDELSON, A.B., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

Manometric recordings of tympanic membrane displacement indicate fairly consistent stimulus-response relationships in most subjects when the auditory reflex is elicited acoustically. In one subject the loud sounds needed for testing resulted in phasic, spontaneous displacement resembling clonic spasms of the tensor tympani; in several others who had been exposed to gunfire noises chronically the testing sounds seemed to induce persisting, tonic contraction of at least the stapedius muscle, associated with elevation of the reflex threshold and with development of more phasic reflex patterns. The relationships observed with a battery of auditory variables suggest that methods may be attainable for assessing: (1) the capacities and deficiencies of the middle ear muscles as sound attenuating organs, and (2) the individual needs for extraneous ear protection when exposed to hazardous noises.

Crew Accommodations for Aerospace Missions.

C. A. METZGER and A. B. HEARLD, B.S., Aerospace Medical Laboratory, Wright-Patterson Air Force Base, Ohio.

The results of research by the Aerospace Medical Laboratory on techniques and devices for crew accommodation for use in a weightless environment, which would exist in an earth-orbiting vehicle, are presented. New and unique methods for storing human wastes, with and without chemical treatment, in sealed containers are described. Specialized techniques for bathing, shaving, oral cleansing, laundering, and nail and hair care are reviewed. Gravity-independent procedures for storing, preparing, preserving, and dispensing of foods are presented. The problems of weightlessness and the integration of the accommodations are discussed. Laboratory models of components required for food storage and serving, refrigeration, waste collection and disposal, and personal hygiene and sanitation are described. Feasibility of the techniques and experimental devices will be studied in a 3-man 14-day test in a laboratory life support system evaluator.

The Effect of Microwaves on the Response to Ionizing Radiation.

S. M. MICHAELSON, D.V.M., R. A. E. THOMSON, M.T., W. J. QUINLAN, B.S., MAJ. L. T. ODLAND, USAF, MC, W. J. KRASAVAGE, B.S., and J. W. HOWLAND, Ph.D., M.D., Department of Radiation Biology, University of Rochester School of Medicine and Dentistry, Rochester, N. Y.

Modification of the response to ionizing radiation has been sought for purposes of protection of civilian and military personnel, astronauts, and patients during therapeutic irradiation. Pharmacologic protection by chemicals, even if eventually found to be effective in man, suffers in that they must be given immediately before the irradiation and present in active concentration in the organism during the irradiation. The interaction of different forms of energy resulting in antagonism or modification of response in the organism is a recognized biological phenomenon. Evidence has been obtained that dogs exposed to a physiologically tolerated level (100mw/cm^2) of pulsed microwaves (2800 Mc/sec) are less sensitive to ionizing radiation than animals not previously pretreated with microwaves. Lethality after whole body ionizing radiation is reduced depending on duration of previous microwave exposure. Survival time after head irradiation of 25,000 r is increased from 22 $\pm$ 1.37 (mean $\pm$ s.e.) to 43 $\pm$ 6.7 hours. Simultaneous

exposure to ionizing and microwave irradiation at a sublethal level results in earlier leucocytic recovery than is seen after ionizing radiation alone. The specific use of microwave exposure techniques for protection against ionizing radiation during manned space flight can be inferred from the data presented. The results suggest that additional work be carried out with consideration of time-intensity factors, thus permitting the evaluation of these procedures in modification of injury from ionizing radiation exposure.

A Comparison of Autokinesis in Normal Persons and in Persons With Labyrinthine Defects.

LT. E. F. MILLER, II, MSC, USN and CAPT. ASHTON GRAYBIEL, MC, USN, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

A method of continuously recording autokinesis is described. Test-retest reliability was found to be 0.97 and 0.80 for nine normal and nine labyrinthine-defective Ss, respectively. The magnitude of apparent movement of a stationary point of light in a dark field appeared to be independent of body position (upright, lying on left side). In both body positions the group of anomalous subjects on the average reported significantly more illusory movement than a comparable normal group. Individual differences in both groups were considerable.

Accuracy of Orientation and Positioning in Homogeneous Visual Fields.

JAMES W. MILLER, Ph.D. and ROBERT J. HALL, M.A., Hughes Aircraft Company, Fullerton, Calif.

Although many studies have been conducted recently pertaining to stimulus impoverishment, few have been concerned with the problem of visual orientation in the absence of retinal stimulation. Recent studies, completed by the authors, have shown that the individual possesses a surprising amount of accuracy with respect to the positioning and re-positioning of objects in an illuminated or darkened homogeneous visual field. The data indicate that the accuracy achieved is due to an internal bodily reference system exclusive of any external co-ordinate system. In addition, the data suggest that in the absence of a stimulus background, information can be displayed effectively and arranged in terms of the observer's internal co-ordinate system. The results will be discussed in terms of their theoretical implications and with respect to the role of the visual system in high altitude and orbital rendezvous.

Physiological Support in the Strategic Air Command—A 3½-Year Summary.

MAJOR HENRY C. MORITZ, JR., USAF, MC, MAJ. HARVEY W. HERTZ, USAF, MC, and MAJ. MYRON J. WOLTJEN, USAF, MC, 3973d USAF Hospital, APO 284, New York, N. Y. and Aerospace Medical Center, Brooks Air Force Base, Texas.

Strategic Air Command experience with the epidemiological approach to providing medical support for flights at altitudes in excess of 50,000 feet is presented. Data from 6,725 flight records reflecting 4,408 flights over a 3½-year period are presented. Staffing figures for this type of support and experience factors, including the useful life of the partial pressure suit and related equipment, are discussed, as is dysbarism incidence, number of aborts by type, in-flight emergencies and fatalities. The influence of in-flight aircraft environments upon aircrew protective equipment and compatibility with operational requirements is emphasized. The adaptability of the current Strategic Air Command Aerospace Medicine Program is delineated.

Rapid Weight Reduction for Aircrews.

MAJ. PAUL W. MUSGRAVE, USAF, MC, Preventive Medicine Branch, School of Aerospace Medicine, Brooks Air Force Base, Texas.

Weight reduction for aircrews is problematic because dietary denial is incompatible with flying stresses. This feasibility study examines the physiologic responses to extreme low-calorie intake combined with amphetamine medication. Subjects were able to lose weight at a rate of one-half pound daily with comfort and evident safety. This study serves to establish weight reduction as a specific medical therapeutic procedure as contrasted with conventional concepts of dietary discipline. Proper orientation and education of the patient appears to be the most important single factor in the rapid weight reduction program. Fifty subjects in this study were reduced an average of twenty-eight pounds per subject in fifty-six days with no significant adverse symptoms, physical or laboratory findings.

1960-61 Himalayan Scientific and Mountaineering Expedition. I. USAF High Altitude Physiological Studies.

