Continuing Education in Medicine
University Extension and
The School of Medicine
University of California, Los Angeles

present

The Fifth Annual Symposium

on

AVIATION MEDICINE
October 28-30, 1959

FOREWORD: The Fifth Annual Symposium on Aviation Medicine will continue the theme developed at the Fourth Annual Symposium. The Medical Directors of the Major Air Lines have been invited to discuss various subjects related to Commerical Aviation Medicine and its many phases. The Federal Aviation Agency will be represented by the Chief of the Research Requirement Division who will discuss subjects of current interest to F.A.A. Examiners.

A field trip to the Control Tower and to available commerical Jet Airliners at the Los Angeles International Airport will be on Thursday afternoon. Here, some of the problems in Air Traffic Control will be demonstrated.

PLANNING COMMITTEE: Bruce B. Leamer, M.D., Chairman
Toby Freedman, M.D.
James N. Waggoner, M.D.
J. Gordon Wells, Ph.D.

PROGRAM: Wednesday, October 28, 1959

Morning: COMMERCIAL AVIATION MEDICINE: THE F.A.A. and AIR LINES MEDICAL DEPARTMENTS

Moderator - James N. Waggoner, M.D.

8:30 - 9:00	Registration
9:00 - 9:15	Welcome - John Field, II, Ph.D.
9:15 - 10:00	The Effect of Aging on the Commercial Aviator - George J. Kidera, M.D. - United Air Lines
10:00 - 10:15	Coffee
10:15 - 11:00	Hearing Conservation Program in Commercial Aviation - Ludwig G. Lederer, M.D. - Capital Airlines
11:00 - 11:45	Aircrew Performance: Capabilities and Demands in Commercial Jet Operations - K. L. Stratton, M.D. - American Airlines
11:45 - 12:30	Altitude Indoctrination for Commercial Jet Aircrews - Charles Gullett, M.D. - Trans World Airlines

Afternoon:

2:00 - 2:45 The Medical Implications and Considerations Necessary for Operating International Air Carrier Service - M. F. Leeds, M.D.

2:45 - 3:30 Comment from F.A.A. on above topics and discussion of F.A.A. Research Centers - John E. Smith, M.D.

3:30 - 3:45 Coffee

3:45 - 5:15 Panel Discussion and Open Forum
Subjects to be discussed will include:
1. E.K.G. Requirements as Concerns F.A.A. and the Airlines
2. Reasons for Disqualification from Flight Status
3. Patients as Passengers in Commercial Jet Transports
4. Vision at Altitude
5. Other subjects as developed

Evening:

6:00 - 7:00 Social Hour

7:00 - 9:30 Dinner -
Chairman - Bruce V. Leamer

Marvin Miles, Aviation Editor Los Angeles Times
will introduce

SPEAKER - Scott Crossfield

Thursday, October 29, 1959

Morning: GENERAL MEDICAL PROBLEMS IN AVIATION MEDICINE

Moderator - Toby Freedman, M.D.

8:30 - 9:00 Registration

9:00 - 9:45 Visual Problems and Limitations - Victor A. Byrnes, M.D.

9:45 - 10:30 Radiation Dangers
General - Standard Flight - Jet Transport Flight - High Altitude Flight - Payne S. Harris, M.D.

10:30 - 10:45 Coffee

10:45 - 11:30 Cardiovascular Limitations
A. Academic
b. Practical
George C. Griffith, M.D.

11:30 - 12:15 Electroencephalography and other Electronic Developments
Richard D. Walter, M.D.

Afternoon:

1:30 - 5:30	Field Trip - Visit to Los Angeles International Airport Control Tower and to available Commercial Jet Airliners

Friday, October 30, 1959

Morning: SPACE MEDICINE PROBLEMS

Moderator - J. Gordon Wells, Ph.D.

8:30 - 9:00	Registration
9:00 - 9:45	Recent Developments in Aerospace Medicine - Hubertus Strughold, M.D.
9:45 - 10:30	Aerospace Medicine and Guided Missiles - Captain Carl E. Pruett, MC USN,
10:30 - 10:45	Coffee
10:45 - 11:30	Astronaut Selection and Systemitizing of Medical Data - Albert H. Schwichtenberg, M.D.
11:30 - 12:15	The Air Crew Selection Program - Captain Raymond E. Phillips, USAF MC

Afternoon:

1:30 - 2:15	Reports on Decontamination of Air Craft and Waste Disposal - Thomas J. Bulat, M.D.
2:15 - 3:00	The Biomedical Package - Lieutenant Bruce Pinc, USAF (MSC)
3:00 - 3:15	Coffee
3:15 - 4:00	Factors of Medical Interest in Space Radiation E. H. Vestine, Ph.D.
4:00 - 4:45	Panel Discussion and Open Forum - The Staff
4:45 - 5:00	Summation Bruce V. Leamer, M.D.

