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Lunar Landing Vehicle Helicopter Landing Simulation Study. C. R. ADAMS, M.S., Human Factors Analyst, Chance Vought Corporation, Astronautics Division of Ling-Temco-Vought, Inc., Dallas, Texas.

This paper covers a helicopter lunar landing simulation study from hover to touchdown for the Lunar Landing Vehicle under manual control. Also, it was to define qualitatively a reasonable value of distance from the hover point to a suitable landing site based on nominal translational velocities. A Sikorsky helicopter was used as the test vehicle to accomplish the maneuver. It followed a planned trajectory as closely as possible. Eight test subjects made eight runs each from various directions over a terrain-type approximating what is thought to be the estimated lunar surface roughness. The tests were conducted at noon with the subjects wearing dark goggles to obtain equivalent earth shine values of lunar surface illumination. Five seconds before the initial hover point was reached the subject had clear visibility of the landing area and the site was selected. Time and distance were recorded from hover to touchdown. Results of the test program indicated that if the first site selected is suitable for landing the Lunar Landing Vehicle would be able to land within a specified number of seconds. However, if an alternate site must be selected and traversed due to the poor terrain choice, the time allowed is marginal. Based on these facts, a recommended hover time was made for the lunar landing maneuver of the Lunar Landing Vehicle.

Present Philosophy of Standards Development. WILLIAM R. ALBERS, M.D., Chief, Aeromedical Standards Division, Federal Aviation Agency, Washington, D. C.

Federal Aviation Agency considers three closely related, basic factors in developing aeromedical standards for civil aviation: (1) Job Performance Requirements; (2) Aviation Safety; and (3) Civil Aviation Growth.

An even more basic concept underlies all aeromedical standards development: A constant awareness that this activity is an integral part of the National Aviation System. This concept demands that aeromedical standards development be accomplished, not as an isolated specialty activity, but with competent knowledge of the various disciplines and components that make up the National Aviation System, and full appreciation of how medical standards relate to the System. The National Aviation System concept should underlie all aviation planning.

Of the three basic factors noted above, Job Performance requirements must receive first consideration. Unless medical standards are related to actual pilot, aircrew, or air traffic controller job performance requirements, they are meaningless. Pilot job performance requirements are related to, and vary with, many factors, such as the type and performance of equipment flown (light planes, jet transports, etc.), and the type of flying (pleasure, scheduled air carrier, etc.). Study of the relationship between aircrew job performance requirements and specific aeromedical standards has not been adequate in the past. Research interest has recently been re-stimulated in this area.

A standards development program which will meet the needs of the National Aviation System, and which will help the Federal Aviation Agency attain its primary goals of increasing safety and fostering civil aviation growth, must proceed with a full and constant appreciation of this fact: A standard which is too rigid retards the growth of aviation by keeping people out of the air who could be flying safely, and conversely, a standard which is too lenient compromises aviation safety.

A good aeromedical standards development program must look to the future. It should be involved in the studies and planning of such programs as Project Little Guy and the Supersonic Transport Development Program. Aeromedical Standards development must be dynamic or it will fail in its mission.

Inputs necessary to intelligent aeromedical standards development include (a) operational and statistical analysis of data from the Human Factors Studies of Aircraft Accidents and Incidents, (b) aircrew job performance requirements research, (c) advances in basic medical research, (d) physiological and psychological aircrew research, (e) consultation with experts in the various disciplines of aviation, and (f) consultation with authorities in the various medical specialties.

The basic criterion behind every medical standard is safety. The Federal Aviation Agency has frequently been accused by certain groups of following the so-called "superman" principle in its aeromedical standards development, i.e., requiring that all airmen be perfect physical specimens. Nothing could be farther from the truth. Many physical defects and disease states have been waivered once it has been determined that they do not compromise safety.

Measurement of Body Fat in Men by Displacement of Water. THOMAS H. ALLEN, Ph.D., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

A Flight Surgeon's Assistant can operate a body volumeter with which fat (ether soluble) can be estimated in 15 minutes. The lower portion of a waterproof plywood tank contains 32° C. water and a trace of a disinfecting iodine complex; the upper portion is of uniform cross-section. Here a rise of 1 mm. is caused by 0.2249 liters. A graduated glass standpipe is connected to the tank through a needle valve which is adjusted so that wave motion is rapidly dampened. With a lens, one estimates water levels after the subject blows out his vital capacity and then submerges. An example shows the mean rise on three trials: $338.4 = 1/3\text{-}(429.2 + 429.4 + 429.7) - 78.5 - 12.5$. The 78.5 was the null point and the 12.5 was caused by the elevator platform on which the subject was lowered. Multiplying 338.4 by 0.2249 gives 76.11 liters; subtract 1.66 liters of "predicted" residual lung volume. Fat, calculated from volume and weight, is $4.834 \times 74.45 - 4.366 \times 79.00 = 14.98$ kg. The average in 243 healthy men, aged 19 to 29 years, is 19 per cent of their fat-free weight. Since $14.98 - 0.19 \times 64.0 = 2.8$ kg., this is the excess fat.

Therapy of Acute UDMH Intoxication. KENNETH C. BACK, Ph.D., MILDRED K. PINKERTON, M.T. and ANTHONY A. THOMAS, M.D., Wright-Patterson Air Force Base, Ohio.

The potentially toxic agent, 1.1-dimethylhydrazine (UDMH), has become very important from a medical viewpoint because of its large scale use as a missile propellant. Pharmacological studies have revealed that the compound is primarily a central nervous system irritant, and latently causes cardio-vascular collapse and ensuing irreversible shock. Symptomatic treatment consisting of a combination of sedatives, anticonvulsants, neuromuscular blocking agents, cardiac glycosides, potent vasoconstrictors, artificial respiration, and plasma expanders failed to protect animals from lethal doses of UDMH. A recent breakthrough with pyridoxine therapy constitutes the first successful approach to specific treat-

ment which prevents convulsions and death in all species tested. The ED 50 (effective dose) of two Vitamin B_6 congeners, pyridoxine hydrochloride and pyridoxamine dihydrochloride were determined in mice, rats, dogs, and monkeys. The only manifestation which was not abolished by this therapy in dogs and monkeys was vomiting. The data presented in this paper are the basis for suggested emergency treatment of severely exposed personnel. The toxicity of pyridoxine is discussed with overall therapeutic and clinical considerations including routes of administration and dosage regimens.

Applications & Limitations of Some Toxic Propellant Detection Equipment. KENNETH E. BALL, Mine Safety Appliances Company, J. T. Ryan Laboratory, Pittsburgh, Pennsylvania.

The use of MSA equipment in various propellant hazard applications such as the Agena, Titan II, and Edwards R & D programs is described. The complex multi-point Titan II system complete with alarms, recorders, fail-safe features and purge interlocks is contrasted with hand carried portable devices as extremes of area monitoring. Limitations discussed include problems of obtaining representative samples, sample line losses, and the human factor. Especially emphasized is the need for toxicological education among persons concerned with design, construction, and operation of missile facilities. Several field experiences are reported to exemplify this need.

Rapid Decompressions Above 50,000 Feet. RICHARD W. BANCROFT, Ph.D. and LT. COL. DAVID G. SIMONS, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

To provide further information concerning the capability of human subjects to perform emergency maneuvers at high altitude wearing minimum protective equipment, 7 decompressions with 5 subjects were performed from 25,000 feet to altitudes up to 60,000 feet, using only the standard pressure-demand oxygen mask and regular. Decompression times were 3-4 seconds, following which each subject manually opened two recompression valves with consequent repressurization of the test chamber to approximately 30,000 feet at a rate of about 0.3 psi/second. Before, during, and after the decompressions, the subjects performed a psychomotor tracking task, stopping only long enough to open the recompression valves when signalled to do so by a panel light. Psychomotor performance was recorded continuously together with the pressure changes and time course of the decompressions, signal light activation, reaction times, mask pressures, respiratory and heart rates. Simultaneously, the ECG, EEG, GSR, and nasal air flow were continuously telemetered and tape-recorded. Four decompressions were to 60,000 feet, the average time at peak altitude being 1.6 seconds and time above 50,000 feet about 5 seconds. The average reaction time for initiating recompression was 0.98 second. Mask pressures at peak altitude were 22-40 mm. Hg depending on quality of mask fit. Subjective sensations and recorded measurements indicated no important changes characteristic of hypoxia.

Effects of Electric Fields and Negative Ion Concentrations on Test Pilots. CHARLES I. BARRON, M.D. and JOHN J. DREHLER, Ph.D., Lockheed-California Company, Burbank, California.

Ten volunteer test pilots of Lockheed-California Company were exposed to a series of tests designed to elicit possible biochemical, physiological, and psychomotor effects of moderate (average 1,000/cc) negative ion concentrations and positive electrostatic fields (gradient of approximately 1,000 volts/meter). The experiment was conducted in a controlled environment with tests chosen because of relevancy to flying and its demands and to ease of standardization. Laboratory tests were designed to detect changes in chemical stressors and included measurements of blood glucose, serum non-esterified fatty acids (NEFA), urinary ketogenic steroids and ketosteroids, catecholamines, and 5-hydroxyindolacetic acid. Physiological measurements included pulse rate and pressure and respiratory rates. The psychomotor tests gauged brightness discrimination, reaction time, complex mental-motor functions, and muscular steadiness with fatigue. The subjects were tested four separate times for a period of one hour each under baseline, void, electrostatic field alone, and with ions and field combined conditions. Results showed that healthy, non-fatigued pilots, when exposed for short periods of time to a constant positive electrostatic field or a combination of negative ions and electrostatic field, experienced no significant change in subjective state or biochemistries. Except for changes in brightness discrimination threshold, psychomotor functions were unchanged. Additional studies using variable exposure conditions, fewer but more sensitive tests, and fatigued subjects were considered.

Deleterious Physiological Effects Inherent in the Use of the Mae West Type Life Jacket for Survival from "Disaster at Sea." CAPTAIN E. L. BECKMAN, MC, USN and LT. COMMANDER R. E. DEFOREST, MC, USN, Naval Medical Research Institute, Bethesda, Maryland.

Survival from a disaster at sea is not simply a matter of protection against drowning. The standard life jacket prevents drowning, but leaves the survivor to face four other major stresses: (1) heat loss, (2) dehydration, (3) inanition, and (4) spiritual failure.

The partial body immersion which results from the use of the Mae West type life jacket for flotation induces two deleterious physiological changes in the body which increase the severity of these stresses: (1) profuse and prolonged diuresis, and (2) inexorable heat loss into the sea even at water temperatures which have heretofore been considered to be innocuous. Because of these effects, the use of the life jacket stringently limits the survival of those saved from immediate drowning. An alternative type of individual flotation garmet will be described which would obviate these difficulties.

Ocular Hyperoxia. CAPT. CECIL C. BEEHLER, USAF, MC, CAPT. NORRIS L. NEWTON, USAF, MC, and LT. COL. JAMES F. CULVER, USAF, MC, Experimental Surgery Department, School of Aerospace Medicine, Brooks Air Force Base, Texas.

Large amounts of oxygen used in the Air Force under a great variety of conditions demands that the toxicity of oxygen be clearly defined. There is some evidence to suggest that the eye may be especially sensitive to hyperoxia. This experiment is concerned with the special effects of hyperoxia.

Ten healthy adult standardized dogs were placed in a chamber contained 684-752 mm. Hg of oxygen for 72 hours. Temperature, humidity and CO_2 level were monitored and controlled. At the end of 72 hours the animals were examined by direct or indirect ophthalmoscopy. Interesting findings were photographed. Surviving animals were sacrificed immediately after examination. All eyes were submitted for histologic study.

The following pathological changes were noted. Bilateral retinal detachments, conjuctival edema and corneal haze were each seen in two animals. Venous engorgement of the retinal vessels was seen in three cases. Horizontal nystagmus and anterior chamber hemorrhage were each seen in one animal. Histological section confirmed these findings.

Some of the changes resemble the early stages of retrolental fibroplasia. It is conceivable that hyperoxia is capable of producing a similar disease in the adult eye. The chronic effect of lesser degrees of hyperoxia should be evaluated.

Triaxial Human Ballistocardiogram in Zero G Environment. D. E. BEISCHER and W. C. HIXON, USN School of Aviation Medicine, Pensacola, Florida.

The linear and angular accelerations in three perpendicular axis of a free floating man have been telemetered and recorded. The flights were performed on a KC-135 with cooperation of the Aerospace Medical Research Laboratory at Wright-Patterson Air Force Base, Ohio.

The spatial relationship of the cardiovascular forces will be demonstrated and the significance of the results for cardiovascular performance in the gravity free state discussed. The equipment used in this study will be on exhibit and vectorballistocardiograms demonstrated.

Origins of Conscious Sensations of Warm or Cold in Man. THEODOR H. BENZINGER, M.D., Sc.D., Naval Medical Research Institute, Bethesda, Maryland.

In addition to the automatic, hypothalmic mechanisms for human temperature regulation (the human thermostat) man

possesses a large, although less precise capability of regulating his temperature by behavior. In order to react intelligently to adverse environments by locomotion, exercise, or adequate clothing man depends on conscious sensations of warm or cold. Our study was concerned with the origin of these sensations, from the skin or from the interior of the body. In water baths skin temperatures were either changed to, and maintained at, a large variety of different constant levels, or gradually reduced to find thresholds of temperature perception. Internal temperature was deliberately varied by pre-warming or pre-cooling in appropriate baths. Internal (cranial) temperatures were measured at the tympanic membrane. It was found that the feeling of being cold is predominantly mediated by skin cold-receptors whereas unpleasant feelings of being over-warmed are predominantly mediated by an internal warm-receptive system, possibly the anterior hypothalmic "temperature's eye" or "human thermostat." The internal conscious sensation of warm, if mediated by anterior hypothalamic warm-sensors, would appear to be an important parallel to the conscious perception of light, registered at the retina, and transmitted through the thalamus opticus to the occipital cortex.

A Composite Model of the Atmosphere and Surface of Venus. RAINER BERGER, Plasma Physics Department, Lockheed-California Company, Burbank, California.

Venus has been a planet very difficult to observe visually. Its orbit closer to the sun permits inspection only after sunset or before sunrise, but never during an entire dark night. Also, the planet is shrouded in dense obscuring cloud layers.

Besides visible light investigations, many measurements have been carried out in recent years in the infrared, ultraviolet and in the microwave regions trying to broaden our knowledge. Both earthbound and space-probe observations have led a number of investigators to describe the atmosphere and surface of Venus on the basis of these data. However, different models have resulted, some of which appear to exclude one or the other hypothesis.

It is the purpose of this paper to re-examine the issues, especially in the light of the Mariner II results and arrive at a composite model for the environment on Venus including: radiation belts, solar flux, composition of the atmosphere, meteorology, temperature and the nature of the surface.

The Importance and Value of Electroencephalography in Aeronautical Medicine. C. BLANC, E. LAFONTAINE, and R. LAPLANE, Air France, Central Medical Department, Paris, France.

The Air France medical department has been using electroencephalography for about ten years and we have obtained data of great interest for the selection and medical supervision of flight personnel. The evolutive studies we have been able to carry out on subjects examined periodically—either in the course of systematic check-ups or in the event of pathological episodes—have enabled us to clarify certain problems which, a few years ago, were considered insoluble: the limits of normality; the value of EEG as an index of organicity.

The experience acquired from material consisting of 8000 graphs, spread out over a period of 10 years, has led us to set the discussion on EEG data in a reference system made up of three parameters: 1) lesional or commissural organic factors; 2) psychological and psychiatric factors; 3) general physiological and pathological factors. The electrical patterns of the encephalon constitute non-specific expressions which can be observed in identical forms in different etiological contexts. The importance of the EEG data can only be elucidated by placing them in the pluridimensional context of the individual. The study of the psychological context and the biography are, just as with the neurological examination, necessary for decoding the EEG data. Used in this perspective, EEG has provided us with data of considerable practical importance:

1) The absence of "organic" signification of certain figures previously considered as eliminatory.

2) Correlations between the infraclinical "anomalies" and the psychological and psychiatric factors.

3) Discrimination and grading of EEG data leading to a readjustment of the "conventional EEG" criteria.

Biomedical Results from X-20 Dynamic Simulation Program. MAJOR HARRY R. BRATT, USAF, MC and JOHN KURAMOTO, Edwards Air Force Base, California.

The results of the biomedical monitoring of the six pilots in the Dyna-Soar Dynamic Simulation Program at the Naval Air Development Center, Johnsville, Pennsylvania, and a description of the instrumentation used are presented. An instrumentation package was designed and fabricated by the AFTC Instrumentation Branch to collect data on the following parameters during each centrifuge operation: Suit vent inlet temperature, suit vent flow rate, oxygen partial pressure (1%), skin temperature, respiratory rate, electrocardiogram, blood pressure, and suit pressure. Each pilot received pre-and post-run medical examinations. The analysis of the data demonstrated no significant differences of the pilot's physiologic responses between static and dynamic conditions, and it is concluded that the time-acceleration boost profile of the Dyna-Soar vehicle produces no significant physiological stress on the pilot.

An Analytical Treatment of the Fluid Shift in the Weightless State. PHILLIPS M. BROOKS, Ph.D., Department of Aerospace Medicine, McDonnell Aircraft Corporation, St. Louis, Missouri.

If it is assumed on the basis of the relationships, P=hdg and F=Mg, that part of the hydrostatic pressures in the vascular and extravascular compartments are due to gravity, then on the basis of the Starling osmotic-hydrostatic pressure equilibrium, a differential equation can be derived which will relate pressure changes and fluid movement to time in the gravity-free state.

Such an equation was derived and was found to describe the fluid shifts of the Landis plethysmograph data in relation to time and pressure quite accurately. If the time-pressure-constants obtained from the Landis data are applied to man in the gravity-free state, it is found that a fluid shift, from the extravascular to the vascular compartment equivalent to about 20 per cent of the plasma volume occurs and that such a shift is 99 per cent completed within 110 minutes from start of exposure.

Pathology of Chronic Acceleration. RUSSELL R. BURTON, D.V.M., WILLIAM P. C. RICHARDS, D.V.M., and ARTHUR H. SMITH, Ph.D., University of California, College of Agriculture, Davis, California.

Chronic acceleration produced by centrifugation is a highly lethal treatment. When growing chickens are exposed to an accelerative force of 2.5 G, about half of them die in eleven days —however, the mortality curve is not a smooth exponential relationship. Resistance to chronic acceleration requires a true physiological adaptation, and the factors involved in that adaptation are heritable. After five generations of selection (on the basis of survival) for resistance to chronic acceleration, the exposure to 2.5 G leading to a 50 per cent mortality is increased to 60 days.

When animals dying during chronic acceleration are examined post-mortem, a variety of pathological changes are evident—however, none is present systematically. It seems likely that several pathologies are involved in chronic acceleration death. Recent routine examination of centrifuged birds has indicated about 25 externally observable items which change in some birds during chronic acceleration, including: general appearance; evidence of normal nutrition; posture and locomotion; and reflexes. When these were graded on a + (normal), or – (abnormal) basis, a score varying from +20 to –20 was obtained. On the basis of rate of development of symptoms (zero-time being the onset of symptoms, rather than start of centrifugation) the birds can be divided into five groups.

A Psychometric-Clinical Approach in Personnel Selection. CAPTAIN G. K. CANTRELL, USAF, MC and MAJOR R. A. DAGAUGH, USAF, MC, Hq. 6570th Personnel Research Laboratory, AMD, Box 1557, Lackland Air Force Base, Texas.