THOMAS O. NEVISON, JR., M.D., JAMES E. ROBERTS, M.D., WILLIAM W. LACKEY, B.S., ROLF G. SCHERMAN, M.D., and KEITH H. AVERILL, M.D., Lovelace Foundation, and School of Aerospace Medicine, Albuquerque, N. M., and Brooks Air Force Base, Texas.

The USAF participated in a Himalayan expedition led by Sir Edmund Hillary. A major objective was to study mechanisms of acclimatization and effect of prolonged exposure to altitude. A physiological laboratory was established at 19,000 ft. Eight physiologists spent periods up to 5 months at this altitude or higher. This paper presents results of total body water determination and respiratory, ECG, and EEG recordings made during exercise and rest at altitudes at 24,500 ft.

Alterations in Physiological Accommodations to Stress Induced by Irradiation.

BERNARD D. NEWSOM, Ph.D. and DONALD J. KIMELDORF, Ph. D., General Dynamics Life Sciences Laboratory, Astronautics Division, San Diego, Calif., and USN-RDL, San Francisco, Calif.

A series of animal experiments will be presented that indicate changes in physiological adjustment to stress following neutron exposure. Rats exposed to −20°C following sub-lethal doses of fast neutrons show significant decreases in mean survival time. Rats of various ages reacted differently to the cold test and survival did not appear dependent on body size. Heart rate and body temperature changes during cold exposure differed in irradiated and non-irradiated rats. The decreased cold tolerance following neutron exposure was more profound and of longer duration than was observed after x-irradiation. A decreased physiological performance can be anticipated following large doses of space radiations. Implications to complex space stresses and effects on design criteria will be considered.

Decreases in Arterial Oxygen Saturation as an Indicator of Cardiopulmonary Stress During Forward ($+G_x$) Acceleration.

A. Clark Nolan, M.D., Hiram W. Marshall, M.D., Lucille Cronin, Earl H. Wood, M.D., Ph.D., Mayo Clinic and Mayo Foundation, Rochester, Minn.

Blood oxygen saturation was recorded by ear oximetry and by cuvette oximetry in blood withdrawn continuously from the radial artery during 3-4 minutes at 2.1, 3.7, 5.4 and sometimes 6.5 G in eight subjects. Observations were made when air and 99.6% oxygen were breathed. Thoracic roentgenograms were obtained before and 30-50 seconds and 5 minutes after 5.4 and 6.5 G. In five subjects pressures were recorded in the aorta, radial artery, right atrium, esophagus and rectum (intra-abdominal). While air was breathed, a progressive decrease in arterial oxygen saturation from control value of 97.5% occurred with increasing levels of G, beginning about 10-25 seconds after onset of peak acceleration, which attained a stable level of 87.5% by cuvette and 86% by earpiece after 130 seconds at 5.4 G. When the centrifuge was stopped, a return toward control values occurred, but recovery was incomplete during the ensuing 1 minute or more. When oxygen was breathed, the decrease was prevented or its onset delayed, and its magnitude reduced, 93% being the minimal figure obtained. Comparative studies in the mercury couch (legs flexed) position and with legs extended parallel to the floor of the cockpit yielded closely similar results. Progressive increase in right atrial pressure occurred with increasing G, reaching a mean of 29 mm. Hg (3 times control) at 5.2 G. Esophageal pressure increased similarly, but to a lesser mean of 20 mm. Hg (control −1) at 5.2 G. It is postulated that the oxygen desaturation is due to blood flow past atelectatic alveoli in dependent portions of lungs, atelectasis resulting from increased segmental blood volume and pressure due to hydrostatic effects, plus an apparent increase in intrathoracic pressure. Changes indicative of atelectasis in lower lung fields were demonstrable roentgenographically after exposures to 5.4 and 6.5 G when oxygen was breathed.

Failure-to-Complete as a Family Characteristic.

William F. O'Connor, Ph.D., and Marshall B. Jones, Ph.D., Federal Aviation Agency, Norman, Okla., and U. S. Naval School of Aviation Medicine, Pensacola, Fla.

Completion of naval air training has very little to do with how much education the student's father and mother had. However, if parental education is analyzed in terms of whether or not the parents completed a natural unit of education, the result is quite different. Students whose fathers completed grammar school and then stopped are less likely to attrite than students whose fathers dropped out *either* of grammar school *or* high school. Similarly, students whose fathers terminated their education after completing high school are less likely to attrite than students whose fathers went part way through *either* high school *or* college. Also, students whose fathers graduated from college are less likely to attrite than students whose fathers left college in midstream. And this pattern holds for the mothers of cadets and officers in training as well as for their fathers. In other words, students who have a family history of failure-to-complete in education are more likely to attrite from naval air training than students who don't, altogether apart from the amount of parental education.

Space Travel: A Suggested Approach to the Problem of Human Response to Ionizing Radiation.

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Because of the great effort and expense involved in initial manned cosmic probes it is mandatory that human response to ionizing radiation be defined in as many ways as possible. The decision to recall a mission may rest upon these definitions. "Solar flares" and other astroradiations are largely unpredictable and it will not be possible to construct space vehicles capable of protecting against all possible quantities and qualities of radiation. Dogs exposed to 75 r at intervals of 12, 24, and 48 hours to a total dose of 300, showed a markedly different response in that mortality in the 24-hour group was double that of the twelve-hour and that of a group given 300 r in a single dose. When 56 r was given every 24 hours x 4, mortality was zero, and morbidity slight. Data from the literature reveals a striking relationship between indices of radiation damage and species metabolic rate. The suggestion is offered that within species cyclic cellular and metabolic activity may determine ultimate injury from repeated doses of radiation. Since predictions of human response must rest upon extrapolation from animal data, an approach to the use of metabolic rate is suggested, first in poikilotherms, whose rates can be easily varied, and then a detailed study of the same relationship in homeotherms.

Glaucoma as an Aviation Hazard.

Brittain F. Payne, M.D., New York, N. Y.

Glaucoma or increased intraocular pressure, of which there are numerous types, is one of the major causes of blindness and may be a definite hazard in aviation. Its presence in the individual should not only disqualify for flying crew members but also passengers who cannot be controlled with miotics. Aviation is concerned with the primary or so-called chronic simple type of glaucoma rather than the many secondary kinds described in textbooks and journals. The time may come when all glaucomas will be determined as secondary to some other process but for the present the established classification will be followed. The etiology of primary glaucoma has never been determined satisfactorily but anatomical, physiological and neurological variations play important roles in the progress of the disease. The important anatomical features favoring the development of increased intraocular tension are as follows: the diameter of the cornea may be less than the average, the anterior chamber is usually shallow, the iris angle may be narrow or wide depending on the depth of the chamber, the crystalline lens may be enlarged, the pupil dilated and the ciliary body hypertrophic. The angular meshwork and the scleral drainage channels (Schlemm) may be deficient and block the normal aqueous drainage. The intraocular tension of the normal eye is kept in perfect physiological balance and varies between 18 and 30 mm. of mercury Schiötz. Any alteration in the composition of the aqueous, increase in the secretion or drainage may change the pressure within the eye. The aqueous outflow may be diminished with the secretion remaining the same or increased, which would cause glaucoma. Nervous stimuli such as severe pain in some other part of the body may cause an increase in intraocular pressure. Fear, anxiety and anger have been known to precede attacks of acute glaucoma. Since there is always the danger of an acute attack of glaucoma, which might cause blindness or an emergency operation, it might be in order that individuals over the age of 40 years be tested in the altitude chamber or in actual flight.