INSTRUCTIONAL STAFF:

Thomas J. Bulat, M.D., Sonic Energy Application and Research Laboratories, Pioneer Control Division, Bendix Corporation, Davenport, Iowa
Victor A. Byrnes, M.D., Director of Medical Education, Mound Park Hospital, St. Petersburg, Florida
Scott Crossfield, X 15 Project Test Pilot and Design Test Pilot, North American Aviation, Los Angeles
Toby Freedman, M.D., Corporate Flight Surgeon, North American Aviation, Los Angeles
George C. Griffith, M.D., Professor of Medicine (Cardiology), University of Southern California, Los Angeles
Charles Gullett, M.D., Medical Director, Trans World Airlines, Kansas City, Missouri
Payne S. Harris, M.D., Los Alamos Scientific Laboratory, Los Alamos, New Mexico Atomic Energy Commission, Los Alamos, California
George J. Kidera, M.D., Medical Director, United Air Lines, Chicago, Illinois
Bruce V. Leamer, M.D., Chairman Aerospace Medical Association Committee on Education and Training; Assistant Professor of Surgery, University of California School of Medicine, Los Angeles
Ludwig G. Lederer, M.D., Ph.D., Medical Director, Capitol Airlines, Washington, D.C.
M.F. Leeds, M.D., Medical Director, Pacific Alaska Division, Pan American World Airways, San Francisco, California
Marvin Miles, Aviation Editor, Los Angeles Times
Captain Raymond E. Phillips, Human Factors of Space Flight Aircrew Selection Program, HDQ. Wright Air Development Command, USAF, Wright Patterson Air Force Base, Ohio
Lieutenant Bruce W. Pinc, USAF (MSC), Chief Biomedical Division Bioastronautrics Directorate of A.F.B.M.D., Inglewood, California
Captain Carl E. Pruett, MC USN, Chief, Bioscience Office, HDQ. Pacific Missile Range, Point Mugu, California
Albert H. Schwichtenberg, M.D., Chairman - Department of Aviation and Space Medicine, The Lovelace Foundation, Albuquerque, New Mexico
John E. Smith, M.D., Chief, Research Requirements Division, Office of the Civil Air Surgeon, Federal Aviation Agency, Washington, D.C.
K. L. Stratton, M.D., Medical Director, American Air Lines, Flushing, New York
Hubertus Strughold, M.D., Professor of Aerospace Medicine, Aeromedical Center, Brooks Air Force Base, Texas
E. H. Vestine, Ph.D., Senior Staff, Engineering Division, The Rand Corporation, Santa Monica, California
James N. Waggoner, M.D., Medical Director, The Garrett Corporation, AirResearch Manufacturing Division, Los Angeles, California
Richard D. Walter, M.D., Assistant Professor of Medicine, University of California School of Medicine, Los Angeles
J. Gordon Wells, Ph.D., Supervisor, Human Engineering, Northrop Corporation, Norair Division, Hawthorne, California

MEETING PLACE: The Miramar Hotel, Corner of Ocean Avenue and Wilshire Boulevard, Santa Monica, California

DATES: October 28, 29, and 30, 1959

TIMES:

Wednesday	8:30 a.m. to 12:30 p.m. and 2:00 p.m. to 5:15 p.m.	
Thursday	8:30 a.m. to 12:15 p.m. and 1:30 p.m. to 5:30 p.m.	
Friday	8:30 a.m. to 12:15 p.m. and 1:30 p.m. to 5:00 p.m.	

FEE:

Full course (including dinner and Field Trip)	$65.00
Wednesday only (does not include dinner)	25.00
Wednesday dinner only	5.00
Thursday only (includes Field Trip)	30.00
Friday only	25.00

The MIRAMAR HOTEL will have available a limited number of rooms at $9.00 and $10.00 per day single; $13.00 and $15.00 per day double ($6.50 and $7.50 per person). Rates for military personnel will be $6.50 per day single; $9.00 per day double ($4.50 per person). For reservations please write the Miramar Hotel, Santa Monica, California. Telephone EXbrook 4-3731 for reservations.

Bus Service available from the Miramar Hotel to the International Airport daily from 5:55 a.m. to 10:25 p.m., leaving approximately every hour.

INFORMATION: Requests for additional applications or information concerning this course should be made to:

Thomas H. Sternberg, M.D.
Assistant Dean for Postgraduate Medical Education
University of California Medical Center
Los Angeles 24, California
or telephone: GRanite 8-9711 or BRadshaw 2-8911, extension 7114, 7115.

AVIATION MEDICINE
October 28-30, 1959
Ludwig G. Lederer, Ph.D., M.D.

HEARING CONSERVATION PROGRAMS IN COMMERCIAL AVIATION

Although the experience of the author has dealt with turbo-prop noise as emanating from the 510 Rolls Royce jet-prop power plant, programming for a hearing conservation program will not differ greatly in pure jet operation or other types of turbo-prop power plant noise sources.