A special USAF project required the selection of volunteer personnel, from a technically qualified Air Force population, who would be required to behave in a stable, reliable manner in a new and stressful environment. To accomplish this requirement the following procedure was used: (1) A battery of personality tests was administered to all volunteers, and pertinent biograph-

ical data were obtained on each. (2) Psychologist who had access to the results of personality tests conducted individual psychological interviews; Clinical Psychologists administered the Rhorschach test; and Psychiatrists conducted a brief psychiatric interview. Each evaluator assigned a numerical rating to each volunteer. (3) An overall numerical rating was then assigned by the three interviewers in conference, and a "go, no-go" evaluation was made. This study presents the validity of the psychometric measures in predicting the overall numerical ratings, and also presents inter-rater reliabilities.

The Pathology of Ejection Failure. CAPTAIN RICHARD M. CHUBB, USAF, MC, CAPTAIN W. HARLEY DAVIDSON, USAF, MC, and LT. COMMANDER WALTER D. GABLE, MC, USN, Armed Forces Institute of Pathology, Washington, D. C.

A review of all fatalities accessioned since 1957 at the Armed Forces Institute of Pathology as a result of ejection failures has been completed. The circumstances surrounding death and the autopsy findings, both anatomical and toxicological, have been studied in an effort to determine the causes of fatal injuries. The results of this study are presented in order to point out the patterns of injury seen in the different ejection situations. Representative cases are briefly presented in order to show the mechanism of injury and thus form a basis for recommendations for prevention of these injuries.

Human Vibration and Impact Isolation with a Prototype Full Length Air Bag Restraint System. CARL CLARK, Ph.D., BRUCE COOPER, B.S., and CARL BLECHSCHMIDT, B.S., Life Sciences and Structures Departments, Martin Company, Baltimore, Maryland.

A preliminary air bag restraint system has been developed, with the subject supported in front and back by full length air bags inflated within a box container of 22 x 34 x 84 inches at pressures up to 10 inches of water. An opening through the top bag and box allows respiration. By November 1, 1962, 95 vibration tests and 68 impact tests with three subjects had been carried out. With a box vibration of $1G_x \pm 3G_x$ (sine wave) at 11 cps and a lower bag pressure of 3.5 inches of water, the subject experienced $1G_x \pm 0.4G_x$ (sine wave) at 11 cps, for five minutes with only slight discomfort. To prevent waist flexure during impact, the subject lay on a back board. With a box impact into sand from four feet up, hitting at 16 feet per second with a peak deceleration recorded of $310G_x$, and with the lower air bag at 10 inches of water pressure and the upper at 7 inches of water pressure, the accelerometer on the hip of the subject peaked at $17.2G_x$. A valve system for dumping the bag pressure at maximum displacement, to prevent rebound, is under development. Technical developments of means of control to prevent "bottoming" and to vary resonance frequencies warrant further exploration of acceleration isolation restraint systems.

Biodynamic Response to Supersonic Ejection. CAPTAIN NEVILLE P. CLARK, USAF, VC, Aerospace Medical Research Laboratories (MRMAV), Wright-Patterson Air Force Base, Ohio.

Six supersonic test ejections of the B-58 escape capsule were made from a specially modified Hustler. Five black bears and one chimpanzee were used as subjects. Ejection altitude was between 35,000 feet and 47,000 feet and speed varied betwen Mach 1.3 and 2.0. In the second test ejection, made from 45,000 feet at Mach 1.6, excessive positive pitching of the capsule induced unstable flight producing cyclic high amplitude lateral acceleration associated with oscillation in yaw. The bear subject sustained bilateral complete fractures of the acetabular branch of the ischium. In the following ejections, a change in orientation of the rocket thrust vector to prevent excessive pitching was tested and shown to be successful. In addition to the supersonic ejections, three subsonic ejections using bear subjects, one from 40,000 feet at Mach 0.8, one from 5,100 feet at Mach 0.9 and one rolling runway ejection at 100 knots were done to validate satisfactory performance of the capsule over the flight envelope of the aircraft after the change in rocket thrust vector. The results of these ejections will be discussed using engineering test motion pictures to illustrate capsule performance and to relate capsule motions and acceleration to the response of the subjects.

The Problem of Heterotropia in Trained Pilots. CAPTAIN WILLIAM B. CLARK, USAF, MC and LT. COLONEL JAMES F. CULVER, USAF, MC, Ophthalmology Department, USAF School of Aerospace Medicine, Aerospace Medical Division, Brooks Air Force Base, Texas.

This paper is presented to fill a serious gap in the Aerospace Medicine literature: the lack of any reports concerning the aeromedical consequences of heterotropia. This diagnosis automatically indicates the end of a flying career unless the benign or even beneficial effects of some types of heterotropia are understood by the aeromedical examiner. For example, a pilot who involuntarily and unconsciously suppresses the vision of either eye cannot be a victim of visual confusion or diplopia. Aeromedical hazards, of course, exist in some cases. The visual effects of the various types of heterotropia patients will be discussed as well as recommendations concerning their disposition. Specific cases with their follow-up studies will be presented.

Pathology of Experimental Dysbarism. MAJOR JAMES R. CLAY, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

Several groups of investigators at the USAF School of Aerospace Medicine are producing dysbarism in dogs attempting to simulate decompression sickness in man. At the end of these experiments the dogs were autopsied and studied by routine histopathologic methods. In general, the tissue changes were similar to those of fatal human decompression sickness. Findings included multiple fat emboli in lungs, scattered petechiae, congestion, and pulmonary edema. A very interesting and previously unreported finding of bone marrow and other tissue emboli in the pulmonary arteries occurred in approximately one-third of the animals. This is the first instance in which bone marrow emboli have been found in the absence of trauma of the bones. Also of interest was the finding of fat emboli in the renal glomeruli even in the absence of defects in the heart. Possible mechanisms of these findings are discussed.

Carbon Dioxide Management in Space Capsule Atmospheres by Regenerable Adsorption of Carbon Dioxide on Synthetic Zeolites at Low Temperatures. C. S. COE and GEORGE CHRISTENSEN, Airesearch Manufacturing Company, Los Angeles, California.

The utilization of low temperatures to increase the efficiency of regenerable adsorbents for carbon dioxide management appears to have possible applications in manned space missions. In some vehicles, cryogenic fluids carried to supply atmospheric gas or power systems would be used to lower the temperature of the contaminated inlet gas to the adsorber. In order to evaluate the effectiveness of this proposed process, engineering data were obtained on the adsorption of CO_2 on various types of synthetic zeolites at temperatures as low as 300°R. Data were obtained to determine the capacity of the synthetic zeolites for CO_2 at various temperatures and at various superficial velocities. The effect of canister length on adsorption efficiency was studied and canister pressure drop measured.

The tests indicate a distinct increase in the adsorption capacity of the synthetic zeolites for carbon dioxide as the temperature is lowered. Adsorption was found to be more efficient at longer contact times. Results of vacuum desorption tests are also reported.

Analysis of Induced Disorientation in Primates. LEONARD A. COHEN, Ph.D., Head, Department of Physiology, Korman Research Laboratories, Albert Einstein Medical Center, Philadelphia, Pa.

The physiological principles underlying the overall ability of an organism to orient itself in its environment is being investigated by developing quantitative objective methods for analyzing normal orientation, and then applying these methods to the study of disorientation which is experimentally induced in the same subjects. In this specific study, certain drugs—LSD, Sernyl,

Ditran—are used as research tools for experimentally producing body disorientation, thus permitting repeated studies of disorientation and normal orientation in the same individual. The ability of "pigtail" monkeys and baboons to orient themselves in relation to specific objects in their environment and to maintain body balance was measured in a special testing room containing mechanically operated climbing pegs, a constant speed or a free running swing, a vertical ladder and adequate floor space for walking, running and playing activities. Performance of the subjects was permanently recorded by motion picture camera and orienting ability was measured in terms of certain objective criteria. Normal orientation, and disorientation caused by hallucinogenic drugs and also that resulting from surgical interference of orienting components done in concomitant studies, were then compared and analyzed.

Urinary Excretion of Corticosteriods and Catechol Amines in Normal Persons (Non-Pilots) and Deaf Subjects With Bilateral Vestibular Defects Subjected to Acrobatic Flight Stress. JAMES K. COLEHOUR and CAPTAIN ASHTON GRAYBIEL, MC, USN, Naval School of Aviation Medicine, Pensacola, Florida.

This report is one of a series dealing with comparative studies between normal subjects and deaf persons with bilateral labyrinthine defects (L-D subjects) exposed to identical or nearly identical force environments. In this instance all of the subjects were exposed to a standardized series of acrobatics in an AD-5 Skyraider. The total daytime and nighttime urinary excretions were collected the day prior to flight and on flight day. The activities of the subjects were standardized insofar as possible. Adrenalin and nor-adrenalin were measured according to the method of Crout, 17-hydroxycorticosteroids according to the method of Kornel and uropepsin according to the method of Anson.

On the day of the flight compared to the control day, the excretion of catechol amines and corticosteroids was significantly higher for the normal but not the L-D group. Other interesting intergroup differences were noted as well as individual variance. Some of the differences were clearly attributable to the vestibular organs but other differences were either related to basic personality trait or unexplained.

There were no significant differences in uropepsin secretion between the control and flight days either in the case of the normal or L-D group. The difficulties attending the use of this method are mentioned.

Unexplained Loss of Consciousness. CAPTAIN JOSEPH H. COMBS, JR., LT. COLONEL ROBERT L. JOHNSON, and L. E. LAMB, M.D., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

Recent surveys have documented a high incidence of syncope, or unexplained loss of consciousness, in USAF flying personnel and have led to greater latitude in medical disposition of such cases. Factors other than severe blood loss, acute or severe illness, and pain from severe trauma now receive recognition as potentially adequate cause for syncope. The relative importance of less dramatic factors such as fatigue, minor illness, hunger, prior alcoholic indiscretion and other which may act cumulatively must be assessed in each case if flying strength is to be conserved without compromising flying safety.

Since current knowledge does not allow completely reliable prediction as to recurrence of syncope in the individual case, all of these factors as well as information derived from clinical examination must be evaluated in terms of what is known from previous experience to be important in this prognostication. The experience of the School of Aerospace Medicine in the evaluation of many problems of this type confirms the important etiological role of numerous factors other than the recognized major causes of syncope. Current opinion regarding such factors and certain important findings on examination will be summarized.

Radiation Protection for Manned Space Flight. LT. COL. JOSEPH A. CONNOR, JR., USAF, MC, National Aeronautics and Space Administration, Washington, D. C.

Protection of astronaut crews from ionizing radiation during space flight presents a complex problem due to the nature of radiations in space, interactions of these radiations with different shielding materials, and the responses of biological tissue.

The National Aeronautics and Space Administration, assisted by the National Academy of Sciences, the Atomic Energy Commission, the Department of Defense, University and Industrial research centers, has been conducting an intensive nationwide analytic and experimental investigation of the problem, using ground laboratory facilities, high energy particle accelerators, space probes, and scientific satellites.

A comprehensive review of this work will be presented, together with the current NASA Office of Manned Space Flight analysis of the space environment, vehicle radiation sources, radiation risks, shielding concepts, acceptable astronaut exposure tolerances, mission considerations, and possible medical operational measures.

General Aviation Accidents: An Epidemiologic Approach. CAPT. RONALD E. COSTIN, USAF, MC, USAF School of Aviation Medicine, Brooks Air Force Base, Texas.

Although much research data are available in the field of general aviation (private flying) accidents, most of it is oriented toward one narrow aspect of the problem. To aid in the establishment of prevention programs this epidemiologic analysis attempts to delineate the relative importance of the known accident causal factors so that efforts may be directed toward those of most significance. The study includes a general review of the nature and extent of the accident problem followed by an application of accepted epidemiologic methods in the descriptive and analytic study of available accident data. The subject is approached at three levels of causation—the host (pilot), the agent (airplane), and the environment.

The analysis points out some factors in which further analytic studies are needed and factors which are amenable to immediate attack, wtih recommendations as to how their correction might be approached.

In conclusion a strong appeal is made for improved investigation of the light plane accident, oriented more directly toward finding the reasons for pilot errors, the number one "cause" of general aviation accidents.

Definitive Surgical Treatment of Spontaneous Pneumothorax. COLONEL PHILIP A. COX, USAF, MC, Chief, Surgical Services, USAF Hospital, Andrews Air Force Base, Maryland.

In the past four years at USAF Hospital, Andrews Air Force Base, 74 patients have been admitted for treatment of spontaneous pneumothorax. The treatment has been varied, ranging from bed rest and observation, needle aspiration, and tube thoracotomy with underwater bottle drainage with or without controlled suction to definitive thoracotomy. Ten of these cases have come to this latter procedure, either for repeated pneumothoraces or because of the necessity for a cure in order to return them to "flying status."

The indications for surgery, the pathology, and the type of surgery performed are discussed. The 10 cases are tabulated and a follow-up is given.

The cases wherein open thoracotomy is considered after only one episode of pneumothorax are those patients in the military who are subject to rapid and marked changes in atmospheric pressure. Some of these have been pilots or paratroopers and after definitive surgery they have been able, after suitable convalescence and chamber testing, to resume their military duties without recurrance.

Psychological Correlates of Biodynamic Stress. RAY A. CRADDICK, Ph.D., Assistant Professor of Psychology, New Mexico State University, Las Cruces, New Mexico.

Current research studying psychological correlates of biodynamic stress at Holloman Air Force Base suggests several methodological problems. An outline of the methodological approach being used and concurrent problems will be discussed. Comparisons of performance on various psychological tests prior to and immediately after experiencing different "G" stress on sled-run impact are being studied. Over-all performance changes following six months of biodynamic stress will be measured. Discussion of five subjects exposed to over 500 cumulative "G" stress will be discussed in terms of their test performances.

Manpower, Missiles and Morale. CAPT. E. H. CRAMER, USAF, MC and CAPT. P. R. HANSON, USAF, MC, USAF School of Aerospace Medicine, AMD, Brooks Air Force Base, Texas.

The two major psychiatric problems of the missile medicine officer are the selection and the maintenance of effective missile personnel. Whereas the relevance of psychiatry to problems of selection is generally recognized, there is all too little appreciation of the relationship of psychiatric principles to the maintenance of functional effectiveness of those troops already selected.

The scope of this paper is to emphasize the impact of *extra*-psychic factors (stresses and environmental problems) on the functional effectiveness of the "normal" individual.

The functional effectiveness of the normal individual is impaired by excessive levels of tension or anxiety whether chronic or acute. While moderate increases of anxiety may facilitate attention and other mental processes, excess anxiety leads to impairment of thinking, concentration and judgment.

The "normalcy" of the Air Force population is discussed. Stresses, personal factors and environmental factors are presented to show how their inter-relationship influences a man's performance. Of major importance is the identification, prevention and elimination of those extra-psychic factors which increase the normal individual's anxiety and thus reduce his functional effectiveness. Concrete examples are given to show the direct impact of such factors on the individual's anxiety level. Finally, practical measures, relevant to these principles, are outlined.

Vastibular Responses to Oscillation About the Yaw Axis. R. L. CRAMER, Ph.D., P. J. DOWD, M.A., and D. B. HELMS, M.Ed., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

Nystagmus varies systematically in amplitude and phase with the frequency of oscillation. The relationships can be expressed in terms of a simple analog. Both these relationships can be altered by repeated stimulation in a conditioning program.

Whole Body Exposure Mechanism for Exposure of Primates to Protons. GEORGE W. CRAWFORD, Ph.D. and JOHN E. HEWITT, Ph.D., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

In order to evaluate the radiation hazards of space flight the USAF SAM is exposing the primate, Macaca mulatta, to whole body irradiations using accelerator proton beams. The problem of moving an animal through the beam to achieve uniform radiation is discussed.

Dose calculations, based on dE/dx data, are presented for the irradiation of a cylindrical model with 40 Mev and 200 Mev protons.

A mechanism is described which has been designed to expose the animals with a minimum of trauma. A simultaneous rotational and translational movement of the monkey holder permits uniform surface irradiation. The animals are irradiated transverly. The rotational speed may be varied from 0 to 3 RPM with a simultaneous translational motion of 0 to 6 inches/min. The dose rate is controlled by adjusting the beam intensity and the motion of the holder.

Results of experimental calibration runs with a collimated x-ray beam are presented. Depth dose measurements are given for a phantom exposed in the holder to a high energy proton beam.

The Aeromedical Problem of Glaucoma. LT. COLONEL JAMES F. CULVER, USAF, MC and CAPTAIN WILLIAM B. CLARK, USAF, MC, USAF School of Aerospace Medicine, Aerospace Medical Division (AFSC), Brooks Air Force Base, Texas.

The problem of glaucoma in aircrew personnel has aroused exceptional interest in recent years. The US Air Force Surgeon General's Office, recognizing its aeromedical significance, requires tonometry examinations to be included in the annual physical examination for aircrew members over forty years of age. Aeromedical screening has detected not only bona fide cases of unsuspected glaucoma but has also presented a "borderline group" with intraocular tensions in the range of 22-26 mm. Hg. The medical, administrative and technical problems presented are preplexing. This paper discusses these problems and relates cases seen by the Aeromedical Evaluation Service at the USAF School of Aerospace Medicine.

Human Tolerance for Carbon Dioxide in Nitrogen-Free Atmospheres. CAPT. R. G. CUTLER, USAF, MC, F. ULVEDAL, Ph.D., CAPT. JAMES E. HERLOCHER, USAF, MC, and B. E. WELCH, Ph.D., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

Knowledge of the effects of prolonged exposure of man to carbon dioxide-rich atmospheres is important for the design of the human environment of the spacecraft. Although no studies have been available on the chronic effects of carbon dioxide on man in the type of atmosphere used in present and future spacecraft (5 psi, 100% O_2), theoretical justification is available which suggests that tolerance for carbon dioxide might be different, possible greater, in 100 per cent oxygen, low-pressure atmospheres than in normal air of sea level pressure. Studies were carried out on healthy young USAF pilots exposed for three days to 23 mm. Hg of carbon dioxide (BTPS) in atmosphere of near sea level (700 mm. Hg) and of reduced (200 mm. Hg) barometric pressures. A greater increase in alveolar carbon dioxide occurred in the 700 mm. Hg atmosphere than in the 200 mm. Hg atmosphere, suggesting that tolerance for carbon dioxide may be greater in atmospheres of reduced pressure. Metabolic balance studies and other pulmonary function studies are also reported and discussed.

Rapid Decompression Hazards After Prolonged Exposure to 50% Oxygen-50% Nitrogen Atmosphere. LCDR. MORRIS J. DAMATO, MSC, USN, LCDR. FRANCIS M. HIGHLY, MC, USN, EDWIN HENDLER, Ph.D., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pa., and EDWARD L. MICHEL, M.S., NASA Manned Spacecraft Center, Houston, Texas.

The National Aeronautics and Space Administration (Manned Spacecraft Center) requested a study to determine the rapid decompression hazard following exposure to a proposed space capsule atmosphere. This hazard, after prolonged exposure to a 50% oxygen-50% nitrogen atmosphere, can be minimized with adequate denitrogenation as indicated by the results of tests described in this report. Seventeen naval enlisted personnel participated in a total of 136 man ascents to simulated altitudes. Tests were conducted in the ACEL Bioastronautical Test Facility with subjects breathing a 50% oxygen-50% nitrogen mixture for various durations at a simulated altitude of 18,000 feet prior to rapid decompression to a simulated altitude of 35,000 feet. Results of this investigation indicate that a minimum of 18 hours under the above conditions, or 3 hours of preoxygenation at sea level, provide adequate protection against the decompression hazard of bends, with no apparent noxious or toxic effects due to exposure to the 50-50 mixture or 100% oxygen for the durations tested.