The Mechanism and Cause of Vertebral Injuries Sustained on Ejections from U. S. Naval Aircraft.

LT. CHARLES F. PAYNE, JR., MC, USN and CAPT. ROLAND A. BOSEE, MSC, USN, Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

Considering the available evidence, the basic mechanism responsible for the high incidence of vertebral injury on ejection from U. S. Naval aircraft is the concentration of inertial and restraint force components on the front of the vertebrae by spinal flexion. Flexion occurs because of poor positioning, lack of support, and inadequate restraint of the body. Until further improvements are made in these areas and spinal flexion kept to a minimum, it will not be possible to subject the body to its potentially tolerable limit of ejection acceleration without perpetuating the high incidence of vertebral injury.

The Cause of Death and Injury in Modern Lightplane Crashes.

RICHARD G. PEARSON, Ph.D., Aviation Crash Injury Research, Phoenix, Ariz.

The purpose of this study was to evaluate the interrelationship between primary impact variables, seat and belt tie-down effectiveness, and injuries sustained by occupants of 342 lightplanes involved in spin-stall crashes or collisions with the ground while in flight. The data were obtained during the period 1953-1960 and are to be contrasted with data previously reported for the period 1942-1952 in which light aircraft were primarily of fabric-skin covering. Contrary to the earlier findings, seat failure now occurs more frequently than belt failure. The curve of belt failure plotted as a function of impact velocity does not accelerate as rapidly as that from the earlier data, whereas the seat-failure curves are comparable. Since injuries are found to be more severe when seats fail than when belts fail, there is a suggestion that seat tie-down improvements may not have kept pace with improvements in seat belt manufacture and installation. Overall, however, when tie-down is considered effective, injuries are less severe for the more recent data, thereby suggesting that better protection is afforded today's pilots. Occupants wearing shoulder harness were least severely injured although some still received facial and skull fractures. Since structural collapse was generally not extensive for these data, flailing of the body against injury-producing structures within the occupant's environment is seen to be a significant source of injuries. Injury severity was found to increase little as a function of impact velocity, but did increase rapidly as a function of angle of impact.

Visual Orientation in Three Dimensional Space.

MARK G. PFEIFFER, M.A., Senior Engineer The Martin Company, Baltimore, Md.

It is understandable the Air Force is concerned with space perception. The obvious application is toward a better understanding of the role of extra-cockpit visual information in pilot performance. Toward this end a hypothesis concerning visual orientation in three dimensional space was developed which considered the task variables and perceptual variables. The key word was synthesis. It was assumed that there exists an infinite number of stimulus combinations and a finite number of cue combinations in the visual world which could be used for purposes of orientation as to relative displacement, velocity and acceleration in three dimensional space and that synthesis of stimulus variables in varying degrees was required for accurate perception of displacement, velocity and acceleration. The quality and magnitude of this synthesis and its locus were expounded to explain the facts of visual space orientation.

Ambient and Cockpit Luminances Measurements.

CAPT. DONALD G. PITTS, USAF, MSC and CAPT. LESTER R. LOPER, USAF, MSC, Aerospace Medical Laboratory, Wright-Patterson AFB, Ohio.

A procedure is described for obtaining ambient and cockpit luminances measurements during operational flying. Data were taken at various altitudes during clear, cloudy and heavy overcast weather and while flying low over snow. A comparison of luminances measured at equal altitudes above a solid overcast and above snow shows remarkable likeness. Changes in cockpit and ambient luminances through a solid overcast from 7,000 to 17,000 feet are graphically presented. Polar coordinate presentation of the data illustrates ambient luminances that "surround" the aircraft at different altitudes. The data can be used in the design of laboratory experiments to determine the effects of glare on visual performance, in evaluation of future eye protective devices, and as a guide in operational flight planning.

Changes in the Amino Acid Composition of Rat Brain Caused by Acceleration Stress. B. DAVID POLIS, Ph.D., H. W. SHMUKLER, Ph.D., and MARIA CHIANTI, B.A., Aviation Medical Acceleration Laboratory, U. S. Naval Air Development Center, Johnsville, Pa.

Previous work from this laboratory showing the importance of hormonal and other cellular factors in the tolerance to acceleration stress suggested the possibility of a reversible "metabolic lesion" that results from acceleration stress. The following study was undertaken in an effort to reveal the metabolic defects in cerebral metabolism induced by acceleration. Rat brains were rapidly excised from normal and centrifuged animals, frozen, weighed, deproteinized with picric acid and analyzed for the complete free amino acid pool composition by ion exchange chromatography. Large decreases (>50%) were found for the new amino acid β-hydroxyaspartic acid, as well as for serine, urea, and glutathione. A large increase in the concentration of free ammonia was also found. The interrelationships of the changes in amino acid composition suggest a block in the energy yielding mechanisms from the respiratory enzyme systems in mitochondria.

Aircrew Obesity. G/C T. J. POWELL, S/L E. P. CARRIGAN, F/L M. J. STANFIELD, Air Defence Command, RCAF Station, St. Hubert, P. Q.

There has been a continual struggle to define obesity. According to one standard, RCAF aircrew are not overweight—grossly obese by another. The finding of obesity in many fatal cases of dysbarism has helped to stimulate stringent weight reduction programmes in aircrew. The plea is made for a re-examination of the concept of obesity from a pathological viewpoint.

The Effect of Backscatter on the Visibility of Aircraft Navigation Lights. T. H. PROJECTOR, P.E., Applied Psychology Corporation, Arlington, Va.

Backscatter from the exterior lights of a pilot's own aircraft may affect his ability to see the lights of another aircraft. A series of experiments have been carried out at the FAA Visibility Test Range near Atlantic City, New Jersey, to provide some measure of the magnitude of such effect. The apparatus is designed to permit variation of the lateral separation between the observers and the backscatter generating light (BGL), varying the color of both the BGL and the target light (red, green, or white), and varying the beam cutoff direction of the BGL. Threshold intensities for each combination of parameters were obtained by the method of constant stimuli. Observer responses were objectified by requiring identification of dot-dash or array coding. Optimum brightness levels for various atmospheric transmissivity conditions are specified.