The presentation will cover a study of:

1. Overhead noise levels of turbo-prop aircraft compared to conventional aircraft.
2. Noise levels within the turbo-prop Viscount type aircraft.
3. "Turn-around" noise levels of turbo-prop aircraft compared to conventional piston powered aircraft.
4. The medico-legal implications of a hearing conservation program.
5. The utilization of Air Force experience, forms, and procedures in conducting this program. Reference: Air Force Regulations 160-3 published by the Department of the Air Force October 29, 1956.
6. Description of a sound-band analysis conducted by an insurance carrier to delineate severe and moderate exposure areas.
7. Classification of affected employees into hearing groups which delineate those who need moderate protection i.e. ear plugs only and those who need severe protection i.e. plugs and muffs.
8. Summary of findings in one airline classifying results into:
   a. So-called normal group I - Hearing loss binaural of less than 1%.
   b. Noise liability group - Hearing loss binaural of more than 1%, Group II.

c. Accountable hearing loss Group III wherein hearing loss was variable but accountable due to previous ear disease or injury.

d. Group IV wherein hearing loss was found in only one ear, certainly not due to noise exposure but possibly from past unilateral (unknown to individual) ear disease such as hemorrhagic labyrinthitis or possibly due to previous head injury or blast effect.

CONCLUSIONS:

a. Base-line audiometry a "must" in all employees in the airline industry.

b. Careful otic examinations in all pre-employment physical examinations recommended.

c. Presbycusis very important in evaluating results - hearing loss must be correlated with age of the individual. Males are more prone to effects of Presbycusis than females.

d. With proper protection, plugs in moderate exposure areas, plugs and muffs in severe exposure areas, no problem at present in present day airline operation.

e. With more pure jet operation vigilance must be maintained.

f. Above conclusions do not cover future rocket-plane operations in commercial aviation when decibel levels above 150 may be encountered and helmet type protection may be needed due to sound transmission from bone structures of the skull.

AVIATION MEDICINE
October 28-30, 1959
Charles Gullett, M.D.

ALTITUDE INDOCTRINATION FOR COMMERCIAL JET CREWS

It has been approximately five years since the first serious talk began in commercial airline circles regarding the purchase of turbo-jet powered airliners. To insure the selection of the best all-around airplane for our particular route structure, our company formed a Jet Planning Committee. Our medical staff became an active participant on this committee. We were charged with the responsibility to study and develop all aspects of health, sanitation, safety, and human engineering in general.

Based upon personal military aviation experience and association, we began planning early on the development of an adequate, but practical altitude indoctrination program for the air crews.

The desirability for the utilization of a low pressure chamber seemed necessary in the early stages. However, the investigation of the availability of a chamber of adequate size and with rapid controlled decompression capabilities, proved none existed. It, therefore, became evident that an alternate solution must be found. The result was the development of didactic aviation physiology material, written in appropriate terms, and incorporated in each flight crew flight operation training manual. In addition, one of our staff physicians gives a lecture with appropriate viewgraph type projection material to aid in the understanding of certain points and followed by movies of various types covering the overall subjects. This is then followed in the flight simulator by routine pre-flight procedures -- the oxygen equipment check which includes the actual manipulation of O_2 supply switches, checking pressure, donning of the mask after adjustments to his face, and the actual inhalation through the mask to insure it's functioning. Emergency decompression is simulated with the sounding of a horn simulating the cabin pressure as passing up through the 10 M ft. range and each crew member practices donning his

O_2 mask from either on his person, or hanging conveniently available on the flight deck where he can don it with one hand in a few seconds.

It is felt that this training program accomplishes several things. We have an opportunity to counteract misinformation and rumors concerning the potential hazards of a decompression. We are able to recommend protective action procedures to counteract the physiological stresses associated with high altitude, high speed jet flight, thereby having instilled this awareness of the dangers they gain confidence in the survivability in case of an accidental decompression. The likelihood of a decompression at high altitude appears to be infinitesimally small thanks to the far sighted aircraft manufactures design engineers. The cabin doors are plug type and the double windows, either of which can withstand far greater pressure differentials than will be used, plus they are made of shatter-proof material. One engineer has stated that there is no more chance of losing a window than a wing. Another possibility would be the perforation of rupturing of the fuselage skin. The clever rip-stop design has completely eliminated the possibility of a disintegration such as occurred on the early Comet airplanes. Although the unexpected decompression has been ruled out, there is still the possibility of a deliberate decompression for other reasons, such as smoke, etc. We, therefore, felt it was necessary that the crews recognize the dangers of remaining at high altitude under these conditions.

We give the crews a rapid review of the physics of the atmosphere, pointing out the drop in temperature, decreasing density and pressure and its effect on the voice and hearing. The four basic gas laws applicability to flight physiology is explained. Although the composition of the air is fairly constant up to 70,000 ft., the decreasing pressure is insufficient to force enough O_2 into the blood. Since we do not store O_2 our respiration and circulation must continue uninterrupted to remain conscious. A brief anatomical description of the lungs and particularly the alveoli clarifies the exchange site of the gases. In addition they are shown that O_2 is not carried in solution, but because of greater capacity it is carried chemically attached to the hemoglobin. Lung-brain circulation time helps explain the time of useful consciousness resulting at the higher altitudes. The fact that the brain comprises only 1/50 of the body mass, yet receives $\frac{1}{4}$ of the blood flow readily shows why the central nervous system symptoms are first to appear in hypoxia. The reasons for the variations in symptoms are discussed, along with the importance of early prevention. The cause and symptoms of dysbarism are outlined, as well as pointing out that the bends usually occur most frequently above 30,000 feet and take several minutes exposure to develop. Therefore, the bends should not be a problem in commercial aircraft decompressions. We usually describe in detail the actual subjective and objective signs that are felt or seen during an actual decompression. We attempt to impress upon the crews that they must use O_2 and descend to low altitude immediately at the first sign of decompression and not to attempt to find the cause or remedy. It is further impressed on them that, even though a well trained crew would be safe utilizing their O_2 equipment, the untrained passengers might not get theirs on and the consequences would be serious.