The Pathology of Light Plane Accidents. CAPT. W. H. DAVIDSON, USAF, MC, H. H. KARNITSCHNIG, M.D., and W. J. REALS, M.D., Armed Forces Institute of Pathology, Washington, D. C.

Little information is available on the causes of death and the injury patterns in light plane accidents. Some 800 people were killed as the result of 450 light plane crashes last year; yet over the past 20 years only 150 fatalities were investigated by medical personnel.

The cases of death, the injury patterns and the role of pre-existing disease and other environmental factors surrounding the accident will be discussed. Plans for a comprehensive pathological and toxicological study of light plane accidents will be outlined.

Effects of Red Lighting on Accommodation in Aircrew Personnel. STANLEY DIAMOND, M.D., Pan American World Airways, Overseas Division, San Francisco, California.

Studies of accommodative amplitude in aircrew personnel under conditions of red and white lighting, indicate a definite, consistent, and significant decrease of apparent available accom-

modation under red light. Retinoscopy reveals that the eye is rendered optically more hyperopic under red light, because of the physiological chromatic aberration of the eye. This probably explains the accommodative loss under red light because a part of the total accommodative amplitude is required to overcome the optical or spectral hyperopia, leaving less available accommodation, which may be a source of eye fatigue. Accommodative fatigue (asthenopia) from this source may be expected to occur more in personnel with lowered accommodation; that is, the aging or pre-presbyopic age group who are rendered optically prematurely presbyopic under red light. This also suggests that a slight increase in the presbyopic reading addition or use of mild plus lenses in pre-presbyopes may be helpful for aircrew personnel doing detailed ocular work under red light conditions.

Interpretation of Carbon Monoxide Values in Selected Aircraft Accidents. CAPT. ABEL M. DOMINGUEZ, USAF, MSC, MAJ. JAMES R. HALSTEAD, USAF, MC, and COL. THADDEUS J. DOMANSKI, USAF, MC, Armed Forces Institute of Pathology, Washington, D. C.

The purpose of this investigation was: (1) to evaluate carbon monoxide (CO) values obtained in aircraft accident fatalities associated with drowning, postmortem decomposition, and the absence of whole blood; (2) to explore the possibility of the postmortem formation of CO; and (3) to examine those factors which must be considered in the interpretation of low, but perhaps significant, levels of CO in aircraft accident fatalities under the above conditions. Blood specimens were collected from control and CO-treated dogs prior to submersion in tropical sea water. After four days the animals were removed from water, and the specimens for toxicologic study were immediately placed in insulated boxes containing dry ice. All specimens remained in a frozen condition until examined for the presence of CO by means of gas chromatography. The results of this study are evaluated as they apply to the interpretation of CO levels in the medical investigation of aircraft accidents. In addition, these findings are applicable to medico-legal cases involving an evaluation of CO findings in cases of decomposition.

Ditching in the North Atlantic. B. C. DOYLE, Civil Aeronautics Board, Washington, D. C.

On September 23, 1962, Flying Tiger Line L-1049H, N6923C ditched in the North Atlantic with 76 occupants aboard. Of these, 48 survived. Of the five 25-man life rafts only one was available for the rescue of survivors. This raft was launched but did not inflate immediately. It was necessary for all survivors to evacuate the airplane and get into the water prior to boarding the life raft. A total of 51 passengers boarded the raft of which three succumbed prior to or shortly after rescue, some six hours following the ditching. The paper will cover the lessons learned regarding life raft stowage, life jacket design, and briefing of passengers prior to ditching.

Short-Term Psychotherapy for the Aviator. LT. ROY E. EHRLICH, MC, USNR and CAPT. PHILIP B. PHILLIPS, MC, USN, Division of Psychiatry and Neurology, U. S. Naval School of Aviation Medicine, Pensacola, Florida.

Records on all of the naval aviators who have been treated in the Psychiatry Division of the Naval School of Aviation Medicine and continued in a flying status have been collected and reviewed. The records were subdivided into type of problem presented and treatment given. By means of questionnaires, the results of treatment have been determined. Freedom from symptoms and ability to continue in a flying status were among the criteria used in evaluating results. From these reports, an attempt has been made to evaluate the effectiveness of short-term psychotherapy for the aviator whose flying status is jeopardized by psychological conflict. A further attempt has been made to determine if one particular type problem is more amenable to treatment than another, and whether any particular form of psychotherapy is better than another in this setting. Based on these results, certain recommendations are made as to preferred types of office treatment and results which may be expected.

The Cover Test in the Aviation Motility Examination. COMMANDER W. L. ERDBRINK, MC, USN, U. S. Naval School of Aviation Medicine, Pensacola, Florida.

Ocular abnormalities constitute the greatest single cause for rejection of prospective candidates for flight training. Defective visual acuity is the most frequent cause. However, heterophoria is the commonest problem seen in the evaluation of candidates who have already been screened and found qualified by flight surgeons in the field. Designated aviators are occasionally encountered with congenital heterophoria problems.

The present aviation motility examination is totally subjective, does not differentiate between a phoria and a tropia, and is subject to great variation and error.

The objective evaluation of heterophoria is based on the cover test both at distance and near, with an accurate measurement of the muscle balance utilizing prisms. Combined with the cover test, a complete extraocular muscle evaluation requires the objective testing of binocular eye movements in the cardinal positions of gaze. This complete objective motility evaluation of heterophoria and binocular eye movements is simple and not time consuming. The inclusion of the cover test in the routine aviation eye motility examination would insure an accurate objective evaluation of the true muscle balance and would insure complete single binocular vision for flying.

The Ideal Relationship Between Inspired Oxygen Concentration and Cabin Altitude. S/L J. ERNSTING, RAF Institute of Aviation Medicine, Farnborough, England.

The minimum concentration of oxygen required in the inspired gas is determined by the need to prevent hypoxia during routine flight. Recent experimental studies have demonstrated that in a high differential pressure cabin a higher concentration of oxygen must be breathed if hypoxia is not to occur following decompression to above 30,000 feet. A high inspired oxygen concentration, however, increases the magnitude of lung collapse induced by exposure to accelerative forces and in long duration flights introduces the possibility of oxygen toxicity. The best compromise between these conflicting requirements is considered in relation to various types of aircraft, pressure clothing and sealed cabins.

Current Resources and Primary Medical Programs. HILLIARD D. ESTES, M.D., Acting Civil Air Surgeon, Federal Aviation Agency.

This presentation discusses the existing organization, functional elements of the Federal Aviation Agency's medical program, and the basic missions of the medical program which are: 1) development of standards, rules and regulations governing the mental and physical fitness of civil airmen, 2) evaluation of environmental health problems in the civil aviation industry and the conduct of a health program for FAA personnel, 3) conduct of a medical research program oriented to the needs of civil aviation, 4) administration of a program of medical certification for some 350,000 active civil airmen, and 5) provision of the medical phase of the investigation of civil aircraft accidents.

Aviation Medical Service activities are carried out at the Washington headquarters of the Agency, in seven regional offices at Georgetown University Hospital in Washington, and at the Aeronautical Center in Oklahoma City. Advantages of the location of all operating divisions together in Oklahoma City are discussed.

Viewer Reaction to Abstract Visual Forms. WILLIAM E. EVANS and JOHN J. DREHER, Ph.D., Bionics and Human Factors Group, Lockheed-California Company, Burbank, California.

The purpose of this study was to evaluate the psychological responses of a group of 52 subjects to 20 simple geometric forms, including abstract representations of conventional and swept-wing aircraft.

Subjects rated each form in six categories: (a) certain shapes and position orientations and definite implications of danger, safety, or pleasantness; (b) that subjects could assign these descriptive terms to each of the symbols with a high degree of

agreement; and (c) a significant difference existed among and between the various abstract representations of conventional and swept-wing aircraft forms. Implications of these results for further experiment and for visual displays are discussed.

Tolerance and Performance Under Severe Transverse ($+G_x$) Vibration. DENIS B. FAUBERT, B.S., BRUCE S. COOPER, B.S., and CARL C. CLARK, Ph.D., Life Sciences Department, Martin Company, Baltimore, Maryland.

Seven male subjects, exposed to vertical vibration while in the supine position in a prototype Mercury couch, made 115 runs at peak couch accelerations ranging from $1G_x \pm 1G_x$ to $1G_x \pm 3.5G_x$ at 11, 22, 140, and $22 + 70$ cps, and $(1G_x \pm 0.5G_x)$ at 11 cps $+$ $(1G_x \pm 4G_x)$ at 140 cps. Tasks consisted of: (1) push button responses after detecting changes of two linear meters, parallel to the body y and z axes, which moved with the subject; (2) reporting meter number changes; and (3) response times to a panel abort light requiring manual operation of a panel switch. After familiarization runs, mean meter change response times were 0.5 seconds at rest, 0.7 seconds at $1G_x \pm 1G_x$ at 11 cps, 1.0 second at $1G_x \pm 2G_x$ at 11 cps, and greater than 1.5 seconds at $1G_x \pm 3.5G_x$ at 11 cps, for a short durations, after which time subject discomfort precluded further meter response. Accelerometers located on the couch and also on the chest, helmet, and hip showed acceleration ratio amplifications (to 4x at the head) which can occur in this restraint system. Blurring of the vision was judged less severe than when under equivalent G_z vibration conditions. Blurring and body acceleration ratios decreased progressively at the higher frequencies. At $1G_x \pm 2G_x$ at 11 cps, some subjects experienced severe chest pains and headaches even when straining. At 1 $G_x \pm 1G_x$ peak at 11 cps, which we recommend designating as $1G_x \pm 0.7G_x$ RMS with an accompanying power spectrum, here all at 11 cps, simple adequate performance was maintained for 60 seconds. Problems of vibration isolution are discussed.

The Effect of Cold on the Time and Frequency of Radiation-Induced Chromatid Deletions. ROBERT H. FETNER, Ph.D., Research Associate Professor of Applied Biology, Georgia Institute of Technology, Atlanta, Georgia and ALLAN A. KATZBERG, Ph.D., Chief, Cellular Biology Section, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

The frequency of chromatid deletions produced by 250 KV X-rays in frozen and unfrozen KB cells was determined. After irradiation, all cells were incubated at 37.5 C. In the unfrozen cells the optimum production of chromatid deletions was 12 hours after irradiation with doses up to 200 r. Between 200 and 1,000 r a mitotic inhibition was produced which resulted in the maximum number of chromatid deletions being observed 24 hours after irradiation. In the experimental group, the cells were irradiated in liquid nitrogen: no mitotic inhibition was observed with doses up to 2,000 r. The maximum production of chromatid deletions was 12 hours after irradiation. The time of maximum production of deletions in both groups as a function of dose indicated a high positive correlation between time and dose. Cells irradiated in liquid nitrogen were found to have one-third as many chromatid deletions as cells irradiated at room temperature.

Neurological Manifestations of Dysbarism—A Review and Report of a Case With Multiple Episodes. LT. COLONEL DON E. FLINN, USAF, MC and MAJOR GRANVILLE J. WOMACK, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

A USAF jet pilot was evaluated at the USAF School of Aerospace Medicine after having experienced 8 episodes of neurological dysbarism in a three year period. Comprehensive clinical and laboratory studies were performed before and after two chamber exposures in which neurological dysbaric symptoms were produced, and the results are documented. A thorough literature review on possible etiologies and the observed manifestations of neurological dysbarism is presented. The well documented similarities between the aura of migraine headaches and neurological dysbarism are explored. The hazards to the individual and flying safety of the milder forms of neurological dysbarism and more subtle mental symptoms frequently occurring in this disease are emphasized. General recommendations for treatment of the disorder are presented and restrictions on the degree of future exposures to altitude in victims of neurological dysbarism are promulgated.

Air Force Research on Non-Adaptive Enlisted Personnel. ELI FLYER, Ph.D., Personnel Research Laboratory, Lackland Air Force Base, Texas.

During the period 1958 through 1960 over 45,000 airmen were discharged for unsuitability, and 20,000 were hospitalized one or more days for psychiatric reasons. This large scale problem has led to extensive research to identify factors relevant to non-adaptive behavior, and to the development of screening procedures useful at the recruiting level and during early training. In longitudinal follow-up studies of airmen enlisting during 1956 and later years, a variety of demographic, aptitude, and adjustmental data collected at initial enlistment and during early training has been investigated to determine the predictability of non-adaptive behavior occurring up to five years later. Results to date have shown moderate positive relationships between measures of pre-service adjustment and Air Force adaptability criteria. In addition, certain types of behavior manifested during basic military training have been found to predict later adjustment.

Follow-up of extremely large samples of incoming airmen entering the Air Force each year has led to the identification of sizable subgroups (though small in terms of per cent of the total) such as schizophrenic patients or homosexual offenders. Study of psychological data collected for these cases at the time of initial enlistment provides information of considerable theoretic interest.

Laboratory Methods for the Detection of Anti-Hypertensive Drugs in Flying Personnel. CAPTAIN JOHN W. FOFT, USAF and A/1C ROBERT J. WILLIAMS, USAF School of Aerospace Medical Division, Brooks Air Force Base, Texas.

The occult use of anti-hypertensive drugs by flying personnel is an important consideration in the clinical evaluation of this group. Not only does the presence of hypertension demand thorough clinical evaluation for possible serious complications of the disease, but the side effects of most drugs employed in its treatment preclude the use of these drugs in persons performing aircraft crew duties. This paper presents the procedures used to detect anti-hypertensive drugs in patients being evaluated by the Consulation Service at the USAF School of Aerospace Medicine. Most of these technics involve the extraction of the drugs from blood and urine with organic solvents, and subsequent observation of the ultraviolet absorption spectra of the extracts. If the entire screening procedure is carried out it is moderately time-consuming, but the methodology is relatively simple. The majority of drugs commonly used in the treatment of hypertension are detectable following administration of therapeutic doses. There are a few notable exceptions, but if the patient is made aware that he is being subjected to such a screening procedure, a skillful examiner can be expected to overcome much of this technical handicap. It is hoped that the presentation of these technics will aid others who are faced with a similar diagnostic problem.

Effects of Low Altitude High Speed Flying Upon Pilot Performance. LT. F. J. FORMELLER, MSC, USN and R. H. SELTZ, B.S., Aeromedical Branch, Service Test, NATC Patuxent River, Maryland.

This study was conducted to determine the quantitative deterioration of human performance as a result of stress provoking airplane flights. Five Navy test pilots performed various tasks during 32 flights in a jet airplane at high speeds and low altitude. A bioelectric package from the NASA Ames Laboratory was used to monitor the ECG, blood pressure, respiratory rate and volume of the pilot during flight. Twelve airplane parameters were also recorded on the same magnetic tape to measure the effect of turbulence upon pilot performance. Pre- and post-flight blood and urine samples were collected for biochemical analysis.

Since the most significant physiological change noted was a reduction in respiratory tidal volume during the latter portion of some flights, the respiratory response of each subject was analyzed by an analogue computer. This was a routine effect not limited to flights during which subjective fatigue was reported. Some blood serum enzyme changes have also been noted. There was a very appreciable degradation of pilot performance with high levels of turbulence. An integration of all this information has been attempted and should prove valuable in predicting man's ability to control supersonic airplanes and spacecraft.

A Second Look At the "Graveyard Spiral." G/C W. R. FRANKS, RCAF-R, RCAF Institute of Aviation Medicine, Toronto, Ontario.

In the past, the "graveyard spiral" has been explained on physiological grounds of human disorientation. In this pilot while flying without visual references, i.e. at night or in cloud, inadvertently enters a turn which either is not appreciated or is falsely sensed. This can arise from either subthreshold rates of rotation, "reversal" sensation, or from coreolis disorientation or combination of these. The turn results in an increasing positive acceleration which may be sensed by the disorientated pilot as a climb, and which if acted upon results in a closing spiral descent. Apparently, however, under similar circumstances an error may arise in the attitude gyro which "if not appreciated by the pilot will cause him to put the aircraft into descending turn." The inherent reliance on such instruments by the unconsciously disorientated pilot may thus play a sinister potentiating role in the etiology of this classical accident.

Aspects of the Human Response to High Speed Low Level Flight. SQUADRON LEADER F. T. FRASER, M.B., M.Sc., Institute of Aviation Medicine, RCAF, Toronto, Ontario, Canada.

As a preliminary investigation of the human response to high speed low level flight, a T-33 aircraft was flown at not more than 100 feet AGL and approximately 400K on a selected course for a duration of about 40 minutes per run. Three pilots of differing anthropomorphic form each made several flights in varying conditions of turbulence. Continuous acceleration tracings were registered on an airborne recorder, from the seat, the "hard hat," and the pilot's hip, along with ECGs and pneumograms. A photographic record of head movement was obtained. Analysis of the tracings showed the dimensions of vertical accelerations and jolts, the predominant frequency response, etc. ECG showed no aberrations, but varied in rate in association with buffeting and flying stress. Pneumograms showed the effects of buffeting on respiratory rate and pattern. A technique was devised for analysing the tracing in terms of jolt function, believed to give a closer representation of the intensity and duration of the buffeting. Subjective reports, borne out by the photographic record, indicated that on some runs the pilot was approaching the limit of his ability to control the aircraft. Pilots varied in their subjective and physiological response.

The Common Cold—A Continuing Aeromedical Problem. CAPTAIN JOHN W. FUNK, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

A review is presented of current concepts in the etiology and course of the common cold as it applies to aircrew members. The magnitude of the problem is briefly discussed. Special emphasis is placed on the pathophysiological mechanisms which are the basis of the complications incident to infection with a cold.

Commonly accepted treatment is outlined together with a discussion of its rationale. A review of the dangers attendant to the use of commonly prescribed cold medications in flyers is made.

A suggested guide to the management of colds in flyers is presented.

An Analysis of Cardiovascular Injuries Resulting From Accelerative Force. LCDR. WALTER D. GABLE, MC, USN and COL. FRANK M. TOWNSEND, USAF, MC, Armed Forces Institute of Pathology, Washington, D. C.

The autopsy protocols of approximately 3,400 victims of fixed wing aircraft, rotary wing aircraft, and parachuting accidents (accessioned at the Armed Forces Institute of Pathology) were surveyed for cardiovascular injuries. In this series, 442 cases showed significant cardiovascular trauma. These cases were analyzed with emphasis being focused on direction and magnitude of accelerative forces, sites of injury and types of injury. A statistical summary of the frequency of injury in a particular anatomic location was prepared from the data obtained. This material serves as the basis for a discussion of the pathogenesis of specific lesions found in the cardiovascular system following accelerative force application and provides information which may be useful in the design of protective devices.

Characteristics of Noise Problems Associated With the Operation of Modern Day Aircraft. CAPTAIN DONALD C. GASAWAY, USAF, MSC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

This paper presents an overview, with specific illustrations and examples, of noise problems associated with modern aircraft during various phases of their operation. Characteristic noise exposures during ground and airborne operation of both fixed and rotary wing aircraft are presented. Emphasis is placed on the noise characteristics inherent to each of the major power packages; including reciprocal, turbojet, turboprop, and turbofan. The influence of power package-to-aircraft mating on these basic noise characteristics is described and illustrated.