Operational Aspects of Aerospace Biological Research Flight Programs. CAPT. CARL E. PRUETT, MC, USN and SEYMOUR N. STEIN, M.D., Pacific Missile Range, Point Mugu, Calif.

Increased emphasis on the Manned Lunar Flight Program now accentuates the urgency of obtaining valid answers in several areas of biology. These areas in certain cases must be studied by actual flight of biological payloads through the aerospace environment. The necessity for this difficult and expensive exploration dictates the optimum in experimental design, payload design, launch and recovery techniques, and data collection. To achieve this optimum a sound and efficient planning and working arrangement must be established between the Research Team, the Flight Vehicle Team, and the Missile Range Team.

The Elements of Rescue and Survival. COL. JOS. M. QUASHNOCK, USAF, MC, Biomedical Laboratory, Aerospace Medical Laboratory, Wright-Patterson AFB, Ohio.

The application of modern electronic technology has provided search systems of high reliability. An electronic location marker, previously developed for primarily over-water search, has been extensively evaluated over rugged terrain by the Arctic Aeromedical Laboratory. It is of proven value and is being adapted for operational use. Experimental results are presented. As a result of the availability of a dependable search system, survival equipment and training requirements are now altered and can be brought into alignment with reality. Specific needs are discussed.

Practical Methods in the Autopsy Investigation of Major Aircraft Accidents. WILLIAM J. REALS, M.D., and RICHARD E. DANIELSON, A.B., M.T., Federal Aviation Agency, Washington, D. C.

Investigations into the human factors in major aircraft accidents have contributed greatly to air safety. Autopsy studies have been utilized in this effort as well as biochemical and histologic techniques. The Federal Aviation Agency has a consulting staff of pathologists who are sent to the scene of disasters to study wreckage, environment and other factors. These consultant pathologists join in the human factors team upon arrival working closely with the

F.A.A., C.A.B. officials, Federal Bureau of Investigation and local police officers, Armed Forces Institute of Pathology teams and the local coroners or medical examiners, airline flight surgeons and rescue parties. A number of practical points will be emphasized using the experience gained in two recent major air accidents (Denver, Colorado and Chicago, Illinois). Since efforts are now underway to utilize F.A.A. designated Aviation Medical Examiners as investigators in the general aviation field this paper will help in the understanding of the problem encountered. The availability of proper equipment to be carried to the scene as well as the organization of the autopsy procedure will be detailed. The practice methods of liason, utilization of facilities and means of investigations will be presented.

A Study of General Aviation Accidents. H. L. REIGHARD, M.D., C. E. WILBUR, M.D., J. C. CHERRY, and M. Y. MCCORMICK, Medical Standards Division, Aviation Medical Service, Federal Aviation Agency.

General aviation accident notification, investigation, and reporting procedures are examined briefly and the lack of privileged status for accident reports is emphasized. In an attempt to elicit human factors data, a questionnaire, with privileged status, was sent to 1,570 civilian pilots involved in general aviation accidents during the period June 1960 to May 1961. Completed questionnaires were received in 949 cases —a response rate of 60 per cent. The questionnaires were matched with the corresponding accident reports and studied. The results are presented, along with recommendations.

The Effect of UDMH Injection Upon Learned Behavior in Java Monkey Performance. CAPT. HERBERT H. REYNOLDS, USAF, LT. COL. FREDERICK H. ROHLES, JR., USAF, MSC, KENNETH C. BACK, Ph.D., and CAPT. JERRY FINEG, USAF, VC, Aeromedical Field Laboratory, Holloman AFB, N. M.

The physiological effects of Unsymmetrical Dimethylhydrazine (UDMH)—a rocket fuel by-product —have been studied extensively in recent years, and maximum tolerable dosages have been ascertained for a variety of animal species. However, little if any performance data had been gathered prior to these experiments. A series of three experiments—involving the administration of UDMH—were accomplished in an effort to determine the effects on performance of the maximum tolerable physiological dosage. Results of the first two experiments were of a contradictory nature, necessitating the third experiment. The ultimate findings of this research should be of considerable interest to researchers in Aerospace Medicine.

Response of the Rhesus Monkey to Lateral Impact. CAPT. F. R. ROBINSON, USAF, VC, R. L. HAMLIN, D.V.M., W. M. WOLFF, B.S., Mech. Eng. and R. R. COERMANN, Dr. Eng., Aerospace Medical Laboratory, Wright-Patterson AFB, Ohio.

The physiological response of the Rhesus monkey to abrupt negative acceleration (deceleration) is reported. Eight animals received a series of progressively higher impact loads in the Y axis up to 75 g over a six-month period with use of the Vertical Deceleration Tower. Accelerations on the head, chest and hip of the animal were recorded simultaneously with the acceleration on the cart from which rise time, velocity and displacement were computed and recorded. Three orthogonal electrocardiograms and respiration rates were recorded. Radiographs were taken before and after the impacts. Routine hematological examinations were performed in addition to serum transaminase determinations. Changes in the ECG and respiration will be presented as well as changes of position of the heart as seen on radiographs. Hemograms and serum transaminase results will also be discussed.

Bioastronautics Support of the X-15. LT. COL. BURT ROWEN, USAF, MC.

This paper presents the developments made in the full pressure protective suits worn by the pilot during the X-15 flight demonstrations at Edwards AFB, California. It contains a discussion of pilot physiological response to both speed and altitude flights. The in-flight and real-time systems used for on-board recording and air-to-ground telemetry of physiological and environmental data are described. Quantitative data are presented with comments regarding heart rates and respiratory rates. New instrumentation developments evolving from the X-15 program with application to future manned aerospace systems are also discussed.

A Physiological Evaluation of U. S. Navy Protective Suit Assemblies Under Simulated Cold Conditions. LOUIS J. SANTAMARIA, B.S., and JOHN F. KIEFER, Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa.

A program of study was undertaken to establish the limits of cold protection afforded by aircrew-suit assemblies under simulated environments comparable to those following separation from the aircraft. Subjects wearing the MK IV full pressure suit and the MK-5 anti-exposure suit were exposed to various environments simulating conditions of dry-cold and water-immersion. The experimental temperature conditions were selected as being characteristic of emergency cold and frigid exposures. The evaluation of hoth protective suit assemblies was based on various physiological measurements and on subjective reactions. It is considered that the extended experimental periods of exposure would supply valuable and useful information regarding the capabilities of the U. S. Navy protective suit assemblies under emergency conditions of dry- and immersion-cold.

Automatic Computer Processing of Chimpanzee Physiological and Psychomotor Data. CHARLES S. SAVOINI, B.S., GENE A. REED, B.S. and

HOWARD W. BURNETTE, B.S., Analysis and Computation Division, Holloman AFB, N. M.