Another important phase of the training is the physiology of the eye. The characteristics and use of the central and peripheral vision is explained. Dark adaption and the proper utilization of cockpit lighting is important. Proper scanning techniques and the hazards of altitude myopia are discussed in view of the rapid closing rate of jet aircraft on collision course. At 500 mph, which is 750 ft/sec a pilot must recognize that his aircraft is on collision course at $3\frac{1}{2}$ miles to avoid collision with another aircraft at the same speed.

Until recently it was the opinion of most of us in aviation medical circles that the wearing of an O_2 mask by the pilot above 25,000 ft. was essential. This was primarily based upon experiences in military type aircraft of small compressed volume. Many of us now feel that after almost a year of airline operation and thousands of hours without pressurization difficulties, the airliner type jet is a reliable one. The high demands on the crews in regard to navigation and fuel control demand alertness and unhampered inter-cockpit communication.

Therefore, it is felt that the wearing of a mask by one crew member interferes with these requirements to the degree that the efficiency drops enough to produce a greater hazard, considering the hours involved, than the almost infinitesimal chance of a decompression and inability of at least enough of the crew donning a rapid-don type mask to get the aircraft down.

A rapid-donning type mask will be available for examination and a brief film demonstrating its use, and also the hazard of exposure to 40,000 ft. will be shown.

AVIATION MEDICINE
October 28-30, 1959
Victor A. Byrnes, M.D.

EYE DEFECTS AND THEIR RELATIONSHIP TO FLYING

The determination of the effect of eye injuries and diseases upon flying capability is an important and sometimes difficult determination to make. Certainly the decision must be made, not upon the nature of the disease, but upon the individual. This then requires a review of the visual tasks involved in flying with a careful estimate of the degree of permanent impairment suffered in each capability. The importance of given impairments obviously varies with the type of aircraft and with the type of flying done by the individual. The flight surgeon must have accurate knowledge of the flying tasks involved, or he cannot adequately discharge his responsibility.

The decision concerning visual capabilities is so important to the flyer because he receives by far the greatest percentage of his sensory information through vision. The only other sense which contributes significantly to his knowledge of his orientation in space is hearing - and this to a much smaller degree than vision. Since man cannot fly without vision, a quantitative determination of visual functions is required.

Because of the extreme importance of vision in flying, it is reasonable to require "an eye in reserve". If an individual injures an eye in flight, he may be unable to use it either because of the injury, or because of the blepharospasm it produces. The other eye must be capable of supporting flight and landing requirements.

The visual abilities of importance in flying are the following:

1. The ability to discriminate small distant objects.
2. The ability to perceive relationships between self, aircraft, other objects, and the earth.
3. The ability to discriminate small near objects.
4. The ability to distinguish colors.
5. The ability to distinguish objects in the peripheral field of vision.

6. The ability to perform these visual functions under reduced illumination.

7. The ability to perform these functions with both eyes simultaneously and without confusion.

8. The ability to perform these functions with the eye rotated in the various physiological directions of gaze.

There are many eye conditions which impair one or more of these capabilities. These may be either conditions which have developed or conditions which were overlooked in the original examination for flying. The fact that an individual has had a visual impairment for a time without having an accident is not necessarily evidence that he will not have an accident in the future. The right combination of circumstances may not have presented itself as yet.

Of those problems produced by conditions overlooked on the initial examination, the following present by far the largest number:

1. Defective color vision

2. Defective visual acuity

Other conditions occasionally missed are:

1. Paresis of one or more of the extra ocular muscles - especially in extreme positions of gaze.

2. Strabismus witn only a small angle of deviation and frequently with amblyopia exanopsia in the non-sighting eye.

3. Cases with residuals of eye trauma in childhood - irridodialysis, localized traumatic cataracts, and irregular astignatism.