Other noise producing sources and mechanisms are described and illustrated. These include (a) auxiliary power units, ground and airborne power support systems; (b) aerodynamic friction and boundary layer noise, including effects of speed, altitude, aircraft design, location of station positions, divebrakes, etc.; (c) internal air-flow systems, air conditioning, de-fog, pressurization, air ducting, etc.; and (d) other sources, such as electrical motors, meshing and impact of gears, etc.

The influence of each of the noise exposures will be related to human response; including temporary and permanent threshold of hearing shifts, speech interference, etc.

Hand Preference in Aircrew. FLIGHT LIEUTENANT J. L. GEYDE, M.B., RAF Institute of Aviation Medicine, Farnborough, England.

Evidence from a number of sources suggests that under certain circumstances an individual's ability to make decisions which require the appreciation of the orientation of objects in space may be related to the way in which the organisation of certain brain mechanisms in that individual is lateralised. It was thought that an appreciation of such factors might be of value in understanding some episodes of disorientation in flight, particularly as some examples of flying problems associated with unusual lateralisation of motor skills have recently been reported.

Using a self-administered questionary method, the "within-skill strength" and "between-skill consistency" of lateral preferences for a set of simple unimanual skills was determined in three groups of subjects as follows:

Group I Student aircrew before training

Group II Current flying fighter pilots

Group III Current flying test pilots

Differences between these groups were found which suggest that flying training may exert a selection pressure associated with some aspect, or aspects, of an individual's laterality. This pressure would appear to favour individuals with a high degree of "between-skill consistency," irrespective of the side preferred; and also to favour individuals who regard it as either *very easy* or *very difficult* to perform a unimanual skill in the non-preferred way.

Evidence from this study, and from associated laboratory studies of performance at various tasks, makes it tempting to postulate that the bimodal distribution of strength of lateral preference scores found in trained pilots may be a reflection of two distinct kinds of ability, which may perhaps be of different relative value in different kinds of flying. At present there is no direct evidence for this, but the possible nature of the two types of ability, and ways of investigating the matter further will be discussed.

Pulmonary Gas Exchange During Positive Acceleration. FLT. LT. D. H. GLAISTER, RAF Institute of Aviation Medicine, Farnborough, England.

Quantitative measurements of pulmonary gas exchange, and qualitative measurements of pulmonary gas distribution have been made during positive acceleration on the human centrifuge.

Use has been made of expired air collection, as well as breath to breath analysis of expired air with a rapid response carbon dioxide meter. Findings demonstrate changes in metabolism and gas distribution in man at low levels of positive acceleration.

Mechanisms of the Water-Immersion Diuresis. CAPT. DUANE E. GRAVELINE, USAF, MC, CAPT. MICHAEL MCCALLY, USAF, MC, and MARGARET M. JACKSON, M.S., Biomedical Laboratory, Wright-Patterson Air Force Base, Ohio.

A significant free water diuresis occurs during recumbency and water immersion. This diuresis was studied in six subjects during six to eight hours of complete water immersion and during similar periods or routine office activity (control). Urine flow, serum and urine solute, urea, creatinine osmolar and free water clearances and hemoglobin and hematocrit were determined. There is an increase in osmolar clearance during immersion, reflecting increased solute excretion particularly of urea and sodium (P 0.01). Free water clearance becomes positive during immersion presumably reflecting the inhibition of the antidiuretic hormone (ADH), and urine flow is significantly increased (P 0.01). The administration of Pitressin during immersion returns urine flow and solute excretion to control levels. Plasma volume change was determined serially during immersion by hemoglobin and hematocrit dilution and confirmed by whole blood and plasma volume determinations using the dilution of radio-iodinated serum albumin (RISA). Plasma volume increased approximately 15 per cent during the first thirty minutes of immersion and then decreased over the remaining 5 or 6 hours to approximately 20 per cent less than control. The mechanisms of the water immersion diuresis are discussed and inferences made to human exposure to zero gravity with its absence of hydrostatic pressure effects.

Foam Plastic Inflated Anti-Exposure Suits. R. FLANNAGAN GRAY, M.A., Aviation Medical Acceleration Laboratory, Naval Air Development Center, Johnsville, Pennsylvania.

The development and the testing of a nylon flying suit which can be converted into an anti-exposure suit is discussed. Foam plastic constituents can be dispensed between the two layers of the suit to inflate it and to supply water proofing, non-deflatable flotation and insulation.

Measurements of the Oculogravic Illusion in Healthy Subjects and in Persons with Bilateral Vestibular Defects with a Note on Its Usefulness as a Specific Indicator of Otolith Function. CAPTAIN ASHTON GRAYBIEL, MC, USN, Naval School of Aviation Medicine, Pensacola, Florida and BRANT CLARK, Ph.D., San Jose State College, San Jose, California.

Experiments on a human centrifuge were carried out with nine normal subjects and ten bilateral labyrinthine defective deaf persons who, because their otolith function was unknown, were referred to as OFU subjects. Particular care was taken to ensure that conditions were favorable for perception of the oculagravic illusion which has been defined as an apparent movement and displacement of the visual field when a person is exposed to a change in direction of the gravitational inertial force environment relative to himself. The subject's task was to observe a line of collimated light in the dark, report whether he perceived any apparent motion, and, if the line appeared to be displaced from the horizontal, to restore it to that position. Findings in the normal subjects were remarkably uniform; tables or curves based on mean values of the group were characteristic for all. In the OFU subjects inter-and introindividual variances were so great that it was difficult to combine the results; therefore, the findings had to be summarized on an individual basis. Moreover, there was evidence of learning in the OFU subjects which tended to complicate interpretation of the results. The usefulness and limitations of this test as an indicator of otolith function are pointed out.

Adaptation of Small Groups to Extreme Environments. E. K. ERIC GUNDERSON, Ph.D. and LT. PAUL D. NELSON, MSC, USN., U. S. Navy Medical Neuropsychiatric Research Unit, San Diego, California.

This study is concerned with the nature and the severity of stresses encountered by small groups experiencing prolonged isolation and confinement in an extreme environment (Antarctica) and with the effects of such stresses upon physical and emotional symptomatology, attitudes, and work and social effectiveness. More than twenty groups composed of National Science Foundation scientists and Navy personnel have been studied.

Psychiatric evaluation, personality tests, and biographical information were obtained prior to deployment; medical records, symptom and attitude questionnaires, sociometric evaluations, and performance ratings were collected in Antarctica. Groups varied in size from 15 to 40 men and remained intact for a year.

Participants experienced extreme climatic conditions, prolonged confinement, restricted activity, monotonous routine, and persistent concerns about fire, injury or illness, and family's health. Physical and emotional symptoms increased during the long winter darkness; sleeplessness, depression, and irritability increased markedly during the mid-winter period. Marked attitude changes also occurred in most groups. Personality and leadership style influenced group compatibility and achievement.

Certain combinations of personalities and leadership styles can withstand extreme environmental conditions better than others in the Antarctic and possibly in future lunar scientific expeditions and space colonies as well.

Endocrine and Metabolic Observations of the Sam-Mats Simulator Fatigue Studies. HENRY B. HALE, Ph.D., MAJOR IRA L. SHANNON, USAF, DC, and LT. COLONEL DAVID G. SIMONS, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

This paper presents the analyses and results of urine and parotid fluid samples obtained during the USAF School of Aerospace Medicine Military Air Transport Service simulator fatigue study. Each of four pilots completed a 24-hour similator flight, broken into eleven 2-hour legs, each terminated by an ILS landing. Urine samples were collected approximately every four hours through a 48-hour period, ending with completion of the flight. Analysis included constituents known to relate to autonomic, endocrine, and metabolic functions (norepinephrine, epinephrine, 17-hydroxycorticosteroids (17-OHCS), urea, uric acid, creatinine, Na, K, and PO_4). Parotid fluid samples were collected approximately every 4 hours during each flight. They were analyzed for free 17-OHCS.

Changes in these body fluids showed a stronger correlation with time of day (circadian period) than with time in the cockpit. Analysis of relations are presented between these measures, the physiological and performance measures.

Psychomotor Performance During Total Body Water Immersion for Massed and Spaced Learning on a Complex Task. THOMAS D. HANNA, M.S., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pennsylvania.

An analysis is presented of the learning curves for a complex psychomotor task acquired by two equally matched groups of water immersed subjects under conditions of either massed or spaced practice. The task consisted of a constant demand, multiple stimuli learning situation requiring immediate decision making and different motor responses. Whereas the shape of the two learning curves was similar, significant differences were observed between the elevation of the two groups and the difference between early and late trials. The within-session decrement in performance between initial and final values for the 30 minute massed trials was not found during the 10 minute spaced trials. It is concluded that under the experimental conditions, massed sessions incur attentional drift (boredom) rather than fatigue. Implications of these findings are discussed.

Fatigue Effects in 24-Hour Simulated Transport Flights: Changes in Pilot Proficiency.

BRYCE HARTMAN, Ph.D., LT. COLONEL DAVID G. SIMONS, USAF, MC, and CAPTAIN THOMAS P. BALL, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas and Dover Air Force Base, Delaware.

This paper presents the performance measures and results obtained from the School of Aerospace Medicine-Military Air Transport Service simulator fatigue study. Each of four pilots completed a 24 hour simulator flight broken into eleven two-hour legs terminated by an ILS landing. Three kinds of performance measures were obtained: a) twenty-second time lapse photographs recorded airspeed, altitude and rate of climb or compass heading through cruise portions of each leg; b) control motions of aeleron, elevator and rudder and instrument readings of altitude, airspeed, and skid were continuously recorded through each flight; c) the ground track record of the ILS approach was photographed following each landing.

The cruise portions of each leg showed an increasing variability in performance, but this change was not sufficient to reduce over-all system efficiency. Instrument approaches were carried out at a high level of proficiency for approximately 20 hours, at which point there was a precipitous drop in performance. Circadian periodicity exerted an attenuating influence on these effects.

Simultaneously recorded physiological measures are being reported separately.

Physiological Measure of Training, Fatigue and Recovery in a Human.

E. J. HAWRYLEWICZ, Ph.D., and W. H. BLAIR, B.S., Life Sciences Research Department, Armour Research Foundation of Illinois Institute of Technology, Chicago, Illinois.

This study was undertaken to determine whether the extent of training, severity of fatigue and the rate of recovery could be established by blood and urinary analysis. The stressing factor was swimming. Measurements were made during a period of six months including tests immediately prior to, during and after periods of continuous swimming for 24 and 36 hours. The measurements included analysis of urinary 17 ketosteroids, protein, and serum lactic dehydrogenase (LDH), LDH isoenzyme, glutamic and pyruvic transaminase.

The experiments have demonstrated a marked rise in the 17 KS and protein values during extensive swims. The extent of the rise, subsequent depression and time of recovery being a function of the degree of training. Untrained individuals swimming for 2 hours experienced a greater 17-KS and protein response and a longer recovery period. The serum LDH values had a sharp and sustained (72 hrs.) rise. The rise in LDH values are related to altered serum isoenzyme patterns. New agar-microscope slide methodology permitted the resolution of the isoenzymes in 25 minutes.

The significance of these data will be discussed in relationship to physiological response. The data will be considered for their applicability to training schedules and to prediction of the severity of fatigue.

The Effects on Man of Prolonged Exposure to Pure Oxygen.

W. M. HELVEY, G. A. ALBRIGHT, F. B. BENJAMIN, J. PETERS, L. GALL, and H. RAND, Space Environment and Life Sciences Laboratory, Republic Aviation Corporation, Farmingdale, L. I., New York.

Twenty-four young men, in four groups of six, were confined in a space chamber for fourteen days. The subjects breathed pure oxygen at reduced barometric pressures of 7.4 psia, 5 psia, 3.8 psia or air at a sea level environment (14.7 psia, control group). The subjects were selected from a large population of college and graduate students and each of the four groups included one or more medical students. Pulmonary function was evaluated daily, with particular interest in any evidence of atelectasis by vital capacities, arterial pO_2 and chest x-ray. Biochemical studies included blood electrolytes, glucose and urea, as well as urinary 17-OH corticosteroids. Urinary and hematological studies were accompanied by an extensive survey of the microflora of the skin, throat and intestinal tract to detect evidence of infection or a shift in the normal balance with the changed environment. Physical and mental performance were followed daily. Mental alertness was determined by monitoring and a performance panel, as well as by written tests. Food and fluid intake were carefully monitored and controlled. Medical evaluation was enhanced by daily vital signs and electrocardiograms. Nitrogen was maintained at a very low level and environmental monitoring methods are described. The presentation will include general medical observations, the hemological findings, renal function and excerpts of the microbiology, biochemical, nutritional and performance data.

Continuous Registration of Regional Sweating and Skin Blood Flow.

ALRICK B. HERTZMAN, Ph.D. and FRANZ FLATH, Department of Physiology, St. Louis University of Medicine, St. Louis, Missouri.

Local sweating was recorded by electric resistance hygrometry and a specially designed capsule. Lag time of the system was less than 0.15 sec. Sensitivity permitted measurements of the water of diffusion (approximately 0.004 mgm./cm.^{2}/min.) as well as of the onset and intensity of sweating. The level of cutaneous blood flow was obtained from the linear relation of the cutaneous opacity pulse and flow. The methods may be used on nude or clothed subjects immersed in either air or water and in combination wtih continuous weighing of the subject. Regional differences in the moment of onset and in the amount of sweating were demonstrated readily. "Spontaneous" cycles in sweating were usually synchronous but not equal in intensity in nearly all sweating areas. Such cycles were accompanied often by vasoconstrictions in the palm and sole, less frequently by venomotor activity and not at all by arteriomotor activity in other skin regions (arm, leg, trunk and face). The independence of cutaneous blood flow from sweating was confirmed further, negating the importance of bradykinin in the regulation of the skin circulation.

Human Tolerance to Negative Impact Acceleration.

LCDR. FRANCIS M. HIGHLY, MC, USN, CDR. GEORGE T. CRITZ, MC, USN, and EDWIN HENDLER, Ph.D., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pennsylvania.

A study was conducted to determine human impact tolerance since data presently available regarding human tolerance to negative impact acceleration (head-to-foot-acceleration) are sparse. Five subjects were exposed to negative impact acceleration using the ACEL Linear Accelerator. Restrained, supine subjects were exposed to impulsive loads directed through the long axis of their bodies, from head to foot. Records of tension in the restraining harness, acceleration of the catapult car and the subject's head, vectorcardiograms, and electroencephalograms were obtained. High-speed motion pictures were utilized to determine body deformation. In addition to regular physical examinations, the constituents of the blood and urine were monitored on all subjects. Under the test conditions, accelerations above 10 negative g were tolerated.

The Relationship Between Mathematics and Physics and Flight Training.

LT. (JG.) J. H. JOHNSON, MCS, USNR, U. S. Naval School of Aviation Medicine, Pensacola, Florida and A. S. MORTON, Ph.D., Raytheon Company, Waltham, Massachusetts.

It is frequently assumed that abilities in mathematics and physics are closely related to ability to become a pilot, and in 1958 the U. S. Naval School of Aviation Medicine published a report suggesting that the introduction of mathematics and physics courses into the syllabus of the U. S. Naval School of Pre-Flight was closely associated with improved performance of students in other academic courses. The purpose of the present study is to investigate the relationship between performance in the mathematics and physics courses and subsequent success in flight training.

The subjects are 396 pilot trainees who either completed or failed U. S. Naval flight training. Incoming and final mathematics and physics scores and grades are the independent variables of this investigation. The dependent variables are flight grades, aca-

demic grades, and attrition data. Correlation coefficients were computed between each of the independent and dependent variables and attrition was analyzed in terms of scores on the independent variables. Chi-square coefficients were computed for the "Completion vs. Flight Failure" and the "Completion vs. Other Attrition" distributions to determine the relation of performance in mathematics and physics to failure.

The results are noteworthy from both practical and theoretical aspects: Performance in the Pre-Flight mathematics and physics courses was again found to be closely related to other academic courses taken during flight training, but relationships between mathematics and physics grades and flight grades were generally negligible. However, contrary to usual findings, those significant relationships that were found occurred later on during flight training rather than immediately following the courses in mathematics and physics.

The Effect of Decreased Barometric Pressure on Maximum Pressure-Volume Relationships of the Human Respiratory System. LT. COL. LOUIS F. JOHNSON, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

Rahn et al, in 1946, predicted that maximum pressure-volume relationships of the human respiratory system would be different at decreased barometric pressure than they are at ground level; namely, muscular strength would remain the same but greater lung-volume changes would occur for the same expiratory and inspiratory pressures. These changes would decrease the area of the maximum pressure-volume diagram at altitude. In this study, maximum expiratory and inspiratory pressures and the resulting lung-volume changes were simultaneously recorded at ground level (approximately 747 mm. Hg) and at 30,000 feet pressure altitude (225 mm. Hg). For given pulmonary pressures, lung-volume changes were greater at 30,000 feet than at ground level. The area of the maximum pressure-volume diagram at 30,000 feet was 75 per cent of the area of the same diagram at ground level.

Left Bundle Branch Block in Flying Personnel. LT. COL. R. L. JOHNSON, USAF, MC and L. E. LAMB, M.D., USAF School of Aviation Medicine, Brooks Air Force Base, Texas.

A summary of the School of Aerospace Medicine's experience in left bundle branch block during the past seven years is presented. Left bundle branch block was noted to occur infrequently in the asymptomatic individual during a routine electrocardiogram. Many of the examples of left bundle branch block noted in flying personnel have been demonstrated to be acquired electrocardiographic changes, that is, they have occurred in the face of a previously existing normal record. Several examples of intermittent left bundle branch block in asymptomatic individuals have presented records which suggest the probability of underlying anterior wall myocardial disease when ventricular conduction is normal.

Anatomically the left bundle and the right bundle are appreciably different. The left bundle involves a much greater anatomical area and consequently is more difficult to destroy. Left bundle branch block is considered to represent a wider area of myocardial damage. The etiological significance and the aeromedical implications of left bundle branch block are discussed.

Ejection Seat Accelerations and Injuries. CAPTAIN WALTON L. JONES, MC, USN and COMMANDER WILLIAM F. MADDEN, MSC, USN, Bureau of Medicine and Surgery, Department of the Navy, Washington, D. C.

A review of accelerations measured on ejection seat catapult tests, over the past four years, indicates a much wider range of values than was originally believed. This explains, in part, the occasional injury where no injury occurred in an almost similar set of circumstances. To reduce these values and obtain more performance capability a Rocket Assisted Propulsion Ejection Catapult (RAPEC) was developed by the Naval Ordnance Test Station, China Lake. This system is completely interchangeable size-wise with the present catapults resulting in much lower accelerations with increased trajectory. A review of the back injuries is given along with clinical management and results.

Tolerance of "Shirtsleeve" Crews to Moderately Severe Environments. MAJOR W. C. KAUFMAN, USAF, Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio.

A thermal comfort zone has been delimited and human tolerance to extremes of heat and cold studied. Tolerance of shirtsleeves crew members eating and drinking, ad lib, performing light work in moderately severe thermal environments as might occur in aerospace emergencies has not been studied. Four unacclimatized male subjects were exposed to 115 and 130° F temperature with humidities of 10 and 20 mm. $HgPH_2O°$. Limits of tolerance were based on heart rate, ECG and general malaise. All subjects completed 8:00 at 115-10. Tolerance time at 115-20 was 4:26 ± S.E. :25; at 130-10. 4:02 ± :10; and 130-20, 2:12 ±:11. Water and food at 100° F were offered, ad lib, but subjects tended to abstain and dehydrated at rates from 125 to 556 gm./M^2/hr. Body heat storage ranged from 8.2 to 44.0 Cal/M^2 /hr. Mean terminal heart rates of 138 were recorded. Marked irritability and fatigue were common. Physiological responses did not differ significantly at 115-20 and 130-10. Results indicate man's thermal tolerance is greater than previously calculated but still closely bound to the envelope of thermal comfort.