The Computation Division at Holloman AFB was able to process automatically chimpanzee physiological and psychomotor data from centrifuge tests conducted at the University of Southern California by the Aeromedical Field Laboratory. The magnetic tape playback speed-up technique, the analog computer technique of handling physiological data, and the digital computer processing of physiological and psychomotor data are described. The psychomotor data was processed through a unique method that allowed the computer to recognize the psychomotor behavior as well as reaction time.

Depth of Penetration of Solar Protons into the Atmosphere and Related Tissue Ionization Dosages.

HERMANN J. SCHAEFER, Ph.D., Biophysics Department, U. S. Naval School of Aviation Medicine, Pensacola, Fla.

As more detailed data on fluxes and energy spectra of transitory proton radiation fields in space after solar flares become available, the depth of penetration of these particle beams into the earth's atmosphere can be more accurately assessed. Individual flare events differ greatly with regard to penetrating power of the protons reaching the vicinity of the earth. Even during the same event, great changes occur as the radiation surge gradually declines. An additional variable is the screening effect of the earth's magnetic field which strongly depends on geomagnetic latitude, yet can be cancelled out partially during the magnetic storm following the flare. A spectral model suggested by Bailey as representative for a maximum type flare event has been subjected to computational analysis of the ionization dosages in a human target exposed at different altitudes within the earth's atmosphere. Because of the great heterogeneity of the E-spectrum, the surface dose in the target drops more rapidly than the depth dose toward deeper regions in the atmosphere. The depth dose drops to about 90/50/10/1 per cent of its extra-atmospheric value at 175,000/130,000/95,000/70,000 feet altitude. It is to be emphasized that these data hold for extremely large flares which occur only a few times during the entire period of peak activity of one solar cycle of 11 years.

The Aging Pilot and Heart Disease.

CAPT. VICTOR E. SCHULZE, JR., USAF, MC, Office of the Surgeon, Headquarters ATC, Randolph AFB, Texas.

The Air Force is composed of a progressively older pilot population. In 1954, only 2.5% of all Air Force pilots were over 40. By 1960, this figure had risen to over 26%, stimulating interest in better methods to follow and care for the older flyer. The relationship of heart disease to certain individual hereditary and physiological characteristics is reviewed with respect to the specific duties and functions of aircrewmen. Statistical information is employed in analyzing present methods of physical evaluation of pilots, and more comprehensive tests to detect cardiovascular disease are suggested. Finally, recommendations for preventive medical practices regarding the pilot population are advanced.

An Experimental Approach to Flash Blindness.

CAPT. SANFORD L. SEVERIN, USAF, MC, CAPT. NORRIS L. NEWTON, USAF, MC and LT. COL. JAMES F. CULVER, USAF, MC, School of Aerospace Medicine, USAF Aerospace Medical Center, Brooks AFB, Texas.

Advances in the physical sciences have given man the capability to produce nuclear explosions and will soon enable him to explore extraterrestrial space. Operations in each of these areas will be hazardous to the vision of those involved due to the exposure to intense light fields. Unfortunately, there has been little biomedical effort directed toward elucidating the parameters of visual impairment from such exposures. This paper describes a new technique for the study of flash blindness, utilizing the Meyer-Schwickerath Zeiss light coagulator as a source of high intensity flashes. Experimental results are reported, describing visual recovery from a selected range of intense light flashes, and the operational significance of this work is discussed.

The Travel Syndrome.

CAPT. ROBERT I. SIMON, USAF, MC and CAPT. HERBERT R. LAZARUS, USA, MC, Department of Neuropsychiatry, Brooke General Hospital, Fort Sam Houston, Texas.

We attempt to define psychosis occurring in aerial flight (Travel Syndrome). The definition includes statements about premorbid personality, precipitating factors, presenting symptoms, course of illness and prognosis. Two cases are presented and relevant literature reviewed. We relate the Travel Syndrome to the concept of process-reactive types of schizophrenia and discuss its relations to sensory deprivation experiments. Special emphasis is placed on military implications of aerial psychosis and the direct preventive measures which apply. The specific fear of flying is emphasized. Finally the relevance of this type of study to the psychiatric aspects of space flight is mentioned.

Some Effects of Acceleration on Certain Physiologic Functions Observed During a Centrifuge Study of Pilot Performance.

CAPT. H. A. SMEDAL, MC, USN, TERENCE A. ROGERS, Ph.D., and T. D. DUANE, M.D., Ames Research Center, Moffett Field, California, and Department of Physiology, Stanford University, California.

As a part of a continuing study into the effects of acceleration on pilot performance, this report will present additional physiological data concerning the effects of acceleration on man. Twenty-two test pilots were subjected to sustained acceleration as high as 14 g EBI, 10 g EBO and 9 g EBD. Some observations as to meaningful tolerance levels to acceleration as well as the effect such accelerations have on the

visual, cardiovascular and respiratory systems will be reported. These observations will include a statistical evaluation of the subjective symptoms reported by the pilots during and after the centrifuge runs. The objective findings concerning the function of the respiratory system such as tidal and minute volumes, vital capacities and other pulmonary function indices will be described. Pulse rate changes and variations in blood pressure during acceleration will also be reported. Some problems that arise in the visual system will be brought out.

The Excretion of Phenolic Compounds in Stress.

P. SMITH, Ph.D., RAF Institute of Aviation Medicine, Farnborough, England.

Of many phenols present in urine a few are excreted in increased amounts in stressful situations. Three such compounds are vanillyl mandelic, homovanillic and p-hydroxyphenyllactic acids. The first two of these are indices of catecholamine metabolism, the last is suggestive of ascorbic acid deficiency. Chromatographic analysis of urinary amines has been investigated, the primary object being the detection of metanephrine and normetanephrine, metabolites of adrenaline and noradrenaline respectively. However, many previously unsuspected urinary amines have also been shown to be present. Sometimes excretion of amines in stress may show spectacular abnormalities.

Effects of Low Frequency Vertical Vibration on Human Performance.

F. W. SNYDER, M.A., The Boeing Company, Wichita, Kan.

This program was initiated in 1959 under contract with Office of Naval Research. A laboratory facility designed for human experimentation is used. Seventeen subjects participated in the first experiment establishing judged vibration severity levels identified as definitely perceptible, mildly annoying, extremely annoying, and alarming. Sinusoidal vibration frequencies ranged from 1-27 cps. Acceleration ranged from 0.01 G at 1 cps to 1.5 G at 20 cps. Performance of six to nine subjects was measured for continuous tracking and discrete tasks during vibration. Highlight results are: performance is degraded on some tasks but not on others; subjects are not always aware of performance degradation; some correlation exists between affected body region and vibration frequency; distracting irritation in nose region occurs above 12-14 cps; visual degradation is greatest in the range 12-23 cps.