Conditions which develop and produce impairment of visual capabilities in significant numbers are:

1. Glaucoma

2. Intermittent Exotropia

3. Herpetic lesions of the cornea

4. Central Serous Retinopathy

5. Disciform Macular Degeneration

6. Sequelae of infection such as irregular astigmatism and corneal vascularization

7. Cataract, either traumatic, presenile or secondary posterior subcapsular

8. Other traumatic residuals:

   (a) Hole in the macula
   (b) Choroidal rupture
   (c) Irregular astigmatism
   (d) Retinal detachment
   (e) Corneal vascularization

9. Residual effects of Eye Surgery - especially Monocular Aphakia

10. Retinopathies
    a. Hypertensive
    b. Diabetic

It is obvious that some of these residual visual defects are due to corneal aberrations which might be amendable to correction by either lamellar or full thickness corneal grafting. Some others might be correctible by contact lenses. In the first instance, one must consider the present acuity and the probability of its being bettered by corneal transplant. In many instances there is a statistical probability that the defect will be increased. In the case of contact lenses, the problem of possible displacement of the lenses at a critical period must be considered as well as the useful wearing time. Correction of Monocular Aphakia by contact lenses requires careful consideration.

This presentation will deal with the factors requiring consideration for flying status in individuals with the above mentioned conditions.

AVIATION MEDICINE
October 28-30, 1959
Captain Carl E. Pruett, MC, USN

AERO SPACE MEDICINE AND THE MISSILE RANGES

INTRODUCTION

Objective - To relate development of Missile Range

MISSION - Support to Aero Space Medical Research and Development

(a) Aero Space Medicine - To enable functional man to travel safely in space.

(b) Missile Ranges - Provide range support for the Department of Defense and other designated government agencies in guided missile, satellite and space vehicle research, development, evaluation and training programs.

THE NATIONAL RANGES

(a) Atlantic Missile Range - USAF

(b) White Sands Missile Range - USA

(c) Pacific Missile Range - USN

(d) Equatorial Range - ?

PROGRAM PLANNING

Phase I - Education

Educate the scientific community outside the Life Sciences to the need for a continuous, consistent, scientific approach to Aero Space Medicine Research and Development.

Phase II - Policy

Work toward high level policy establishment of primary requirement for biological packages in special projects and secondary requirement on weight and space available basis in all other projects.

Phase III - Requirements

Obtain from prospective range users the technical requirement which will support the development of an adequate biological laboratory facility near the launch site.

Phase IV - Organization

Establish within the range organization a Life Science component which will be able to support the Industrial and Aero Space Medical Development in competition with other high priority programs.

Phase V - Master Plan

Develop a long range plan analyzing the bio-medical requirements of the individual guided missile, satellite and space vehicle projects, and programming for facilities to support same.

Phase VI - Operations

Work out the assignment of money, people and resources to the development of Aero-Space Medical support capabilities.

CONCLUSION

The Basic Research must be linked to the Applied Research by the efficient utilization of operational testing at the National Missile Ranges.

AVIATION MEDICINE
October 28-30, 1959
A. H. Schwichtenberg, M.D.

The Lovelace Foundation was selected to conduct the physical and certain physiological studies on the Astronaut Candidates and also to assist in their selection by the National Aeronautics and Space Administration.

An extension of previous aeromedical examination concepts was used in that the usual history and special aviation history, physical examinations and specialists examinations, laboratory work, X-ray examinations, etc., were considered for this purpose as being in the nature of static tests of the body at rest. Certain physiological studies including pulmonary function studies and exercise tolerance or physical competence tests were added as a group of dynamic tests to determine the maximum effort the body could safely exert. Physiological effort was measured in terms of oxygen uptake per minute per kilogram body weight, oxygen uptake per minute per kilogram lean body mass, oxygen pulse and several other parameters. These tests, performed by Dr. Ulrich Luft, had been validated by over 600 previous determinations.

At the Wright Aeromedical Laboratory, the candidates were subjected to a series of standard known heavy loads to determine how well the body tolerated these over periods of time. At the conclusion of these tests, the results were summarized and presented to the NASA Group who made the final selection. All data on these Astronaut candidates was recorded on machine record cards.

Under the auspices of USAF Air Research and Development Command, special mark sense type Machine Record Cards were developed at the Lovelace Foundation to record complete medical history, special aviation history, physical examination and various specialists examinations, radiological and laboratory tests, as well as physiocological data. In order to similarly record the results of stress tests, cards were developed for recording heat tolerance, tolerance to G forces on the centrifuge, altitude tolerance in a Partial Pressure Suit, tilt table test, cold pressor test, and tracking under high noise levels. Cards were also developed to record complete anthropological data and various psychological variables. All data on the astronaut candidates were recorded in this manner. This approach to data recording in the life sciences opens a way to the use of computers and other modern data processing equipment.

AVIATION MEDICINE
October 28-30, 1959
Raymond E. Phillips, Capt., (MC) USAF

HUMAN FACTORS OF SPACE FLIGHT: CREW SELECTION PROGRAM

Manned vehicles are expected to explore the area beyond the Earth's atmosphere within a relatively short time. It is predicted that this will place enormous demands on the space traveler. He must not only have reached an extraordinarily high degree of technical competency in flying, but must be both willing and capable of withstanding physical and psychological stress of great magnitude. Obviously, selection of the best possible man for meeting these conditions is desirable both for the safety of the individual and success of the mission.

A program for crew selection has been evolved in the Aerospace Medical Laboratory of the Wright Air Development Center in Dayton, Ohio. Test pilots, with exceptionally good flying records, may be selected for this program. They are then given a searching physical examination and medical laboratory workup, requiring seven days for completion. Those considered acceptable then undertake the testing profile given at the Aerospace Medical Laboratory.