Atmosphere Movement in Sealed Environments For Manned Space Missions. DONALD A. KEATING, Life Support Systems Laboratory, Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio.

The minimal atmosphere movement required for human sustenance in sealed environments for manned space missions is investigated. The minimal atmosphere movement is compared to the combined natural atmosphere movement which occurs in manned sealed environments under convective, reduced convective, and finally nonconvective cases as experienced on earth, lunar, interplanetary, and orbital missions. Mixing of the sealed atmosphere in each case occurs by diffusion currents, by leakage, by the motion and respiration of the astronaut, and by the amount of convection. Recommendations are made for each case as to any need for forced atmosphere movement. This knowledge will find direct application to the design of life support systems for immediate and future manned space missions. The investigation also attempts to solve the question of how long man can survive in a space sealed environment without forced atmosphere movement. This condition arises during a power failure in a forced atmosphere life support system and all blowers and fans stop. The complete investigation is based upon theoretical analysis and manned sealed environment experimentation.

The Effects of Visual Deprivation on Adaptation to the Coriolis Illusion, Postural Equilibrium, and Canal Sickness. LT. ROBERT S. KENNEDY, MSC, USNR, Naval School of Aviation Medicine, Pensacola, Florida, GILBERT C. TOLHURST, Ph.D., Office of Naval Research, Washington, D. C. and CAPTAIN ASHTON GRAYBIEL, MC, USN, Naval School of Aviation Medicine, Pensacola, Florida.

In order to determine the effects of visual deprivation on adaptation to the Coriolis illusion and to canal sickness on the Slow Rotation Room, 10 subjects were exposed on two different occasions to 48 hours continuous rotation at a constant velocity of 5.4 rpm under two experimental conditions: (1) with vision, (2) without vision.

A stress test was employed which caused the subject's head and body to proceed through different complex arcs which in turn produced a bizarre stimulus to the vestibular apparatus. Adaptation was measured by two tests of postural equilibrium, the Coriolis oculogyral illusion and general symptomatology. The findings indicate that vision played a significant role in adaptation.

Medical Evaluation of Missileers. CAPTAIN WILLIAM H. KING, USAF, MC, Sheppard Air Force Base, Texas.

In an age wherein the intercontinental ballistic missile has brought nuclear destruction to within minutes from any point on the globe, it is essential for national safety and security that only personnel of sound mind and body be assigned to missile launch

crew duty in the USAF. Since October, 1961, the Aerospace Medicine Service and the Psychiatry Division of USAF Hospital Sheppard have evaluated several thousand officers and airmen being trained in the Atlas and Titan weapons systems at Sheppard Air Force Base, Texas. This experience is statistically reviewed. A few potential missileers, reaching the training center without prior evaluation, were subsequently withdrawn because of medical disqualification. Notably, officers who had been removed from flying status were found, in a number of cases to be also unfit for missile duty, e.g., those with history of gastrointestinal bleeding or chronic cardiovascular or renal disease. The physical standards for missile launch crew duty are reviewed with comments on particular problem cases and waiver policies. Careful evaluation of personnel prior to assignment to missile training and annual examination of missile crewmen are recommended.

Physiological Responses to Transient Heat Stress in Reflective Versus Non-Reflective Clothing. ABBOTT T. KISSEN, Ph.D. and JOHN F. HALL, JR., M.A., Wright-Patterson Air Force Base, Ohio.

Experiments were conducted to compare physiologic response of non-ventilated clothed subjects to transient heat pulses of various time-intensity profiles while wearing aluminized (reflective) versus relatively non-reflective flight suits. Equivalent thermal insulation (1.0 clo) covered body, hands, feet and head (except for face). Wall temperatures of a heat pulse facility were programmed to increase at 180° F/minute and six subjects exposed to 4 pulses each 200° F, 250° F, and 300° F for 15, 12 and 9 minutes, respectively. Air temperatures passively followed wall temperature. Mean skin, rectal, hand, foot, and head temperatures; blood pressures; pulse and total heart count were measured during control, exposure, and recovery periods. Sweat and evaporation were determined for the overall time period. At 200° F no significant thermal protective difference between the respective suits was noted; at higher stress (250° F) lower mean skin, hand, foot, and head temperatures were observed with the reflective suit. During recovery periods, however, mean skin temperature of subject in non-reflective clothing decreased more rapidly. For heat stress exposures at 200° F or lower, thermal protective effectiveness of reflective clothing is negligible.

Electrical Energy from Biological Systems. J. J. KONIKOFF, BSME, L. R. REYNOLDS, B.S., and E. S. HARRIS, PhD., General Electric Company, Philadelphia, Pennsylvania.

The production of electrical energy by biochemical reaction was studied. Systems containing algae and fecal bacteria separated by a semipermeable membrane into two half cells have evolved current densities of 1.4 to 2.0 ma/ft^2 at 0.3 volts. A simplified biochemical fuel cell system was investigated containing yeast and water. Current densities of 2.2 amps/ft^2 were measured. Paper chromatographic techniques were used to separate the reducing metabolites. Inhibitors were used to block specific enzymatic reactions. The effect of the inhibitor on EMF production was determined. The change from the control (non-poisoned) culture concentration and type of metabolites was also checked by paper chromatography.

A hypothesis has been evolved to explain the production of the EMF as follows:

First, the biological or intra-cellular enzymatic reactions produce the ionizable metabolites which diffuse through the cell wall.

Secondly, a catalytic reaction involving an interaction of the appropriate metabolites with the platinum-black catalyst results in the loss of electrons which then become available in the external circuit.

Serum Lipoproteins in Fatal and Non-Fatal Myocardial Infarction. L. R. KRASNO, M.D., G. J. KIDERA, M.D., and ARTHUR LACK, M.D., Department Clinical Research, United Air Lines, San Francisco, California.

Serum lipoproteins determinations were carried out on patients who survived or died following myocardial infarction. The 0-400 class serum lipoprotein densities were analyzed by means of the ultracentrifuge.

The purpose of this investigation was to determine the relationship of the various classes of serum lipoproteins to survival or fatality with the possibility of developing a more reliable means of prognosis and a better understanding of the pathogenesis in myocardial infarction.

Preliminarily, it appears that whereas an abnormal cholesterol and triglyceride fraction carries an increased risk of fatality, both abnormal cholesterol and triglyceride levels are associated with the pathogenesis of myocardial infarction.

Specificity of Chronic Oxygen Toxicity. G. H. KYDD, Ph.D., L. R. KOWALSKI, B.S., and R. J. MCGOWAN, Aviation Medical Acceleration Laboratory, Naval Air Development Center, Johnsville, Pennsylvania.

The toxic effects caused by exposure to high pressure oxygen have been classified into acute and chronic signs. Convulsive seizures characterize the acute signs. The chronic signs appear after repeated exposures of varying length and number. They were characterized by paralysis of the forelegs and a peculiar posture in which the animal supported itself on hindlimbs and tail, called a "kangaroo stance." Recently we have found that the occurrence of the chronic effects may be dependent more upon the source of supply of the animals than the number of exposures. In one group of animals chronic effects were readily produced while another group of the same strain but from a different source showed no chronic signs after repeated exposures. These results indicate that the chronic effects may depend upon the combined action of oxygen at high pressure and some as yet unknown factor related to treatment, such as diet.

Some Effects of Chlorinated Insecticides on Vertebrate Carbohydrate Metabolism. DANE E. LACEY, B.S., JACK W. DAUGHTERTY, Ph.D., and PATRICIA KORTY, B.S., Civil Aeromedical Research Institute, Aviation Medical Service, Federal Aviation Agency, Oklahoma City, Oklahoma.

Earlier experiments from this laboratory have indicated that exposure to chlorinated hydrocarbons produced significant alternations in the intermediary metabolism of various tissues of rats and chickens. The present work represents a continuation of these studies.

Brain homogenates from animals exposed to dieldrin showed a 50 per cent inhibition in phosphate esterification during anaerobic glycolysis. This did not occur with lindane, endrin or heptachlor.

Rats exposed to lindane and dieldrin exhibited an elevated blood sugar concentration. Their ability to clear sugar from the blood was decreased, as indicated by the glucose tolerance test. Measurement of liver glycogenolysis indicated an increased activity for the dieldrin-treated animals and a decreased activity for those exposed to lindane. This seems to suggest that these compounds alter the activities of glycogea phosphorylace and phosphoglucomutare.

Visual Factors in Aircrew Station Lighting Design. JOHN LAZO, and CAPT. ROLAND A. BOSEE, MSC, USN, Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pennsylvania.

Efficient aircraft interior lighting systems are designed to provide for optimal utilization of the crewman's capabilites in varied flight operations. Lighting system design criteria, therefore, are based on the results of visual (psychological-physiological) and engineering (physical) variables. These visual factors, along with descriptions of their measurement and the problems of visual performance as they relate to the development of naval aircraft lighting systems, are presented. Examples of the manner and the extent to which lighting engineers may employ visual performance data in the design or redesign of lighting systems or components are provided. Several current and future lighting techniques based on specific visual design requirements are covered in detail.

Current Status of a Hypoxia Warning Station. CAPTAIN W. L. LEE, Wright-Patterson Air Force Base, Ohio.

During the past year, polarographic oxygen partial pressure sensors and their associated amplifier equipment have been undergoing static and flight test evaluation by the Aerospace Medical Research Laboratories as well as the RCAF Institute of Aviation Medicine.

The sensor is mounted within an oxygen mask or pressure suit helmet and the output signal is displayed visually on the instrument panel of the aircraft. Static tests have been performed for over 100 hours at reduced barometric pressure and extremely cold temperatures with no degradation.

Calibration of the sensor is easily performed during operational conditions using air as the standard sample and correcting for the existing total barometric pressure. The sensor is designed as a throw-away unit and is sufficiently small to fit behind the microphone within a face mask.

The results of flight tests to date will be described in addition to the effectiveness of the warning system to prevent hypoxia.

Survival Following Controlled Crashes. COL. E. C. LENTZ, USAF, MC, Norton Air Force Base, California.

This study, covering a two and one half year period, presents statistics on air force accidents having a low initial impact force. It covers 415 aircraft accidents or 39 per cent of the major USAF accidents experienced during this period. The accidents were evaluated as to types of aircraft, degree of impact, whether or not fire was associated with the crash, the type and extent of injuries, the cause of fatalities, the effectiveness of crash rescue crews and the type and scope of escape problems. Although fire was a prevalent factor, it was found to be a minor cause of death and injury. The effectiveness of crash crews was found to be mainly in the control of fire; they are of limited value in the saving of lives or aircraft. Their effectiveness in saving personnel is enhanced by the addition of helicopters to the crash rescue mission. The problem of escape from fire following a crash appears to be exaggerated in the minds of pilots; since there is a low statistical probability that they will perish in the fire if they are physically capable of taking escape action.

Studies in Decompression Sickness I. Circulatory and Respiratory Changes Associated with Decompression Sickness in Anesthetized Dogs. CAPTAIN SIDNEY D. LEVERETT, JR., USAF, MSC, CAPTAIN HAROLD L. BITTER, USAF, MC, and CAPTAIN ROBERT G. MCIVER, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

In order to further define the dynamic physiological events occurring during decompression sickness, 16 anesthetized dogs were exposed to a compression-(6 atmospheres absolute) decompression (1 atmosphere) schedule which was shown to produce intravascular bubbles. Following this they were in turn taken to a simulated altitude (0.69-0.5 atmospheres). Pulmonary artery, aorta, inferior vena cava and left atrial pressures were taken as well as respiration rate and hematocrit. In the post-compression one atmosphere environment, the mean pulmonary artery pressure (MPAP) rose from 15.9 mm. Hg to 35.1 mm. Hg. In the subsequent simulated altitude environment, while breathing 100 per cent O_2, MPAP rose to 55.6 mm. Hg. In the same period respiration rate increased 2.4 and 3.5 times greater than control, respectively. All other measurements remained normal.

Five additional animals were exposed to altitude only (0.18 atmosphere) breathing 100 per cent O_2. Arterial and venous cuvettes allowed observation of these respective vascular regions while flow remained intact. A rise in pulmonary artery pressure, tachypnea, and bubbles in the venous cuvette were observed in all preparations.

In a further series intravenous infusion of small bubbles produced similar results to the above. The relationship between these findings and neurocirculatory collapse at altitude will be discussed.

Pathology Produced by Impact Acceleration Applied to Guinea Pigs. CHARLES F. LOMBARD, Ph.D., P. CLOSE, Ph.D., and FRED LARMIE, M.S., Northup Space Laboratories, Hawthorne, California.

In contemporary aerospace vehicles the possibility of exposure of astronauts to impact at any angle has increased the need for experimental data relating to tolerance, pathology and the value of various protective device concepts.

To obtain such information, anesthetized male guinea pigs were placed on a small impact acceleration sled in form fitting fiberglass reinforced plastic support and restraint device. The device was gimbal mounted on the carriage of the sled so that accelerations could be applied to the animals at any of a wide variety of selected angles. Animals were exposed to forces of 80 to 90 g peaks with onset rates of about 11,000 to 14,000 g/sec.

Animals placed in the close fitting support-restraint tolerated the transverse impact accelerations even when repeatedly exposed. A type of sub-clinical damage was observed in some of these animals which resembled air blast. The guinea pigs oriented on the sled in a tail first direction tolerated the impact well. However, animals oriented on the sled the opposite direction, head first, showed little tolerance to the exposures and frequently indicated vertebral injury, ranging from the head tailward to the mid-thoracic vertebrae. The need for improved restraints is indicated.

A Study of Post-Hypoxic Paradox Effect. F. MERAYO MAGDALENA, M.D., General Physiology, Medicine School of Madrid, Spain.

In speaking of the etiology of the post-hypoxic effects provoked by inhalation of O_2 the numerous studies are not concurrent. A great number of authors relate the respiratory inhibition with the decrease of the alveolar CO_2 partial pressure produce by hyperventilation as a result of anoxia. The French authors attribute the preponderance of the effect of O_2 in the production of this apnea. The evidence which these authors present contradicts the results of those who consider it to be the result of hypocapnia.

Three types of experiments were performed; on normal animals, on animals which had carotid sinuses destroyed and on animals which had been given a mixture of N_2 and CO_2 in variable proportions from 3 to 10 per cent during the anoxic phase.

Effects of Sequential Exposure to Acceleration and Space Capsule Atmospheric Conditions. LT. ROBERT E. MAMMEN, MC, USN, CDR. GEORGE T. CRITZ, MC, USN, DONALD W. DERY, Ph.D., LCDR. FRANCIS M. HIGHLY, MC, USN, and EDWIN HENDLER, Ph.D., Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pennsylvania.

A study was conducted to determine the physiological suitability of a proposed space capsule atmosphere. Six subjects were each exposed to typical launch and re-entry acceleration profiles. Between exposures to acceleration, each subject spent 14 days at a simulated altitude of 27,000 feet breathing 100 per cent oxygen. Frequent determinations were made before, during and after the 14-day confinement period to assess the physiological status of the subjects. Blood and urine constituents, including arterial gas tensions, pulmonary, and cardiac activity were closely monitored. Performance was measured at regular intervals using a specially designed task. The results of these measurements are presented and discussed.

Short-Time Tolerance and Pulse Response in Man to Sinusoidal Vibration in the Semi-Supine Position in X, Y and Z Axes. CAPTAIN MORRIS J. MANDEL, USAF, MC, Wright-Patterson Air Force Base, Ohio.

Short time subjective tolerance in man in the semi-supine position was determined to ascertain whether this position, best for sustained linear acceleration, was also best for vibration. Thirty male volunteer subjects were exposed to subjective tolerance vibration levels in the 3-20 cps range, utilizing a Western Gear mechanical shake table capable of either vertical or horizontal oscillation. The subjects were positioned so that

the vertical direction represented the X axis (front to back). Short time tolerance levels for both the head and body were investigated in the X, Y and Z axes, and the results compared to one-minute body tolerance to vertical sinusoidal vibration in the sitting position. Although the Y and Z axes closely parallel each other with regard to both g tolerance and subjective complaints, the X axis was uniquely different. The g tolerance in the X axis had a very slow rise with increasing frequency unlike the hyperbolic contour seen in the Y and Z axes. Moreover, the X axis, chest pain and inspiratory dyspnea were the most singular tolerance limiting factors in all but one subject regardless of frequency. The pulse rate response monitored by ECG was quite uniform regardless of body position or shake-axis, exhibiting the usual response seen with exercise. Comparison of the results with those seen in the sitting position indicate that the semi-supine position is probably not the best one for vibration.

A Space Vehicle Simulator and Atmosphere Control System. D. A. MANCINELLI, B.S., M. SLOANE, B.S., and J. F. KIEFER, Naval Air Crew Equipment Laboratory, Philadelphia, Pennsylvania.

A study was conducted to determine the physiological suitability of a proposed space capsule atmosphere. A description is given of the double-chambered, 3 compartment enclosure known as the ACEL Bioastronautical Test Facility in which this study was conducted. Provisions for prolonged habitation of this Facility by a crew of men including eating, berthing, waste handling, and disposal, atmosphere control, lighting, recreation, etc., are described. Results of an actual 14-day confinement of 8 men within this Facility are presented with respect to maintenance of atmospheric composition, pressure, and control of contaminants.

Aeromedical Support of Bomber Crews. CAPTAIN RICHARD L. MASTERS, USAF, MC, Barksdale Air Force Base, Louisiana.

The application of the principles of the Aerospace Medicine Program, with particular emphasis on the problems peculiar to bombardment crew operations, is discussed. Accumulated years of experience in handling special problems such as crew fatigue and long duty hours in disease prevention and health maintenance programs have resulted in working solutions to these and other problems which have applicability to the general field of aviation medicine. Details of some concepts of support are presented, including such items as the management of dental care and the accomplishment of annual physical examinations utilizing time on alert to minimize the amount of time a crew member must spend when off alert in accomplishing necessary medical functions. The entire program of medical support to combat crew members centers on the concepts of good medical practice accomplished in such a way as to preserve health, improve morale and complement the training that keeps these men in an optimun condition for quick and accurate response at all times.

Chemical Radioprotection. CAPT. G. S. MELVILLE, JR., K. M. GALLO, B.A. and G. S. HARRISON, JR., Balcones Research Center, Austin, Texas.

Chemical agents have been tests for protective effect against gamma radiation in female rats. Tests have been made involving both acute (single doses of 1250 r) and chronic (1 r/hr for a total of 600 r, followed by challenge of 800 r delivered at 500 r/min.)

Serotonin has been shown to be an effective radioprotectant against lethal doses of radiation. Present studies indicate that acetyl choline may augment the protective effect of serotonin.

In chronic low-dose radiation studies, tests were made of a water soluble sulfhydryl agent, a water insoluble sulfhydryl drug, a water soluble disulfide, and a water soluble amine. Drugs were administered daily throughout the period of irradiation. Mortality data following the 800 r challenge are presented.

Gaseous Environment Considerations and Evaluation Programs Leading to Spacecraft Atmosphere Selection. E. L. MICHEL, M.S. and MAJ. G. B. SMITH, JR., USAF, MC, NASA Manned Spacecraft Center, Houston, Texas.