Emergency Aspect of Aerospace Medicine.

MAJ. PAUL A. STAGG, MC, and CAPT. THOMAS P. BALL, USAF, MC, 1607th USAF Hospital, Dover AFB, Del.

Medical support of aerospace operations requires the potential to care for many casualties likely to result from aircraft accidents, explosions, fires, storms, and nuclear incidents. Several administrative elements are needed. The alert system must promptly provide needed personnel in proper quality and quantity. There must be concise, adequate, written guides. Proper equipment must be acquired, packaged, stored, and readily available. Developing an organization's ability to care for an emergency requires that teams practice under closely simulated conditions. Then carefully planned, objective testing determines the state of readiness. The illustrated description of a simulated exercise presents the problems encountered at the scene of a disaster and actions necessary to overcome these problems. Experiences gained from disaster planning on an Air Force Base are presented.

Multidimensional Concept of Coronary Artery Disease.

G. DOUGLAS TALBOTT, M.D., Medical Director, North American Medical Research Foundation.

Coronary artery disease remains not only the leading cause of death in the United States, but also presents a major problem in the Aerospace Medical field. Crew selection for space flights and exposure of air crews to cardiovascular stress make the understanding of the diagnosis, prophylaxis, etiology and treatment of coronary artery disease topics of paramount importance. The formulation of an orderly concept of this disease in the presence of a welter of conflicting theories and seemingly contradictory evidence becomes mandatory to apply our current knowledge to this problem. The multidimensional concept of coronary artery disease meets in part, these requirements. The formulation of this concept, its mechanisms and precepts are presented. The application of this concept in particular to the treatment of acute coronary patients in the new Cox Memorial Heart Institute is discussed, utilizing the measurement of physiological parameters by methods currently employed and projected for personnel involved in space flights.

Effects of Impact—Relative Bradycardia.

MAJ. ELLIS R. TAYLOR, USAF, MC, and CAPT. L. W. RHEIN, USAF, MC, Aeromedical Field Laboratory, Holloman AFB, N. M.

While awaiting acceleration and impact, the heart rate tends to increase due both to the work of respiration against restraint and to epinephrine. Immediately after impact, there is a slowing of the rate lasting several seconds, after which the rate returns to or even exceeds the pre-impact rate. This relative bradycardia has been shown to be directly related to phase of respiration at impact; if at full inspiration, the effect is maximal. The effects of atropine are shown. The relationship to blast injury is discussed. The use of this effect in human sled testing is presented.

A Proposed New Concept for Estimating Limit Human Tolerance to Impact Acceleration.

A. B. THOMPSON, M.S.A.E., Vought Astronautics, Division of Ling-Temco-Vought, Inc., Dallas, Texas.

Mathematical techniques are being developed for determining human whole body response to various

impact accelerations, but no satisfactory method is available for defining the human response tolerance limit to impact loads resulting from abrupt decelerations. Limits set by total G vs. time, rate of onset, and velocity change are ill-defined and variable. A concept is proposed whereby limits are set by the force exerted per unit area on the body by the restraint or support system at maximum deceleration. Correlation is made between blast tolerance, sled test tolerance, and automobile accident and fall impact survivals which indicates that 28 to 30 pounds per square inch is the onset level for shock and 45 to 55 pounds per square inch is the level for 50% mortality for transverse accelerations of less than ½ second duration. In this concept G, rate of onset, and ΔV are all dependent variables.

Accident and Weather. RICHARD TRUMBULL, Ph.D., Office of Naval Research, Washington, D. C.

This paper will deal with psychological and neurological factors believed to be relevant to accidents in "ideal" weather conditions. It will describe accident-weather relations which have not received adequate considerations and present research findings supporting the new orientation in accident analyses, and orientation based upon the man as the determinant of "ideal."

Medical Factors in Non-fatal Civil Aviation Accidents. DAN L. URSCHEL, M.D., F.A.C.P., Mentone, Ind.

This study was initiated prior to institution of a similar program now being conducted on a national basis by the Medical Department of the Federal Aviation Agency. The author felt that no adequate information was available on the possible importance of medical factors in causation of aircraft accidents involving private pilots and non-airline commercial pilots. Therefore, through the cooperation of the Indiana Aeronautics Commission, the Indiana Chapter of Flying Physicians Association undertook to interview either personally or by mail all pilots involved in such non-fatal accidents in the state of Indiana for a period of one year. 132 such inquiries were initiated, and adequate data were obtained in 96. These accidents covered all of the usual causes of such incidents—weather, fuel exhaustion, poor pilot technique, engine failure, etc., and in many instances the pilot or passengers sustained significant injuries. This paper will review the etiologic factors involved in all instances, discussing briefly the aeronautical features as well as possible medical or psychologic causes. In evaluating the final results it appeared to the investigator that inadequate training and poor mental attitude were far more important in the production of these accidents than were either mechanical failures or poor physical condition.

Human Physiological Response to Extremity and Body Cooling. CAPT. JAMES H. VEGHTE, USAF, MC, Arctic Aeromedical Laboratory, Fort Wainwright, Alaska.

A study of the critical regions of the body which must be protected with insulation against a cold stress made it necessary to ascertain the response of the extremities as opposed to the rest of the body when subjected to a cold environment. Five subjects at rest were exposed to a temperature of —18° C in an environmental chamber while wearing three different clothing configurations: Thermistor underwear, approximately 10 clo insulation on the body with the exception of only the hands and feet which were left bare, and approximately 10 clo insulation on the extremities with the rest of the body bare or covered with the thermistor underwear. The average subject tolerance time, defined when any skin site reached 4° C, while wearing only the thermistor underwear and having the body heavily insulated while the extremities were bare was 8 minutes. The average subject tolerance time with the extremities heavily insulated and wearing only the thermistor underwear was 83 minutes. The results illustrate the temperature sensitivity of the extremities and their tolerance limitations in extreme cold environments. A large quantity of insulation on the body excluding the extremities does not ameliorate tolerance despite a warm core temperature. If the extremities are adequately protected, however, the rest of the body with the possible exception of the ears is able to tolerate a low environmental temperature for extended periods of time.

Preventive Medicine Concepts in the NASA Space Programs. CAPT. FRANK B. VORIS, MC, USN, Aerospace Medicine Office of Manned Space Flight, National Aeronautics and Space Administration, Washington, D. C.

A brief review of the present requirements for preventive medicine practice in our national space programs and a look into future problems being created by the multi-ton exotic-fueled booster systems being planned. Ground crew safety and the protection of surrounding populations and property becomes increasingly difficult as the newer space systems come into being. A short review of the NASA's approaches to the solution of these problems will follow the review. There are two additional potential hazards involved in the long-range space mission. One is the possible effect on the reproduction cycle, growth, viability, and pathogenetic conversion of terrestrial organisms following mutation in space environment and return to earth. The other is the effect of terrestrial environment to these same factors on extra-terrestrial organisms should any, in fact, be brought to earth by returning space vehicles. A discussion on the means and methods of controlling and/or preventing cross-contamination of space and earth will conclude the paper.