Fundamentally, an attempt has been made to anticipate those stresses that may be encountered in space flight. The stresses are then individually simulated under controlled laboratory conditions in order to observe the candidate's responses to each. The profile includes the following general areas:

1. Psychological and psychiatric evaluation.
2. Prolonged high altitude exposure.
3. Physical endurance.
4. Forces of acceleration.
5. Heat exposure.

6. Anthropological measurements.

7. Vibration and equilibrium.

The overall performance of each subject is then considered so that he can be placed in a ranking system. Emphasis is on uncovering undesirable psychological and physiological features that may not have appeared even during the stresses of high performance aircraft operation. This method is felt to be the most objective possible in selection for a future mission in which we can only guess the amount and kinds of stress involved.

AVIATION MEDICINE
October 28-30, 1959
E. H. Vestine

FACTORS OF MEDICAL INTEREST IN SPACE RADIATION

Various unpleasant and undesirable effects due to ionizing radiations are known which may be encountered by living organisms beyond the terrestrial atmosphere. In general the effects depend upon how rapidly a radiation dose is upplied, upon the kind of radiation applied, and may vary within wide limits with the kind of biological specimen studied. The laboratory information regarding effects upon organisms or parts of organisms, of proton and electron bombardment in space appears meager and in need of study. The information on actual radiations to be encountered in space is also meager, and in need of measurements over extensive spacial areas not yet visited by space probe, and changes in radiation intensity with time are unknown or ill defined.

It is known that high dose rates of radiation to man may quickly result in nausea, alopecia, anemia, sterility and death. Other effects are said to appear after some years as cataracts of the eye, anemia, cancer, and effects upon genes. Chronic effects have been suggested also.

Results of American and Soviet space probes show that one or two primary cosmic rays per cm^2 per sec is the flux encountered on a lunar light. This flux is expected to comprise about 80 per cent protons, about 19 per cent alpha particles and the remainder is made up of occasional heavy atomic fragments or electrons. Energies range from 10^9 to 10^{18} electron volts (1 electron volt = 1.6×10^{-12} ergs). The dose is of order 130 mrad per week, and somewhat higher within the terrestrial polar atmosphere due to production of secondaries. At a little about 100,000 feet, the brain of man would receive about 50 hits per hour by heavy particles, causes of ionization along the path of internal penetration. During occasional large solar flares (about one per year lasting 20 minutes to several hours), the flux may increase by a factor of 10,000 or more.

In the Van Allen radiation belts the flux of radiation is much higher, but considerably less energetic, with good possibility of shielding. The particles consist of protons and electrons. There appear to be three or more belts, the inner two of which are thinner and would be quickly crossed in space flight. Dose rates of order 10 to 100 rads per hour might be encountered. It is also known from ground observations that intervening belts occur on a transient basis. The outer part of the third radiation belt can be regarded as extending into a region in which transient supplies of high energy particles drain along geomagnetic field lines into the polar regions. Transient radiation comprising protons near cosmic ray energies are noted, at heights of 100,000 feet in an auroral belt encircling the earth near latitude 67° north. Effects of such regions can be minimized by choice of flight paths, so that effects upon the genes of future colonizing populations and their lifetimes are minimized, during travel to the moon or planets.

Since the astronaut will be unlikely to avoid a considerable exposure rate for an hour or two while he travels through the terrestrial atmosphere and radiation belts, a standard of exposure should be set up. Perhaps a dose of 100-300 rem per year might be considered, if supplied slowly enough.

There will be some risk of life shortening and genetic damage, at special times of solar activity. At the top of the atmosphere, the cosmic ray dose during a great solar flare may exceed the normal rate of 300 milli rem/day by a factor 10,000 during a period of several hours of a great solar flare. The actual increase in cosmic rays in the upper atmosphere at such times should be measured rather than inferred from low level data, since dangerous exposures appear to be approached.

C.A. Berry M.D.

TEXT OF SPEECH AT

THE FIFTH ANNUAL SYMPOSIUM

ON

AVIATION MEDICINE

OCTOBER 28, 29, 30, 1959

THE SCHOOL OF MEDICINE

UNIVERSITY OF CALIFORNIA, LOS ANGELES

MIRAMAR HOTEL, SANTA MONICA

CARL E. PRUETT
CAPTAIN, MC, USN
BIO-SCIENCE OFFICE
HEADQUARTERS PACIFIC MISSILE RANGE
POINT MUGU, CALIFORNIA

AEROSPACE MEDICINE AND THE MISSILE RANGES

I HAVE SELECTED AS MY SUBJECT TODAY - "AEROSPACE MEDICINE AND THE MISSILE RANGES." THIS SUBJECT MAY AT FIRST SEEM UNRELATED TO THE SUBJECT FOR THIS SESSION. RECENT DEVELOPMENTS IN AEROSPACE MEDICINE, HOWEVER, SHOW HOW INTIMATELY RELATED THESE SUBJECTS ACTUALLY ARE IN TODAY'S PROGRAMS OF RESEARCH AND DEVELOPMENT.