The Crew Systems Division of the NASA-Manned Spacecraft Center has been actively involved in the direction and support of evaluation programs leading to the selection of the atmosphere for forthcoming Gemini and Apollo missions. The presentation discusses the physiologic and engineering considerations involved and introduces presentations of activities participating in the NASA sponsored atmosphere selection program. The implications derived from the results of these investigations are discussed together with indicated areas of future study.

Rotary Autokinesis and Displacement of the Visual Horizontal Associated with a Recumbent Posture. LT. EARL F. MILLER, II, MSC, USNR, and CAPTAIN ASHTON GRAYBIEL, MC, USN, Naval School of Aviation Medicine, Pensacola, Florida.

The visual horizontal as judged by four normal subjects (authors and two astronauts) was recorded every two seconds during periods lasting up to thirty minutes. Each subject was treated in an upright then recumbent (left side) position. In both positions the procedure was identical: empirical visual cues serving as background to the luminous line target were alternately illuminated for two minutes, then darkened completely for five minutes during each period.

It was found that empirical cues did not appreciably influence judgments in the upright position; however, in the recumbent position the target appeared to rotate markedly in the Aubert direction and to oscillate when visual cues were absent. The time course of these illusions is presented. The astronauts demonstrated similar and significantly less errors (1/3) than the authors in the recumbent position. In another test of the authors only, a decrease in average error during prolonged observation of the luminous line in the dark while recumbent was found for one subject but not the other. Implications of these findings are discussed.

Unusual Manifestations of Coronary Artery Heart Disease. MAJOR PERRY B. MILLER, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

On occasion, the clinical manifestations of coronary artery heart disease depart from classical patterns. To fulfill his responsibility for maintaining flying safety the practitioner of Aerospace Medicine must recognize unusual patterns of coronary disease and the limitations of methods used in the clinical evaluation of the patient with possible coronary disease.

The patient with sufficient narrowing of the coronary arteries that myocardial asphyxia develops during exercise may not complain of typical angina pectoris. Instead, atypical pain or exertional dyspnea without pain may be noted. The Master 2 step test may show no changes after exercises. Paradoxically, ST segment and T wave changes seen in a routine electrocardiogram may revert to normal after exercise.

Extensive coronary atherosclerosis may be present without sufficient compromise of the coronary circulation to produce symptoms or electrocardiographic changes even after maximal exercise on the treadmill. In this setting the first indication of disease may be a coronary thrombosis. A silent or a "missed" myocardial infarction may occur. The electrocardiographic findings of a myocardial infarction may disappear in time and exercise tests may then be normal. In the presence of acute myocardial infarction electrocardiographic changes may not appear for several days.

Civil Aeromedical Research Progress. STANLEY R. MOHLER, M.D., Chief, Aeromedical Research Division, Federal Aviation Agency, Washington, D. C.

Civil aeromedical research conducted by the Aviation Medical Service of the Federal Aviation Agency is concerned primarily with (1) elucidating those mental and physical attributes of civil airmen most vital to the safe operation of present and proposed civil aircraft; (2) providing the civil aviation industry, from the designer to the operator, with adequate information

relative to the physiological, psychological and medical characteristics of civil aircrew members, passengers, and ground support personnel; (3) determining the means by which human tissues may be protected from injury during civil aircraft accidents; and (4) developing means by which the effects of aging, drugs, fatigue, hypoxia, toxic substances and other factors, can be measured with respect to their influences on performance by civil airmen.

Disc Disease in Flying Personnel. LT. COL. PAUL W. MYERS, USAF, MC, Lackland Air Force Base, Texas.

The literature abounds with data substantiating the relationship between motivation and results in disc surgery. Observations made in a single Air Force Neurosurgical Clinic confirm this concept. However, it has also been noted that disc surgery in no way alters the ability to perform in aircraft of all types. No structural imposition occurs on the interspace. The main factors to be considered are: (1) careful case selection, (2) precise localization of the offending disc, and (3) thorough removal of the latter. Early ambulation and early return to flying have produced the desired results. Of late the morbidity of cervical disc surgery, even with apondylosis, has been significantly altered by means of the anterior approach. The disc is removed in toto and an interbody fusion using an autograft is done at the same time.

Sympathoadrenal Response to Water-Immersion Hypodynamics. CAPT. MICHAEL MCCALLY, USAF, MC, CAPT. JACK K. GOLDMAN, USAF, MC, and CAPT. GEORGE W. BARNARD, USAF, MC, Wright-Patterson Air Force Base, Ohio.

Orthostatic tolerance on the tilt table is impaired following exposure to bed rest or water immersion. Adrenaline and noradrenaline were bioassayed in the urine of sixteen subjects collection during six hours of complete water immersion and during six hours of routine office activity (control). The excretion of adrenaline increased and noradrenaline decreased significantly (P 0.01) during immersion. The serum free fatty acid and glucose response to passive vertical tilt was determined in control and post-immersion subjects. The absence of the normal serum free fatty acid mobilization within ten minutes of vertical tilt in the post-immersion subjects suggests impaired synthesis or release of noradrenaline as a result of immersion. The relatoinship of these findings to the deconditioning of gravity-responsive physiologic systems is discussed.

Studies in Decompression Sickness II. Cardio-Respiratory Responses of Anesthetized Dogs to Overcompression Following Experimental Decompression Sickness. MAJ. ROBERG G. MCIVER, USAF, MC and CAPT. SIDNEY D. LEVERETT, JR., USAF, MSC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

The rationale for the use of compression treatment for decompression sickness was investigated in two groups of dogs. Caisson's disease was produced in one group of animals by compressing to 6 atmospheres absolute pressure for one hour, and then returning to one atmosphere pressure. Altitude dysbarism was produced in the second group of animals by decompressing from 1 atmosphere absolute pressure to 0.185 atmospheres. Pulmonary air embolism was diagnosed in both groups, using the criteria of pulmonary hypertension, tachypnea, and the presence of intravascular bubbles.

Pulmonary artery pressure and respiratory rate, in both groups of animals, returned immediately to normal upon recompression, and visible intravascular bubbles disappeared. In the animals with Caisson's disease, recompression to only 3 atmospheres pressure completely reversed the signs of pulmonary air embolism.

Rorschach Indications of Emotional Instabilitiy and Susceptibility to Motion Sickness. LCDR. ALLEN E. MCMICHAEL, MSC, USN and CAPT. ASHTON GRAYBIEL, MC, USN, School of Aviation Medicine, Pensacola, Florida.

Almost all studies of motion sickness have referred to "underlying personality factors" but have not included such factors in the variables studied. The present study investigates relationships between aspects of personality, as measured by the Rorschach test, and susceptibility to experimentally induced motion sickness.

Eleven volunteer normal subjects were administered a battery of psychological tests, of which one was the Rorschach, prior to their exposure to four experimental conditions designed to induce motion sickness. These experimental conditions included exposure to: aerial acrobatics; going to sea in a power boat; a Slow Rotating Room; experiencing zero G. An overall rating on susceptibility to motion sickness was also made by another experimenter as a composite of these four criterion conditions.

Five composite dimensions of the Rorschach test (Beck) were correlated to the results of each of the five criteria. These dimensions were: drive, dependency; rigidity; anxiety; impulsivity. The resulting rank order correlations are presented and discussed in light of the previous findings.

Continuous, Functional Testing of Oxygen Breathing Equipment. J. RYAN NEVILLE, Ph.D., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

Previous communications have described (1) an electrochemical device for measuring oxygen, and (2) the application of such a unit as a hypoxia-warning indicator. The present communication deals with the use of this instrument for both routine and experimental testing of oxygen breathing equipment. The continuous, direct measurement of oxygen concentration within the mask is shown, and the manner in which such a method may indicate faulty mask fits, not otherwise detectable, is explained. The use of the instrument for the specific and continuous testing of oxygen regulators is also discussed.

Decompression Tests for the B-58 Escape Capsule System. CAPT. NICHOLAS C. NICHOLAS, USAF, CAPT. JAMES R. WAMSLEY, USAF, MC, and RICHARD W. BANCROFT, Ph.D., USAF Hospital, Carswell Air Force Base, Texas.

Data on the high altitude decompression tests for the B-58 Escape Capsule system to determine the ability of human subjects to operate the controls for encapsulation within the time of useful consciousness and to determine the compatability of the capsule oxygen and pressurization systems with the human subject are presented and discussed.

Thirty-one rapid decompression tests were conducted in accordance with ECP 592 AN and with the directives of the Surgeon, SAC, to peak altitudes of 50,000 ft. to 60,000 ft. from cabin pressure altitudes of 12,500 ft. to 30,000 ft. A second series of tests were conducted at the request of the Surgeon, SAC, again to determine reaction times. This second series of tests consisted of 3 slow decompressions and 9 rapid decompressions to peak altitudes ranging between 31,000 ft. and 50,000 ft.

The test procedures, instrumentation, and findings, as well as the physiological implications of high altitude flight, are discussed.

Speech in Vibration Environs. CHARLES W. NIXON, Ph.D., and HENRY C. SOMMER, B.Sc., Wright-Patterson Air Force Base, Ohio.

A capability for continuous speech communication from the space vehicle is a vital requirement in rocket-propelled, manned space flight. The influence of vibration and buffeting to be experienced during powered flight and re-entry upon the speech of space travelers is problematical for vehicles with the increased thrust of future propulsive systems. This communication problem is intensified by the high noise levels which accompany the transient low-frequency vibrations. Certain regions of the body structure most susceptible to low-frequency vibrations are regions also fundamental to normal speech production. This discussion describes research on man's ability to produce adequate speech during exposure to intense low-frequency vibrations. Talkers positioned on a Mercury space couch were exposed to three different modes of sinusoidal vibration along the x, y, and z axes at frequencies from 6 cps to 20 cps. Efficiency of the vibrated speech in quiet and in the presence of noise was evaluated by trained observers. Results indicate changes in intelligibility and other basic parameters of speech due to the

vibration stimulus. These data are useful to assist in predicting man's ability to produce satisfactory speech communication during phases of space flight accompanied by low-frequency vibration.

High Frequency Audiometry. JOHN E. PARNELL, Bionics and Human Factors Group, Lockheed-California Company, Burbank, California.

Measurements of the response of the human ear to frequencies above 8000 cps have been made. Suitable instrumentation was devised to assess the hearing function through the upper frequency limits. These measurements have provided the basis for previously unavailable normative data on hearing in this range. A dual application has been developed for this information. Research has demonstrated a latent ability in humans to perform the echolocation function utilized by certain whales and bats. The physical nature of this echo return from distant objects through echolocation appears to be correlated with acute hearing for high frequencies. A second application is in the field of auditory pathology. Data from these measurements show unexpected deviations from the normal curve for pathological ears. It is conceivable that some predictive index of impending pathology may be drawn from the audiogram for this high frequency range.

Extension of the Measured Experience of Human Impact Loads. G. J. PESMAN, Head, Biodynamics Section, and H. F. SCHERER, JR., Biodynamics Section, Environmental Physiology Branch National Aeronautics and Space Administration, Houston, Texas.

The Manned Spacecraft Center has initiated a broad research program to establish human impact tolerance limits as required for spacecraft design. This paper outlines the broad research objectives, outlines the program organization, and summarizes the results. Proposed future study requirements are presented to indicate additional tolerance requirements for spacecraft design.

A Study of Sensory Deprivation, Pain and Personality Relationships. J. M. PETERS, F. B. BENJAMIN, W. M. HELVEY, and G. A. ALBRIGHT, Space Environment and Life Sciences Laboratory, Republic Aviation Corporation, Farmingdale, L. I., New York.

This study was conducted to determine the relationship between the ability to endure pain, personality characteristics, and the ability to endure conditions of reduced sensory input. Sixty-five subjects were administered pain and personality tests and three groups of 8 subjects each were selected on the basis of their ability to endure pain. These subjects were then studied in pairs which were homogeneous in respect to pain endurance, to determine their ability to endure conditions of reduced sensory input. These subjects were isolated for periods unknown to them in an unchanging environment in terms of sight, sound, touch and the sensory modalities. Their reactions were observed throughout the study, both by direct vision and by multiple physiological sensors such as ECG, respiration, GSR, and EEG. The methods of the study, as well as the results, will be described.

Biological Effects of Whole Body Irradiation. COL. JOHN E. PICKERING, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

Groups of Macaca rhesus primates were exposed to 730 Mev protons at the University of California 184 synchrocyclotron in doses ranging from 300 rad to 700 rad and the biological effects evaluated. Thirty day lethality, clinical observations, pathological evaluation and survival curves are reported. From statistical analysis RBE for lethality was calculated to be approximately 1.3. This agrees well with previous studies relative to the RBE of high energy proton irradiation with acute radiation effects as the endpoints.

Biochemical Pharmacology in the Tolerance to Acceleration Stress. B. DAVID POLIS, Ph.D., and HERMAN W. SHMUKLER, Ph.D., Aviation Medical Acceleration Laboratory, U. S. Naval Air Development Center, Johnsville, Pa.

Experimental work from this laboratory defined the tolerance of the rat to acceleration stress in terms of a heart-brain interaction mediated by hormones of the pituitary-adrenal axis and demonstrated a 300 per cent increase in acceleration tolerance by the rat after hypophysectomy. Efforts to reproduce by pharmacological means this high tolerance to acceleration were realized in part with the drug Lucidril. Since pharmacological studies in animals suggested involvement of the hypothalamic area of the brain as a mode of action for this drug, some basic studies of biochemical changes in the brain during acceleration were carried out with the hope that a logical chemical approach to acceleration tolerance might be attained. These revealed a striking decrease in the brain concentration of a component identified as B-hydroxyaspartic acid by its position in ion exchange chromatography. This component also was increased significantly in the brain of hypophysectomized animals; it therefore appeared to be a critical metabolite of brain under anoxic stress. The parenteral administration of synthetic B-hydroxyaspartic acid to rats resulted in a significant increase in the median survival time from 7 minutes at 20 G for the litter mate controls to 14 minutes for the treated animals.

Atrial Fibrillation in Flying Personnel. L. M. POLLARD, M.D. and L. E. LAMB, M.D., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

Atrial fibrillation in flying personnel evaluated during the past seven years was noted to occur most frequently as a single isolated episode associated with an acute precipitating factor. The most common precipitating factor was acute alcoholism. Acute illnesses of various types were also seen as a cause for initiating atrial fibrillation. Less commonly, atrial fibrillation occurred without a known precipitating cause and less commonly atrial fibrillation persisted or recurred. A summary of the age distribution of individuals with atrial fibrillation, apparent precipitating causes, and frequency of subsequent episodes is presented. The significance of atrial fibrillation in relationship to flying duties is discussed from a point of view of the etiological considerations and the performance capability during the presence of fibrillation.

Instrumentation of the USAF School of Aerospace Medicine-Military Air Transport Service Simulator Fatigue Studies. WESLEY E. PRATHER, EE and LT. COL. DAVID G. SIMONS, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

This paper presents the miniaturized, personalized radio telemetry techniques employed to obtain physiological data during the SAM-MATS simulator fatigue study. It includes the instrumentation used to monitor 3 channels of simulator control motions and 3 channels of instrument readings.

Six physiological measures were transmitted: EEG, ECG, Respiration, BSR, GSR, and Temperature. Two transmitters were employed, one for EEG and one for the remaining measures. Parieto-occipital EEG leads modulated the simple FM transmitter directly. The remaining physiological measures modulated standard IRIG subcarrier channels 8, 10, 12, 14, and 18 of a six channel FM/FM miniaturized personalized transmitter. Newly developed plastic cup electrodes were employed for the ECG and the skin resistance measures. Respiration was measured by a thermistor inserted in one nostril. Basal skin resistance/galvanic skin reflexes were measured exosomatically from a single palmar site and adjacent to the active skin resistance electrode.

Measures derived from the simulator were obtained by mechanically coupling a low torque potentiometer to the Selsyn drive shaft of the desired parameter.

All measures were recorded on a portable precision 14 channel magnetic tape recorder.

Cellular Oxygen Consumption at Low Oxygen Tensions. ROBERT J. RAYES, M.S., and J. RYAN NEVILLE, Ph.D., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

As part of a preliminary investigation into certain aspects of exobiology, a base-line study has been made of various factors, including pH, cell concentration, temperature, and metabolic state, which might affect the critical oxygen tension (C.O.T.) of *saccharomyces cerevisiae*. The metabolic state and the temperature are found to have a significant effect on the C.O.T. The C.O.T. in the starved condition is independent of temperature, while the exogenous state exhibits an increase in C.O.T. with an increase in temperature. A comparison of the C.O.T. value at 25° C gave approximately 7 mm. Hg O_2 in the exogenous state, and less than 1 mm. Hg O_2 in the starved state. These results, in general, confirm earlier studies. No effect of the C.O.T. by pH or cell concentration changes could be found.

The C.O.T. of cytochrome deficient *Neurospora crassa* mutants has been compared with that of the normal strain, and no difference was observed.

The polarographic methodology used in the study is described, and a brief discussion of the practical significance that the C.O.T. measurement may have in the study of cellular processes is given.

Effects on Arterial Oxygen Saturation of Positive Pressure Breathing During Acceleration. JOHN H. REED, JR., M.D., CDR. BENJAMIN F. BURGESS, MSC, USN, and LCDR. HAROLD SANDLER, MC, USN, National Aeronautics and Space Administration, Houston, Texas.

A project has been completed where continuous recordings of arterial oxygen saturation by Waters covette were taken during acceleration while the subject breathed air, air positive pressure, oxygen and oxygen positive pressure. Records were taken on subjects subjected to accelerations of 7-10g in the transverse $+G_x$ position. Breathing air with and without positive pressure showed marked decreases in arterial oxygen saturation. Breathing pure oxygen at ambient pressure with and without positive pressure showed decreases, but these appeared after a lag time at peak g.

Physiological Effects Resulting from Different Types of Fluid Replacement During Water Immersion. CDR. E. REEVES, MSC, USN, CAPT. E. L. BECKMAN, MC, USN, and LCDR. R. E. DEFOREST, MC, USN, Aviation Medical Acceleration Laboratory.

With the advent of man into prolonged space travel, the problems of zero G have become increasingly important. The most convenient method of studying the weightless state for any length of time in the Earth's gravitational field is by means of water immersion. This method of investigation also has lent itself to the study of the problems of survival at sea because of the magnitude of the diuresis which results from water immersion.

Four subjects were studied while floating immersed to the neck level in water of 95° F and 85° F. Replacement of urinary loss was by two fluids: (a) Metrecal (a balanced dietary liquid), and (b) Sanalac (a powdered milk product). Non-replacement of fluid loss was also studied during immersion for each temperature. Data were collected concerning body temperatures, pulse, respiration, blood pressures, oxygen consumption, blood morphology, urinary output and electrolyte changes in serum and urine.

Aerospace Medical Surveillance of the Titan II. LT. COL. ROBERT N. REINER, USAF, MC and CAPT. JOHN J. MCCAMBRIDGE, USAF, MSC, March Air Force Base, California.