The Need for Routine Tonometry. B. J. WOLPAW, M.D., Cleveland, Ohio.

The speaker will review his experience in the first and largest city-wide glaucoma survey. The results of

this study will be compared with other surveys and the necessity for tonometry in aviation examining will be pointed out.

Body Composition of USAF Flying Personnel.

CAPT. JAMES R. WAMSLEY, USAF, MC and JAMES E. ROBERTS, M.D., School of Aerospace Medicine, Brooks AFB, Texas.

Forty-six male USAF/Flying personnel were studied from the standpoint of body composition, applicability of height-weight tables in assessment of obesity, and reliability of anthropometrics in the assessment of body composition. Body composition was determined primarily by deuterium dilution determination of total body water. It was found that height-weight tables are not valid in prediction of obesity and frequently give completely false impressions in regard to relative fatness. Anthropometric methods seem to show promise as a simple means of determining body composition in the field. The findings are discussed especially in regard to aeromedical implications and suggestions are made for further studies based on body composition.

Analysis of Gases in Closed Systems by Gas Chromatography.

T. B. WEBER, School of Aerospace Medicine, Brooks AFB, Texas.

Accurate measurement of respiratory and atmospheric gases in space cabin simulators constitutes a serious problem. Usually a variety of detectors employing several diverse methods are used, with each procedure delineating only a single component. With the development of precision gas chromatography, however, it is feasible to measure the major gases simultaneously. In a single routine operation with the SAM, two-man, space cabin simulator oxygen, nitrogen and carbon dioxide were quantitated within a wide range and carbon monoxide detected before it reached the minimum tolerable level. Cabin atmosphere was measured repeatedly by sampling the circulating cabin air. Additional samples were analyzed by obtaining respiratory and atmospheric gases at specified intervals. Numerous packing and coating materials and column arrangements were evaluated and constructed to give optimal separation in minimal time. Optimum performance was found with parallel columns of uncoated silica gel and molecular sieve as the adsorbents. Peak heights were used to ascertain the volume of each gas and these heights were directly referable to standard curves. It was thus possible to collect the sample, measure the percentage composition of each effluent and obtain permanent chromatographic records within a period of a few minutes. This methodology compared favorably with other gas analyzers and required less maintenance and prerequisites for replicate analyses.

A Liquid Preflight and Inflight Meal for Tactical Fighter Pilots.

CAPT. DONALD K. WHEELER, USAF, MC, CAPT. JOHN LOCKSMITH, USAF, MC, CAPT. ROBERT G. RYDER, USAF, MC, and CAPT. DOMENIC VAVALA, USAF, MSC, Physiological Training Department and Flight Surgeon's Office, 832nd Tactical Hospital, Cannon AFB, N. M.

Tactical Air Command Fighter Pilots in the past have crew conditioned with a low residue, high protein diet prior to long flights. We used a preflight and inflight liquid diet (Sustagen) for crew conditioning. Preflight barium x-ray studies in the altitude chamber comparing intestinal mobility of the liquid and regular diets revealed Sustagen had a much faster upper G.I. emptying time. Tests to 43,000 feet revealed no symptoms from gas expansion of Sustagen. Simultaneous glucose tolerance tests showed no hypoglycemia with Sustagen. A Tactical squadron on a Far East Operation used Sustagen to its destination and regular crew conditioning methods on the return flight. Comparisons revealed the liquid diet furnished adequate energy without excessive filling; it was a convenient high-energy in-flight lunch; there was no excessive gas formation. No contraindications were found for its use in pilots and it offers an improvement in present crew-conditioning methods in Tactical fighter pilots.

The Measurement of Tissue Thickness by Ultrasound.

WING CMDR. P. D. G. V. WHITTINGHAM, RAF, RAF Institute of Aviation Medicine, Farnborough, England.

A brief account is given of the physical properties of ultrasound and the use of ultrasonics in engineering practice and medical diagnosis. Attempts have been made to measure the thickness of subcutaneous fat in men by the use of reflection methods, where a single transmitting crystal acts as its own receiver in the intervals between pulses of emitted waves. The measurement of the thickness of subcutaneous fat in this way is considered in relation to methods for determining the lean body mass of men.

Flutter Valve for Drainage of the Pleural Space.

CAPT. L. F. WILLIAMS, JR., USAF, MC, CAPT. A. T. K. COCKETT, USAF, MC, and CAPT. C. C. BEEHLER, USAF, MC, School of Aerospace Medicine, USAF Aerospace Medical Center, Brooks Air Force Base, Texas.

Since conventional underwater drainage of the pleural space is cumbersome, inconvenient, and particularly very dangerous during air evacuation, a suitable substitute is required. The valve provides this substitute so that such patients may be evacuated without danger. The valve is also being adapted for use in a mass casualty situation.

Biomedical Effects of Continuous and of Intermittent Exposure to Ionizing Radiation for Periods of Hours to Weeks.

R. BLAND WILLIAMS, JR., Naval Medical Research Institute, Bethesda, Md.

Roentgen and gamma rays, alpha and beta particles, neutrons, deutrons and protons have in common the ability to produce ionization in materials

which absorb them and their biological effects are believed to be produced almost entirely through the mechanism of ionization. Studies involving the effect of dose rate and fractionation upon certain recoverable and irrecoverable components of ionizing radiation injury may therefore be of considerable importance to space travelers exposed to solar flares of various duration and intensity as well as to the optimal speed *and shielding* for passage through *belts of trapped corpuscular high-energy ionizing radiation* on inter-planetary flights. The recovery of certain rapidly proliferating, steady-state mammalian tissues has been followed in over 8000 animals of a single strain, age, sex and narrow weight range following exposure to ionizing radiation. The goal is to derive a set of postulates and equations that will best fit and explain a variety of experimental observations, which include mitotic counts, DNA synthesis at the cellular and tissue level, body-weights, wet and dry small intestinal weights, mortality and bone marrow and testicular recovery. It should then be possible to make certain generalizations by which related but unknown biological responses of similar and different mammals to particulate and electromagnetic ionizing radiations may be predicted and subsequently experimentally tested. For example, total-body exposure to 1050 r delivered at a dose-rate of 36 to 40 r per minute produced profound distention of the gastrointestinal tract, profuse diarrhea and 100% mortality of Sprague-Dawley rats within 4 days. The same dose delivered to a 5 cm exteriorized loop of small intestine destroyed over 50% of the crypts. To date, biologically comparable doses up to 1500 Roentgens have been given at a dose rate of approximately 9.5 r per hour continuously over a period of 144 hours without producing distention, diarrhea, a single death, or loss of a single crypt. When the total dose, total-time and dose-rate are the same, either the size of the dose increments or intervals between doses may determine the nature and extent of injury. The dose-rate may be reduced by a factor of 30 or more without appreciably affecting recovery, yet reduction by one-half may profoundly affect recovery. In general, the slower the rate or longer the interphase of stem cells of different mammalian tissues and of stem cells in the same tissue, the greater is the damage produced by prolonged exposure to low dose-rates or to small, widely separated dose increments. Different thresholds exist for different biological effects such as acute cell destruction, prolongation of interphase and sterilization of the same stem cell at different stages of interphase. In addition, an overshooting of mitotic activity related to dose may occur during recovery.