I HAVE CHOSEN, RATHER THAN TO RECOUNT THE NAVY'S WELL-KNOWN EFFORTS IN ACCELERATION, CARDIOLOGY, COSMIC RADIATION, AND SIMILAR AREAS OF AEROSPACE MEDICINE RESEARCH, TO DESCRIBE THE OPPORTUNITY FOR APPLIED AND BASIC RESEARCH THAT EXISTS THROUGH THE MISSILE RANGE ORGANIZATIONS.

WHILE I DO NOT PRESUME TO BE A SPACE MEDICINE EXPERT I DO FEEL THAT I HAVE A PROPOSITION TO PLACE BEFORE YOU THIS MORNING THAT HAS CONSIDERABLE LONG RANGE IMPORTANCE. THE PROGRAM DESCRIBED REPRESENTS, OF COURSE, MY OWN OPINIONS, AND NOT NECESSARILY THE OFFICIAL VIEWS OF THE U. S. NAVY.

IN INTRODUCING A SYSTEM FOR CARRYING OUT A BIO-SCIENCE PROGRAM AT THE PACIFIC MISSILE RANGE, I WOULD LIKE TO QUOTE FROM TWO SOURCES:

> DR. KEITH GLENNAN, DIRECTOR OF NASA, IS REPORTED TO HAVE SAID RECENTLY "THERE SEEMS TO BE A CONTEST GOING ON IN THIS COUNTRY IN WHICH SUBSTANTIAL NUMBERS OF PEOPLE ARE ATTEMPTING TO OUTDO EACH OTHER IN PREDICTING EXOTIC ACCOMPLISHMENTS IN SPACE DURING THE NEXT FEW YEARS. IN MY OPINION, THERE IS NEED FOR MORE COMMON SENSE AND GOOD JUDGMENT TO BE INJECTED INTO THIS PICTURE."

MR. ROBERT HOTZ, EDITOR OF AVIATION WEEK, RECENTLY WROTE, "WE NEED TO SUPPORT THE PEOPLE IN THE MILITARY SERVICES, INDUSTRIAL RESEARCH ORGANIZATIONS, AND NASA, WHO ARE WORKING HARD TO BUILD THE FOUNDATIONS FOR A TRULY EFFECTIVE SPACE TECHNOLOGY IN THE FUTURE, FIGHT FOR ADEQUATE FUNDS TO SUPPORT THEIR PROGRAMS AND AROUSE PUBLIC OPINION TO THE NEED FOR CONTINUOUS AND CONSISTENT SUPPORT FOR DEVELOPMENT OF THE TECHNOLOGIES THAT WILL UNLOCK THE SECRETS OF OUR FUTURE."

NOW, I DOUBT THAT ANYONE HERE WOULD DIFFER STRONGLY WITH THIS QUOTED PHILOSOPHY. HOWEVER, THE QUESTION REMAINS, "HOW CAN WE TRANSLATE THIS PHILOSOPHY INTO THE ACTION IN OUR PRESENT AEROSPACE MEDICINE EFFORT?"

SLIDE NO. 1 - MISSIONS

THIS MORNING I WOULD LIKE TO EXPOUND ON THE RELATIONSHIP BETWEEN THE MISSION OF AEROSPACE MEDICINE-TO ENABLE FUNCTIONAL MAN TO TRAVEL SAFELY IN SPACE AND THE MISSIONS OF THE MISSILE RANGES - TO PROVIDE RANGE SUPPORT FOR THE DEPARTMENT OF DEFENSE AND OTHER DESIGNATED GOVERNMENT AGENCIES ON GUIDED MISSILE, SATELLITE AND SPACE VEHICLE RESEARCH DEVELOPMENT.

AS YOU MAY KNOW THERE ARE THREE MAJOR MISSILE RANGES EXISTING IN THE UNITED STATES

SLIDE NO. 2 - WHITE SANDS RANGE

THE OLDEST RANGE IS THE WHITE SANDS RANGE OPERATED BY THE ARMY

SLIDE NO. 3 - ATLANTIC MISSILE RANGE

THE SECOND RANGE TO BE DEVELOPED IS THE ATLANTIC MISSILE RANGE, OPERATED BY THE AIR FORCE

SLIDE NO. 4 - PACIFIC MISSILE RANGE

THE NEWEST RANGE IS THE PACIFIC MISSILE RANGE OPERATED BY THE NAVY. I CANNOT SPEAK FOR THE FIRST TWO RANGES, BUT I BELIEVE THAT THE SYSTEM NOW BEING APPLIED TO DEVELOPMENT OF A BIO-SCIENCE PROGRAM AT THE PACIFIC MISSILE RANGE WILL BE PERTINENT TO THE PROGRAM OF ANY RANGE, INCLUDING A FUTURE EQUATORIAL RANGE.

SLIDE NO. 5 - PROGRAM PLANNING PHASES

PROGRAM PLANNING CAN BEST BE EXPEDITED BY FOLLOWING A SYSTEMATIC PHASING WHICH IS FLEXIBLE ENOUGH TO ALLOW SEVERAL PHASES TO GO INTO OPERATION SIMULTANEOUSLY.