Although previous ICBM weapon systems posed many original occupational and aerospace medical support problems, it was not until the advent of the SM-68B, Titan II, that large scale toxicological problems, presented themselves as potential impediments to the operation of a desirable weapon system. Chemical and toxicological properties of the Titan II propellants (nitrogen tetroxide, hydrazine) are outlined. The underground Titan II complex is described and illustrated, pointing out those elements of particular aerospace medical interest. Missile combat crew composition is described with skill levels and training requirements discussed. The aerospace medical surveillance of this weapon system required close monitoring by flight surgeons and industrial hygiene engineers in order to minimize built-in hazard situations. Direct participation included Development Engineering Inspections, Safety Reviews, Life Support Sub-System Test Programs, protective equipment design and standardization, and individual advice and assistance during operational planning activities. The SCAPE suit (Self Contained Atmosphere Protective Ensemble) is illustrated and described, and latest developments in design and use of the ensemble are discussed. Preliminary results of the aerospace medical and industrial hygiene engineering surveillance of the Titan II are given with a description of future efforts to monitor the weapon system under operational conditions.

Java Monkey Performance on a Complex Operant Schedule Following UDMH Injection. MAJ. HERBERT H. REYNOLDS, LT. COL. FREDERICK H. ROHLES, JR., CAPT. VERNON L. CARTER, DVM, KENNETH C. BACK, Ph.D., and ANTON A. THOMAS, Ph.D., Holloman Air Force Base, New Mexico and Wright-Patterson Air Force Base, Ohio.

Previous study with 30 mg/kg of UDMH as it affected java monkey performance on a continuous avoidance task led to the conclusion that such a dosage level probably is not sufficient to bring about a performance decrement. However, this and higher dosage levels must be given further attention, and research is now underway with java monkeys performing on a four component operant schedule (auditory monitoring, visual monitoring, continuous avoidance, discrete avoidance, as well as jumping behavior). The subjects are to be injected again with 30 mg/kg of UDMH in an effort to evaluate the effect on a highly sophisticated performance schedule which should provide a more sensitive measure of UDMH toxicity.

Utilization of Bioelectricity as Power Supply for Implanted Electronic Devices. LUTHER W. REYNOLDS, B.S., General Electric Company, Philadelphia, Pennsylvania.

The power source for implanted circuitry such as cardiac pacemakers, etc. is derived from conventional batteries. These batteries are comparatively heavy, occupy a large volume, and have to be replaced every 2 to 5 years. Circuit size and weight could be cut drastically (50-80%) if it were possible to eliminate the batteries. The best anatomical loci for implanting each electrode was determined, observing the magnitude of the emf. Biologically inert electrodes were evaluated by plotting a polarization curve.

The best results were obtained when one stainless steel electrode was implanted in a rat subcutaneously. A second, PT-PT black electrode, was implanted in the peritoneal cavity. Insulated leads were connected to instruments necessary for making the appropriate electrical measurements. The open current voltage was 0.68V. Maximum power output of 115 μ watts was observed under a load of 500 ohms at 0.23V. The rat, with implanted electrodes, was used to replace batteries as a power source for a 500 KC transmitter.

An Approach to the Physiological Study of Heat Stress. HISASHI SAIKI, M.D., Ph.D., and MASAKO SAIKI, Ph.D., Tokyo, Japan.

Experimental studies were made on the changes of physiological functions and the dynamic aspects of thiamine metabolism caused by hot ambient stimulation for a relatively long period. In the first experiments, using human subjects, the following results were obtained. 1) For a relatively short period, the level of thiamine in blood was lowered, and free thiamine was not observed in the blood plasma. 2) When a heat stress over the critical temperature was applied to a subject who had been exposed to a preliminary stress, a marked rise of the total thiamine level in blood was observed.

Using rabbits for subjects, the following facts were clarified. 3) When a heat stress near critical degree was applied to rabbits for some hours, marked rise of esterified thiamine level in blood was observed. 4) The esterified thiamine-like substance was observed in the urine during heat stress and disappeared after longer loading. 5) Later, it was confirmed to be thiamine by thiaminase.

Circulatory Effects of Arterial Hypoxia. PETER F. SALISBURY, M.D., CECIL E. CROSS, and CHARLES I. BARRON, M.D., St. Joseph Hospital, Burbank, California; and Lockheed Aircraft Company, Burbank, California.

Circulatory effects of arterial hypoxia were measured with methods that permitted assessment of the following parameters: heart rate, blood pressure, left ventricular (LV) pressure, contractile strength of the LV, distensibility of the LV, ejection and filling of the LV, arterial vasomotor tonus, venous vasomotor tonus, baroceptor and chemoceptor carotid reflexes. Blood oxygen tension and pH were controlled in all, blood CO_2 tension and plasma sodium in some experiments. Experiments ranged through a wide spectrum of complexity. It was found that: down to a pO_2 of 40 mm. Hg hypoxia decreases cardiac performance slightly, through a direct influence on the heart but not through oxygen lack. Below pO_2 40 the contractile strength of isolated hearts is increased, probably by a humoral mechanism. Below pO_2 15 there is rapid dilatation and the heart stops. Edema of the heart muscle supervenes when isolated hearts beat for 15-20 min. at pO_2 below 40. Reflexes from the carotid body constrict arteries and veins at pO_2 below 40 (confirming others). It is a reflex bradycardia, and not a direct effect on the heart muscle, that causes severe heart failure in hypoxia, because during bouts of slow heart rate there is no decrease of venous return.

A Physiological Evaluation of the Divers' Wet Suit in Simulated Flight and Emergency Environments. LOUIS J. SANTAMARIA, B.S., LCDR. MORRIS J. DAMATO, MSC, USN, and MEREDITH H. RADLIFF, Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia, Pennsylvania.

Results of experimentation with the divers' wet suit as a possible substitute for the USN MK4 and MK5 exposure suit assemblies are presented. Subjects were exposed to (1) cockpit temperature conditions while wearing the wet suit, (2) dry cold simulating separation from aircraft over arctic-like terrain, canopy blow-off or loss of environmental control, and (3) immersion cold simulating separation over frigid waters. The level of stress is based upon tolerance times, body temperature changes, and subjective comments. The relative merits of the wet suit as compared to USN protective assemblies worn in various flight environments are discussed.

The Radiation Field Inside Space Vehicles. HERMANN J. SCHAEFER, Ph.D., USN School of Aviation Medicine, Pensacola, Florida.

The exposure dose inside a closed vessel from omnidirectionally incident radiation varies with location due to different geometrical path lengths of elementary beams arriving from different directions. In general, the dose is smallest close to the wall and largest in the center. The effect becomes more pronounced if wall thickness is not uniformly distributed. Close to a heavy heat shield, e.g. the dose is substantially smaller. The picture becomes more complex if these trivial geometrical relationships are evaluated in terms of spectral degradation of incident elementary beams from all directions. Theoretical calculation of the radiation field inside a fictitious simplified vehicle shell for a typical flare produced and a Van Allen Belt proton beam shows that the variation of dose is more pronounced for the steeper spectrum, i.e., for flare produced protons. The absorbed dose in a human target, under these conditions, depends upon body position and location. For a two- or three-man vehicle, mutual shielding becomes an additional factor which can be optimized.

Space Travel: Complete Emergency Life Sustaining System for Spacecraft. HENRY W. SEELER, Wright-Patterson Air Force Base, Ohio.

The Aerospace Medical Research Laboratory of the Wright-Patterson Air Force Base has prepared the design outline of a complete and independent emergency life sustaining system for astronauts which is capable of insuring return to earth even though under complete cabin depressurization. This system would consist of four novel basic components which are: (1) a combined astronaut's uniform with built-in mechanical pressurization means and a collapsible pressure helmet normally worn around the neck; (2) a balanced pressure breathing regulator for helmet, torso bladder, full pressure suit, and automatic intermittent-forced breathing actuating during physical weakness; (3) completely independent preferably pneumatically or electrically controlled chemical oxygen candle system with the oxygen generation initiated upon cabin decompression; (4) the fourth emergency component would be a one-man combined compression tube and space lock. During or after cabin decompression, this tube may be entered by one man and can repeatedly be compressed by means of an oxygen chemical candle; it can be used for changing pressure suits, using the toilet, relaxing without pressure suit, leaving or entering the space ship, or for additional purposes not yet realized.

Photostress and Flash Blindness in Aerospace Operations. CAPT. SANFORD L. SEVERIN, USAF, MC, CAPT. NORRIS L. NEWTON, USAF, MC, and LT. COL. JAMES F. CULVER, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

The hazard of flash blindness to the success of an aerospace mission is well recognized. Until recently there has been a paucity of information on the effects of short duration high intensity light flashes on visual performance. This paper presents the results of several experiments designed to study the severity of the visual disturbance from this type of photostress using the technique that was presented at the Aerospace Medical Association meeting of April, 1962. In these expanded and more comprehensive studies subjects have been exposed to brief light flashes that illuminate the cornea with intensities up to 242,000 lux (about twice the illumination that an unprotected astronaut would be exposed to on an earth orbit). An analysis has been made of the effect of drug-induced miosis upon the time required for recovery. The relevance of the information derived from this work to problems of space and nuclear operations is mentioned and the operational significance is implied.

Continuous Determination of Physiologic Profile with a Blood Flow Monitor. R. F. SHAW, M.D., N. B. MARPLE, and W. SCOLNIK, Biomedical Engineering Laboratory of the Electronic Research Laboratories, Columbia University, New York, New York.

Investigation has been directed toward the perfection of a technique for acquiring an organ-by-organ physiologic profile continuously from moment-to-moment over extended periods of time and suitable for flight, space, simulation and stress studies. The technique employs continuous measurement of blood flow to individual organs of physiologic interest. Physiologic studies performed in this and other laboratories have demonstrated that homeostatic hemodynamic mechanisms operate to regulate blood flow to individual organs to meet the level of organ activity and tissue needs. Since the level of blood flow to an organ is adjusted to the level of that organ's activity, monitoring of blood flow to the organ will reflect the level and changing pattern of organ performance. A simultaneous array of such monitors will consequently present continuous and detailed overall physiologic profile.

A reliable electromagnetic blood flow monitor has been developed for acute use in humans and chronic use in experimental animals. The blood flow monitor will be described and practical aspects concerning its use will be discussed. Physiologic studies of the regulation of organ blood flow and the relation of blood flow to organ performance will be presented.

The Exposure of Ambulatory Patients to Moderate Altitude (1) Responses in Severe Pulmonary Impairment. FREDERICK H. SHILLITO, M.D., JOSEPH F. TOMASHEFSKI, M.D., and WILLIAM F. ASHE, M.D., Department of Preventive Medicine, College of Medicine, Ohio State University, Columbus, Ohio.

This study was designed to determine the ability of ambulatory patients suffering from advanced pulmonary fibrosis, emphysemas, surgical pneumonectomy and a variety of other pulmonary conditions to withstand the stress of moderate altitudes up to 8000 feet. A simulated flight profile was decided upon,

using a pressure chamber large enough for airline seats and equipment and observers. Each patient had received a very complete clinical study prior to the experiment. An airline type of luncheon was served. The usual clinical parameters were observed. Special attention was given to vital capacity, timed vital capacity, metabolic rate and minute ventilation both during rest and mild exercise. Undesirable reactions occurred in several of the subjects. These reactions which required prompt detection and attention are of importance to physicians practicing aviation medicine.

Experience with Newly Developed Medical Certification Procedures. PETER V. SIEGEL, M.D., Chief, Aeromedical Certification Division, Federal Aviation Agency, Washington, D. C.

Applications for medical certification have increased from 150,000 in 1950 to 260,000 in 1962. Manual review of all applications to insure adherence to the medical standards, and manual compilation of biomedical statistics, became impractical. A feasibility study demonstrated that processing of applications for medical certification could be adapted to ADP. Subsequently, a program was developed utilizing an IBM 1401 computer in daily processing and for storing data on magnetic tape for future biomedical studies.

There is no substitute for sound medical judgment in determining an applicant's eligibility for medical certification. The computer is only one phase in the processing of records.

Experiences encountered during the development, conversion, and early operational periods will be related.

Analysis of Multiple Physiological Data from the Sam-Mats Simulator Fatigue Studies. LT. COL. DAVID G. SIMONS, USAF, MC, and BRYCE O. HARTMAN, Ph.D., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

This paper presents some of the physiological data and results obtained from the USAF School of Aerospace Medicine—Military Air Transport Service simulator fatigue study. Each of four pilots completed a 24 hour simulator flight broken into eleven two-hour legs terminated by ILS landings. Six channels of physiological data were transmitted by miniaturized personalized radio telemetry and recorded on magnetic tape continuously. Monitoring included EEG, ECG, Respiration, BSR, GSR, and temperature.

All measures are analyzed in terms of patterns observable through a 24 hour period. Analysis of EEG includes 10 second sums of Ua (ratio of frequency to amplitude) of all flight periods, and selected periods of alpha rhythm incidence. ECG analysis includes beat by beat (instantaneous) pulse rate written out at 2.5 and 0.2 inches per minute for all flights. The number of premature ventricular contractions per minute were scored through selected intervals. Respiration was analyzed for breath by breath rate.

Characteristic decrease in average amplitude and increase in variability of Ua 10 sec. sums developed as time progressed. The incidence of cardioaccelerator reflexes varied markedly from time to time throughout the flight. They correlated strongly with irregularity of respiration which apparently relates to some aspect of cortical activity. These observations are related to the flight situation (e.g., simulated emergencies) and pilot performance scores.

RCAF Ejection Experience: Decade 1952-1961. S/L J. R. SMILEY, Ph.D., RCAF Institute of Aviation Medicine, Toronto, Ontario, Canada.

The first RCAF ejection was a successful escape from an F86 aircraft, 9 April 1952. In the ensuing decade 218 ejections took place out of which 165 aircrew survived. Each of the 165 has made a report on his experience, procedures, and equipment. Where possible these data have been summarized or coded for analysis.

This report shows the general background giving rise to ejections and the trend of survival rates by years. A review is then made of the circumstances surrounding fatal and successful ejections together with relationship between altitude, attitude and airspeed. The descent phase is examined in terms of retention of equipment, control, and problems of landing. A summary of survival and rescue experience is then presented together with a summary of water landing.

Of major interest is the study of injuries by type and site according to aircraft, phase of escape, preparation for ejection, control of descent and landing conditions. It has been found that the Martin-Baker seat does not give rise to so high a spinal fracture rate relative to other ejection systems as commonly thought.

Human Tolerances to Extreme Impacts in Free-Fall. RICHARD G. SNYDER, Ph.D., Civil Aeromedical Research Institute, Federal Aviation Agency, Oklahoma City, Oklahoma.

Although mathematical model calculations suggest that the human body may tolerate considerably greater impact forces than has been generally found through experimental bio-medical evidence, most deceleration tests involving human subjects have of necessity been confined to lower voluntary aspects. In an attempt to learn more about higher ranges of impact survivability and variability this two-year study has been concerned with selected cases of accidental, suicidal, or homicidal free-falls involving extremely abrupt time durations and velocities up to terminal velocity. Out of nearly 5000 cases of survived free-falls some 150 were subjected to intensive study. In each case selected, the exact distance of the fall, position of the body upon impact, material impacted, and resulting deformation were personally determined, providing reliable basis for biophysical calculations of velocity and impact forces. Complete medical histories, including roentgenograms, were obtained on each subject and the injuries correlated with the direction, magnitude, and distribution of force at impact. These data indicate that under certain conditions the human body can survive and recover from considerably higher impact forces than previously reported.

Psychophysiological Visual Acuity Disturbances in Military Aviators. LT. JOHN A. SOURS, MC, USNR, and CDR. WAYNE L. ERDBRINK, MC, USN, Neuropsychiatry Department, U. S. Naval School of Aviation Medicine, Pensacola, Florida.

This paper presents the phenomenology and etiology of a psychogenic visual impairment, characterized by complaints of transient blurred vision, variable visible acuities, and essentially normal cycloplegic refractions. Heretofore, psychogenic visual defects have been regarded as indicative of hysterical reactions or malingering. With the exception of ophthalmic migraine and retinal arteriolar spasm, little attention has been given to psychophysiological disturbances in visual acuity.

In a study of 449 aviation patients with possible psychiatric disturbances evaluated by the Department of Psychiatry and Neurology, U. S. Naval School of Aviation Medicine, Pensacola, Florida, between 1958 and 1961, 11 patients were found to have subjective visual disturbances which resulted in referral to the Department of Ophthalmology. Ophthalmologic evaluations revealed in this group variable visual acuity defects and essentially normal ophthalmologic findings, which prompted referral of the patients of the Department of Psychiatry and Neurology.

Combined ophthalmologic-psychiatric study demonstrated that these visual findings were related to ciliary body spasm (spasm of accommodation). The physiological visual acuity disturbance was found to be symbolic of either extrapsychic or intrapsychic conflicts, focal to both the perception of and the sentiments about flying and the flying situation. The results of review of 11 cases with ciliary body spasm are presented in tabular form. Several case histories are given in clinical vignettes to illustrate the psychophysiological disorder, its clinical exfoliations and psychodynamic configurations. The disorder is distinguished from other types of visual disturbances by both ophthalmologic and psychiatric criteria. Its natural history and responses to psychotherapy are discussed.

Heat Transfer in Protection from Flames. ALICE M. STOLL, M.S., Aviation Medical Acceleration Laboratory, Naval Air Development Center, Johnsville, Pennsylvania.

Heat transfer through single and double layers of a new high-temperature-resistant, non-melting polyamide was evaluated during short-term exposures to flames at 1200° C. It was found that in 3-second exposures the protection offered by fabrics 0.1

to 0.3 mm. thick varied linearly in inverse proportion to the thickness of the fabric. With a double-layer assembly of 0.15 mm. fabric it was found that within practical limits there is an optimal thickness of air space between the layers such that at greater thicknesses protective capacity is rapidly lost. At lesser thicknesses of air space protection time assayed in anesthetized, depilated rats varies almost linearly in inverse proportion to this thickness. It is inferred that multiple layers separated by relatively small air spaces provide the most effective protection from short-term high-temperature flame contact.

Myoelectric Servo Control. GEORGE H. SULLIVAN, CHARLES J. MARTELL, and GERSHON WELTMAN, Spacelabs, Inc., Van Nuys, California.

Under high accelerative forces, it becomes extremely difficult for a pilot physically to move his arms and hands to exercise control over his craft. By attempting to move his arms, the pilot generates muscle action potentials, or myoelectric signals, which may be utilized as a control source. The basic arm movements desired, and the muscles involved, were determined and the myoelectric activity patterns characteristic of the movements measured. Transforms were performed on the "raw" signals and control logics which relate myoelectric signals to desired servo-action were written. A simulator trainer was constructed which accepts the myoelectric inputs from sets of three or four muscles, indicates the desired arm movement, performs the preset logic on the elicited myoelectric signals, provides success-failure feedback and drives a splint in uniplanar up-down movement. The development of the control logics and servo system mark a significant advance in prosthetic control with direct application to amputees and malformed (Thalidomide) children.

The Effects of Severe Impact on Bears. MAJ. E. J. TAYLOR, MC, R. F. CHANDLER, BSME, CAPT. L. W. RHEIN, USAF, MC, MAJ. R. H. EDWARDS, USAF, MC, and CAPT. V. L. CARTER, USAF, VC, Holloman Air Force Base, New Mexico.

As one phase of the NASA impact studies, a series of high level deceleration tests were performed with bears on the Daisy Decelerator test facility. A series of 11 tests were accomplished at impacts as high as 92 g's and velocities as high as 68.5 ft./sec. The test subject was oriented in the $-G_z$ (eyeballs up), $+G_y$ (eyeballs left), $-G_y$ (eyeballs right), and right and left oblique positions (eyeballs up and right, eyeballs up and left). No significant biological effects were noted in any runs at moderately severe levels (35-50g); at $-92gG_z$, one animal died after a marked vagotonic shock, complicated by severe fractures, visceral lacerations, and pulmonary trauma.