Photosynthetic Gas Exchange Potentialities of the Lemnaceae (Duckweed) Family.

S. S. WILKS, Ph.D., Space Ecology Branch, Department of Space Medicine, School of Aerospace Medicine, Aerospace Medical Center, Brooks AFB, Texas.

Preliminary studies with representatives of three genera of the duckweed family have shown that these simplest of the seed plants may rival the algae as components of closed ecological systems. By using a specially designed cylindrical chamber 11 inches in diameter and 52 inches long, gas exchange rates of 800-900 ml/hour have been obtained. The peak growth rate obtained was approximately 1 gm/hour dry weight. In the chamber, the plants were uniformly distributed over approximately 75% of the surface of the cylinder walls. The nutrient solution within the chamber was approximately eight liters (Hoagland's nutrient plant solution). Cultures have been grown continuously in this chamber for periods of three months, with harvesting occurring at intervals of five to eight days during the last two months. The source of illumination for this chamber consisted of six power-groove lamps arranged around the periphery of the chamber and at a distance of approximately four inches from the surface of the cylinder. In pilot nutritional studies, four adult white mice were fed on dry duckweed pellets for a period of one month without other food supplements. The animals were maintained in a healthy, constant weight state during this time. Studies have also been carried out to determine (a) growth rates; (b) temperature optima, maxima and minima; (c) effects of varying periods of illumination and darkness; (d) effects of different wave lengths of light upon growth rate; (e) effects of light intensities below the 500 foot candle level; (f) effects of (and tolerance to) changes in the concentration of the components of the nutrient solution.

Survival and Growth of Organisms During Life-Long Exposure to High Gravity.

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This paper reviews studies by our own and other laboratories concerned with chronic exposure to centrifugation. Most investigators have studied fields sufficiently intense to cause mechanical damage or impair circulation and respiratory movements. There have been very few studies at fields which permit an almost continual existence. The first such study was performed by Knight in 1806. Working with bean plants, he showed that gravity can influence the direction of growth. The first quantitative studies were reported in 1953 with wheat. Working with the coleoptile of this form, Gray at Emory University observed definite, but decreased, growth at fields as intense as 500 G. At the same time, Matthews at Cambridge, England, reported that rats at 3 G could develop, but to a smaller than normal size. Our own laboratory started investigations along this line in 1954, first with fly larvae, later with hamsters, mice and mouse tumors. Smith and his group at Davis, began comparable studies with poultry in 1955. All forms grew at slower rates at sufficiently high fields and demonstrated structural and metabolic modification, often growing very fast upon return to normal gravity. Fruit fly larvae demonstrate some growth at 5,000 G. At moderate fields, fly larvae, coleoptile, and mouse femurs accelerate their growth. Mice survived for as long as a year at 7 G and for two years at

2 G, even breeding and rearing young at this field. One may reasonably conclude that some types of terrestrial life could survive and multiply in the gravity of another planet.

A Concept of Operational Bioastronautics.

COL. RAYMOND A. YERG, M.D., USAF, MC, and LT. COL. JOSEPH J. ROSA, USAF, Air Force Missile Test Center, Patrick AFB, Fla.

In common with other endeavors, bioastronautic activities occur on three distinct but interrelated levels. Bioastronautic research and development efforts are generally basic in nature and not project directed in approach. Project-oriented bioastronautic activities refine the resultant products through empirical tests for project use. Operational bioastronautic activities begin when the validated bioastronautic elements and the fully trained and conditioned pilots/crew arrive at the launch site for final preparation and integration into the space vehicle for actual flight. It is the function of operational bioastronautics to prepare the bioastronautic elements and the pilot or crew for the voyage during the pre-launch phase and to help assure that they will be capable of performing at a high level of efficiency in a safe and reliable manner during all phases of space flight, including re-entry and landing. These activities end when the findings of each mission are reduced and made available to the basic, project-oriented and other operational bioastronautic agencies for their use. The purpose of this paper is to outline a concept of operational bioastronautics for use by all responsible agencies during every aspect of manned space flight missions regardless of the purpose and duration of each mission.

Ozone Toxicity.

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Ozone is highly toxic, concentrations below 30 ppm producing fatal pulmonary oedema in small animals. Levels of about 9 ppm have produced serious pneumonia in humans. The effect of repeated exposures to concentrations of less than 1 ppm is unknown. A layer of high ozone concentration is known to exist in the atmosphere between altitudes of 10 and 60 Km. and large shifts in the altitude of this band are known to occur. By recording the rate of deterioration of rubber bands placed in different locations in 3 DC-8 airliners cruising between 27,000 and 37,000 feet, we have formed an estimate of the ozone concentration that customarily exists in different locations in the aircraft. This concentration is probably about 0.4 ppm. It is not know whether any of this is being generated by equipment within the aircraft, or whether it is the result of compression of the surrounding atmosphere. A brief report on pulmonary function in a group of welders (argon shielded) who are exposed to ozone will also be presented.

Ophthalmological Effects of Coherent Light Sources.

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A brief description of the optical qualities of laser (optical maser) as related to the refraction and absorption characteristics of the eye are presented. Experiments are described wherein chorioretinal and iris lesions are produced. Physiological applications and personnel hazards are discussed.

Significance of Combined Stresses of G-Forces and Irradiation.

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The occupant of a space vehicle will be exposed to varying amounts of accelerative force upon injection into orbit, escape from Earth's gravitational field and re-entry into the atmosphere. Effects of G-forces ideally will be minimized by proper positioning of the astronaut within the capsule, but malorientation of the capsule could well occur due to system dysfunction. In addition to this stress, the crewman will be required to accept minimum radiation exposure in certain regions of the flight profile or possibly, additionally, larger doses due to unexpected solar flare activity. The additivity of these combined stresses, within time, is the subject of this paper. Groups of rats were exposed in an experimental array designed to explore the interaction of various amounts of positive, negative and transverse G-forces with graded doses of Co^{60} gamma irradiation before and at various time intervals following the acceleration exposure. The end point investigated was the LD^{50}_{30} of the exposed animals. Data will be presented and the significance of these data discussed.