The Acceleration Phosphene. PAUL TOBIAS, Ph.D. and J. P. MEEHAN, M.D., Human Centrifuge, Kerckhoff Laboratories, University of Southern California, Los Angeles, California.

The investigation of phosphenes, or the sensation of light in the absence of light, dates back to antiquity. Recent investigations at the University of Southern California Human Centrifuge have produced a vivid visual phosphene, never before described nor reported during exposure to positive acceleration.

This report reviews the methods of producing phosphenes in general, and the acceleration phosphene in particular. A detailed and graphic description is presented; and the results of several experiments conducted with 60 subjects is reported. These experiments investigated the universality of this phenomenon, its G threshold, characteristics; and the effects on this threshold of (1) dark adaptation, (2) breathing 100 per cent oxygen, and (3) breathing 11 per cent oxygen.

Finally, evidence for the relationship between the phosphene and the cardiac pressor response is presented, giving some explanation to the origin of this entopic sensation and indicating areas for future research.

The Joint Committee on Aviation Pathology. COL. FRANK M. TOWNSEND, USAF, MC and CAPT. W. HARLEY DAVIDSON, USAF, MC, Armed Forces Institute of Pathology, Washington, D. C.

The Joint Committee on Aviation Pathology, an international Committee composed of members from the United States, United Kingdom, and Canadian Armed Forces Medical Services, has been in existence for seven years. The foundation of this Committee was instrumental in establishing pathological procedures in the study of individuals killed in aircraft accidents, both military and civilian. A review of the accomplishments of the Committee members will be presented. This will consist of a brief statement of the publications of the Committee, known as the Joint Committee on Aviation Pathology Memoranda, as well as individual activities of the membership.

Liver Lipids in Hydrazine Toxicity. DAVID L. TROUT, Ph.D. and CAPT. JOHN W. FOFT, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

Hydrazine, a major fuel component of the Titan –2 rockets, induces in rats a rapid accumulation of fat in the liver. This effect is delayed for about two hours, is then accompanied by markedly elevated serum free fatty acids, and appears to result from an accelerated transport of fatty acids to the liver. With dosages which produce little necrosis, fat accumulates first in the periportal zones of the liver and appears as small discrete droplets in the cytoplasm of parenchymal cells.

The fatty metamorphosis produced by hydrazine, unlike that from carbon tetrachloride, is not significantly inhibited by ergotasmine or dibensyline. Pyridoxine, which blocks the convulsant action of 1,1-dimethylhydrazine, does not affect the rate of fatty infiltration produced in the liver by hydrazine. Pentobarbital, at an anesthetic dosage, does retard the accumulation of liver fat but, when given concurerntly with hydrazine, causes a high incidence of death due to laryngospasm. Death in this situation can be prevented by tracheotomy.

The Effects of High Concentration of CO_2 on Urinary Excretion of Steroids and Catecholamines. FRODE ULVEDAL, Ph.D., CAPTAIN R. G. CUTLER, USAF, MC, and B. E. WELCH, Ph.D., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

Urinary excretion of 17-OHCS, corticosterone-like hormones, and catecholamines (epinephrine and norepinephrine) has been investigated on pilots during exposures to increased concentrations of carbon dioxide. The hormones were determined on 24-hour urine samples during the experiment as well as during the pre-and-post experimental periods. The subjects were on a constant diet for the entire period mentioned. The experimental profile was 3 days at ground level (700 mm. Hg pressure with normal atmospheric condition), then for 3 days at ground level plus 2 mm. Hg pCO_2. The subjects were then permitted outside the simulator for 6 days before the second part of the experiment during which the subjects were kept at simulated altitude of 32,500 feet (200 mm. Hg pressure and with essentially 100 per cent pO_2) for three days, followed by a similar period at altitude but with the addition of CO_2 equivalent to the 700 mm. Hg portion. Increased CO_2 at ground level appeared to cause an increase in the secretion of epinephrine and norepinephrine, while a decrease was observed for the two groups of steroids. At 32,500 feet simulated altitude, with the added CO_2, the values for the four parameters are less than those observed at 33,500 feet using 100 per cent oxygen alone.

Control of Seasickness with Trimethobenzamide (Tigan). MAJ. K. VANDENBOS, USAF, MC, COL. V. DOWNEY, USAF, MC, and CAPT. W. WILLIAMS, USAF, Langley Air Force Base, Virginia.

Three hundred and fifty four aircrewmen in the Sea Survival School at Langley AFB, Virginia, participated in the evaluation of Tigan to control sea sickness during simulated sea survival exercises. After a simulated parachute entry into the sea, each student spent the rest of the day in a one-man life raft practicing survival procedures. On the second day, students practiced these survival techniques in six- and twenty-man rafts.

There were 93 episodes of nausea or vomiting treated with Tigan. After the onset of nausea, 26 students had complete relief from symptoms with oral Tigan, 2 students had partial relief, 11 had no relief, and an additional 11 could not retain the capsules due to vomiting. Thirty-four students received intramuscular

Tigan with onset of symptoms and 30 had complete relief, 1 partial relief, 3 no relief from symptoms. Nine students were sea sick but took no medication. Sixty-six students took prophylactic oral Tigan on the second day at sea because of sea sickness on the first day. Fifty-four had no recurrence of symptoms, 11 had partial relief from symptoms, and 1 had no relief of symptoms. There were no side effects from Tigan noted.

The use of Tigan for control of sea sickness in the Sea Survival School is still being evaluated and larger numbers of treated aircrewmen are being obtained. The Hoffmann-La Roche Company is preparing a rapid absorbing Tigan tablet which will be superior to the capsule form.

Nutritional Value of Some Microbial Foods. 1/Lt. John E. Vanderveen, USAF, Ph.D. and Alton E. Prince, Ph.D., Wright-Patterson Air Force Base, Ohio.

Microbial foods including selected algae, fungi, and bacteria have been grown in pure cultures and incorporated into diets for laboratory animals to determine their nutrient value. The microorganisms selected have shown promise as gas exchange mechanisms in bioregenerating systems. The diet was composed of a microbial food source, starch, vegetable fat, vitamins, and minerals. The microorganisms were incorporated into the diet at a level sufficient to provide all the protein for weanling male rats. Animals were fed these diets *ad libitum* in individual metabolism cages for a preliminary period which was followed by the digestion trial.

Data on food consumption, body weight changes, and digestibility of principle macro-nutrients will be compared for the three food sources with similar data obtained from feeding a control diet.

Accumulation of Static Electricity in Arctic Clothing. Capt. James H. Veghte and MSgt. Walter W. Millard, Arctic Aeromedical Laboratory, Fort Wainwright, Alaska.

The accumulation of static electricity on clothing or in fuel systems has been an enigma and is considered the possible cause of many unexplained aircraft and ground explosions in Air Force operations. Recently, during extreme cold weather sufficient static charge was generated on the surface of heavy arctic clothing to start a fire while fuel was being poured into a container. During this same period, static electricity is believed to have caused a fire within a filtering system for aircraft refueling. Because of these accidents and the lack of quantitative work on static electricity in the Arctic, a study was initiated during the past winter by the Arctic Aeromedical Laboratory at Fairbanks, Alaska, to measure the accumulation of electrostatic charges on arctic clothing. The static potential (voltage) and charge (coulombs) on the clothing of a member of flight line maintenance personnel performing routine tasks in the cold was monitored each month. Voltages as high as 7800 VDC were measured on the MA-1 jacket worn by personnel in moderately cold temperatures of –20°F. When the jacket was removed, voltage readings in excess of 8,000 VDC were recorded. Energy values combined with the voltage readings were used to determine critical levels. The potential hazards of electrostatic discharge from arctic clothing and a temperature-electro-static accumulation curve will be discussed.

Retinal Burn Problem. Capt. H. G. Wagner, MC, USN and Myron L. Wolbarsht, Naval Medical Research Institute, Bethesda, Maryland.

This problem stems from the fact that very high intensity light sources may under appropriate conditions produce burns in the retina of the eye. Unprotected visualization of the sun, thermonuclear explosions, laser emissions, and high intensity arcs have often been followed by more or less permanent loss of visual function. The cause is usually identified as due to thermal coagulation of the retina but it may be more complex than this explanation. The biophysics of the lesion has been studied by several investigators and theoretical models given. A brief discussion of this aspect of the problem will be made. The histopathology and functional losses reported will also be reviewed.

A Comparison of Physiological Changes Occurring During Water Immersion and Bed Rest. Capt. Bruce H. Warren, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

Human water immersion experiments have been performed by several investigators under the assumption that the resulting "hypodynamic" environment simulates certain conditions of weightlessness. Bed rest has also been used as a method for studying the hypodynamic state. In the present investigation a controlled comparison of these techniques was made. Twelve healthy male volunteers took part in these experiments. Each subject was studied during two 6-hour water immersion periods and one 6-hour bed rest period. Physical and psychological variables were kept as constant as possible. Electrocardiograms were traced continuously and blood pressures were recorded automatically. Blood and urine samples were collected for physical and chemical determinations. A tilt table was used to produce gravitational stress for measuring cardiovascular responses before and after each hypodynamic period. An analysis of the data revealed that the direction of change of a physiological parameter during water immersion coincided with the direction of change of the same parameter during bed rest. The biological relationship of the above hypodynamic factors to weightlessness can only be hypothesized. Further evaluation of physiological changes occurring during water immersion and bed rest appear warranted, however, before either is accepted as a better tool than the other for studying the hypodynamic state in man. In over thirty hypodynamic periods above, no significant differences were noted in the physiological parameters measured during water immersion and bed rest which could not be attributed to factors other than an increased hypodynamic state during water immersion.

Monitoring of Trace Constituents in Simulated Manned Spacecraft. T. B. Weber, Ph.D. and J. E. Dickey, E.E., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

The detection and identification of microcontaminants in closed environmental atmospheres is a major life support problem but has been relatively unexplored due to the inherent difficulties in obtaining reliable, reproducible data. As a consequence, there is little toxicological information on specific allowable concentrations, especially on low levels for extended missions durations. Two necessary developments to make this possible were: 1. collecting and sampling minute fractions unaltered and free of extraneous components and, 2. the differentiation and quantitation of wide varieties of materials by suitable analytical instrumentation. This paper will discuss the development of a cryogenic system with a glass magnetic pump and thermally variable collecting unit. Data from analysis of sealed cabin atmospheres by gas chromatography and prismgrating infrared spectrophotometry will also be presented. Included in these analyses are materials arising as metabolic by-products of the occupants, from the stored materials aboard and/or from the operation of the instrumentation and sub-systems.

Human Response to Lateral Impact. Capt. Edmund B. Weis, USAF, MC, James W. Brinkley, B.Sc., Capt. Neville P. Clarke, USAF, MC, and Capt. William E. Temple, USAF, MC, Wright-Patterson Air Force Base, Ohio.

Thirty-two tests of human response to lateral impact were conducted (15 rightward and 17 leftward). This study was a joint effort between NASA (Manned Spacecraft Center) and this Laboratory, conducted in order to furnish previously undefined criteria for tolerance to impulsive loads applied through the Y axis for the purposes of attenuator design.

The acceleration impulses were applied on the Vertical Deceleration Tower at this Laboratory. The VDT water brake produces an approximately triangular acceleration pulse after a free fall. The series of graduated tests reached a maximum of 20 g peak acceleration, 22 fps impact velocity, 1,500 g per second onset rate, and pulse duration of 120 milliseconds (exclusive of free fall). Although human tolerance was not reached in these tests, a clinical evaluation of physiological response will be presented in consideration of potential tolerance limiting factors.

The restraint system (integrated shoulder, chest, lap, thigh, and ankle straps) and the support system (microballoon couch) will be discussed and criticized on the basis of subjective response and force and acceleration measurements. The method and current status of mathematical analysis and mechanical modeling of human response to this stress will be presented.

Spacecraft Atmosphere Selection. W. E. WELCH, Ph.D. and CAPT. R. G. CUTLER, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas; and T. E. MORGAN, JR., M.D., University of Washington, Seattle, Washington.

There are many factors influencing the selection of the atmosphere for manned spacecraft. Each of the factors, including physiologic, physical, engineering and reliability parameters, must be critically evaluated and weighted to obtain the best possible atmosphere with the minimum amount of compromise to the overall mission. Data were obtained during two 14-day experiments in the USAF-SAM two-man space cabin simulator relative to the physiologic factors in atmosphere selection. Both experiments were conducted at a simulated altitude of 27,000 feet (258 mm. Hg) and a (pO_2 of 243 mm. Hg). Emphasis was placed on arterial and alveolar pO_2 and pCO_2, chest x-rays and vital capacity, all determined at the experimental altitude and atmosphere. The atmosphere, in general, was well-tolerated by all four test subjects. No atelectasis was evident by x-ray or vital capacity. Vital capacity was slightly reduced, this was not felt to be indicative of atelectasis. Arterial pO_2 was slightly lowered, but again, it did not indicate a significant increase in the normal physiologic shunting of blood.

Resume of Present Knowledge of Man's Ability to Meet the Space Environment. STANLEY C. WHITE, M.D. and CHARLES A. BERRY, M.D., National Aeronautics and Space Administration, Houston, Texas.

The United States and Soviet Union Spaceflight programs continue to compile information on man's ability to operate in this new environment. As more flight data becomes available, better insight into the performance of the body systems can be made while under weightlessness and other stresses of the environment. This information permits the reevaluation of the proposed problems associated with further extension of flight experience and the inclusion of multiple men into the crew. This paper will attempt to summarize the experience to date and present estimation of the problems being encountered or expected in the next phases of flight.

Acceleration and Vision: Brightness Discrimination. W. J. WHITE and M. L. BRAUNSTEIN, Cornell Aeronautical Laboratory, Inc., Buffalo, New York.

Brightness discrimination thresholds were determined at positive acceleration levels of 1, 2, 3, and 5 *G* and transverse acceleration levels of 1, 2, 3, 5, and 7 *G*. Four background luminance levels, ranging from .03 to 31 foot lamberts, were studies. Contrast required to detect an increment in illumination increased with acceleration. This increase was present for both directions of acceleration and for all background levels, but was most marked for positive acceleration, and for the dimmest background. At .03 ft. l., 16 per cent contract was required to detect a target of 5 *G* positive, as compared to 9 per cent at 1 *G*. The differential effects of positive and transverse acceleration permit a comparison of the mechanical and haemodynamic effects of acceleration on brightness discrimination. These results will be related to previous research, and the role of these factors in other aspects of visual functioning will be discussed.

Dynamic Response Characteristics of Weightless Man. CAPT. C. E. WHITSETT, USAF, Kirtland Air Force Base, New Mexico.

A mathematical model is developed to approximate the mass distribution, center of mass, moments of inertia, and degrees of freedom of a human being by segmenting the body into 14 idealized masses. An analysis of the model reveals that the moments of inertia about the segment mass centers of the hands, feet, and forearms are negligible, when compared to the total body moments of inertia. However, the moment of inertia of the torso about its mass center is 10 to 35 per cent of the total body moment of inertia. By neglecting the local moments of inertia of the smaller segments, a simplified method is achieved for calculating the moments of inertia and center of mass when the body posture changes. An investigation of selected problems reveals the applicability of the model in predicting analytically man's dynamic response characteristics in space. Preliminary experiments indicate that the torque which weightless man can exert by applying a sudden twist to a fixed handle varies as a half sine wave, and is approximately 67 per cent of his maximum torque under normal gravity conditions.

Toxic Photo-Oxidation Products in Closed Environments. S. S. WILKS, Ph.D., USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

This paper will present experimental data concerning the effects of light (solar) upon certain classes of organic substances which may be components of the sealed environment of space vehicles. Many materials such as organic plastics, pigments, insulating material, etc., will when exposed to light in the presence of oxygen, liberate a number of toxic end products such as carbon monoxide, aldehydes, acids and certain hydrocarbons. In a sealed environment these agents may, unless removed, reach levels toxic to human beings during a long sojourn in a sealed system. These products, along with those which may result from thermal and electrical (motors, generators, etc.), may constitute a considerable hazard in sealed environments.

Wiley Post: First Tests of High Altitude Pressure Suits in United States. CAPTAIN CHARLES L. WILSON, USAF, MC, Hq., Andrews Air Force Base, Washington, D. C.

This paper represents an attempt to gather and compile pertinent photographs, documents, and interviews concerning the research, development, and low pressure chamber testing of Mr. Wiley Post's high altitude pressure suits.

Mr. Post had three different pressure suits made for him from April through August, 1934 by the B. F. Goodrich Co. The first suit failed in a static pressure test at Wright Field, Dayton, Ohio, on 23 June 1934. The second suit had to be cut apart in late July 1934 to remove Mr. Post who became incarcerated in it. The third and final suit was successfully tested to 7 psi, and protected Wiley during two low pressure chamber tests to 7.0 km simulated altitude at Wright Field on 27 and 28 August 1934, and was flown on at least ten occasions. These last two tests were the first pressure suit tests in a low pressure chamber in the United States. Mr. Post established several other firsts in aviation history. He was the first to use liquid oxygen with a pressure suit. Also, he was the first man in the world to fly in a pressure suit, late in August 1934.

This paper presents previously unpublished documents and photographs of all three pressure suits, and the modified low pressure chamber at Wright Field.

Aeromedical Aspects of Malaria Prophylaxis with Chloroquine-Primaquine. CAPT. JAMES F. WITTMER, USAF, MC, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas.

U. S. Army field studies have demonstrated low doses and blood levels of a chloroquine-primaquine combination to be efficacious in malaria suppression. While numerous side effects which would compromise flying performance have been reported in the use of curative doses of these drugs, very few significant reactions have been reported from the use of the suppressive doses. This study, on human subjects, was designed to discover and describe possible effects of a low dose chloroquine-primaquine mixture on physical parameters of importance to aviation. Among these are effects on the blood elements, tolerance to decreased oxygen partial pressure, psychomotor performance, and visual effects. Included is a discussion of the possible significance of these and other effects, as are conclusions and recommendations.

Effect of Forward Acceleration on Circulatory, Pleural and Related Pressures. EARL H. WOOD, M.D., Ph.D., A. CLARK NOLAN, M.D., and DAVID E. DONALD, Ph.D., Mayo Clinic, Rochester, Minnesota.

Pleural pressures were recorded simultaneously from the ventral and dorsal regions of the thorax using fluid-filled catheters inserted through the chest wall via No. 17 needles using an air-tight technic. Pressures were referenced to the catheter tip levels determined by A-P and lateral roentgenograms taken prior to and after a series of 1 to 3 minute exposures of 8 anesthetized dogs to accelerations of 2, 4 and 6 G in the supine horizontal and 15° head-up and head-down positions.

The negativity of intrapleural pressure in the ventral thorax was uniformly increased during exposures while intrapleural pressure in the dorsal thorax became positive. These changes are believed to result from the increase in weight of the lungs and other intrathoracic elements during acceleration and would be compatible with an average specific gravity of the thoracic contents of about 0.5 since the increase in gradient between the dorsal and ventral recording sites averaged about 0.5 cm. H_2O per cm. of vertical distance between the sites per G to which the animal was exposed. Esophageal and pericardial pressures were similar or somewhat less negative than the intrapleural pressures at the same horizontal plane in the thorax. All dogs showed decreases in arterial oxygen saturation during exposures to 6 G when breathing air or 99.6 per cent oxygen similar to those previously observed in normal human subjects. Collapse of alveoli and consequent arterial-venous pulmonary shunting of blood appears to be the most likely mechanism for the arterial desaturation observed.