SLIDE NO. 6 - PHASE I

EDUCATE MILITARY AND CIVILIAN SCIENTIFIC COMMUNITY WITHIN AND OUTSIDE OF THE LIFE SCIENCES TO THE NEED FOR A CONTINUOUS, CONSISTENT, SCIENTIFIC APPROACH TO AEROSPACE MEDICINE RESEARCH AND DEVELOPMENT. THIS MAY BE ACCOMPLISHED BY MANY METHODS, SUCH AS FILMS, FORMAL PRESENTATIONS, PROFESSIONAL PAPERS, BROCHURES (NO. 6) AND OTHERS TOO NUMEROUS TO MENTION.

SLIDE NO. 7 - BROCHURE

AS THE EDUCATIONAL PHASE ROLLS INTO HIGH GEAR THE NEXT PHASE SHOULD BE INITIATED.

SLIDE NO. 8 - PHASE II

ESTABLISH POLICY. THERE IS A FIRM PRIMARY REQUIREMENT, BOTH SCIENTIFIC AND MILITARY FOR SPACE VEHICLE PROGRAMS FOR THE PURPOSE OF STUDYING BIOLOGICAL PROBLEMS, AND A SECONDARY REQUIREMENT FOR ALL SPACE VEHICLE PROGRAMS TO CONSIDER BIOLOGICAL PACKAGES ON A WEIGHT AND SPACE AVAILABLE BASIS.

THIS POLICY SHOULD BE ESTABLISHED AT VERY HIGH LEVEL AND BE FIRMLY IMPLEMENTED DOWN THROUGH THE COMMAND CHAIN TO THE RANGE USERS, AND THE MISSILE RANGES, IF THE AEROSPACE MEDICAL RESEARCH PROGRAM IS TO PROGRESS AS RAPIDLY AS IT SHOULD.

SLIDE NO. 9 - PHASE III

ESTABLISH REQUIREMENTS. OBTAIN FROM PROSPECTIVE RANGE USERS THE TECHNICAL REQUIREMENTS WHICH WILL ENABLE THE RANGE TO SUPPORT THE LAUNCHING, TRACKING, TELEMETERING AND RECOVERY OF BIOLOGICAL PACKAGES IN THE BEST POSSIBLE MANNER. HERE I WOULD LIKE TO INTERJECT THAT OBTAINING THESE REQUIREMENTS IN WRITING IS NOT AN EASY TASK, YET THEY ARE MORE NECESSARY FOR DESIGN FUNDING AND CONSTRUCTION OF ADEQUATE SUPPORT FACILITIES REQUIRING CONSIDERABLE LEAD TIME.

SLIDE NO. 10 - PHASE IV

ORGANIZATION. THE ORGANIZATION OF A MAJOR MISSILE RANGE IS NECESSARILY COMPLEX, AS DEMONSTRATED BY THE CURRENT ORGANIZATION CHART OF THE PACIFIC MISSILE RANGE.

SLIDE NO. 11 - PMR LIFE SCIENCE COMPONENTS

THE BIO-SCIENCE COMPONENTS WITHIN THE RANGE CONSIST OF THE BIO-SCIENCE OFFICE ON THE STAFF OF THE RANGE COMMANDER. THIS OFFICE IS INTENDED TO FUNCTION STRICTLY AS A MANAGEMENT UNIT. UNDER THE NAVAL MISSILE CENTER THERE ARE TWO BIO-SCIENCE ACTIVITIES. THE MEDICAL DEPARTMENT OF THE NAVAL AIR STATION SUPPORTS THE RANGE WITH INDUSTRIAL MEDICAL CARE FOR MILITARY AND CIVIL SERVICE EMPLOYEES AT POINT MUGU AND PROVIDES MEDICAL LOGISTIC AND PREVENTIVE MEDICAL SUPPORT THROUGHOUT THE RANGE. THE LIFE SCIENCE DEPARTMENT OF THE MISSILE AND ASTRONAUTICS DIRECTORATE SUPPORTS THE

TECHNICAL ASPECTS OF RESEARCH AND DEVELOPMENT IN THE AEROSPACE MEDICAL SUPPORT OF NAVY MISSILE SYSTEMS AND RANGE SUPPORT PROBLEMS. UNDER THE RANGE DIRECTORATE WE ARE PLANNING A COMBINED BIOMEDICAL LABORATORY-HOSPITAL SHIP FOR USE WITH THE FUTURE EQUATORIAL RANGE-PLUS RECOVERY SHIPS NOW ON STATION CAPABLE OF PROPERLY HANDLING VARIOUS TYPES OF BIOLOGICAL PACKAGES. AT THE NAVAL MISSILE LAUNCH FACILITY, POINT ARGUELLO, THE AEROSPACE MEDICAL DEPARTMENT WILL INCLUDE AN INDUSTRIAL MEDICAL AND A RESEARCH DIVISION. THE MISSION OF THIS RESEARCH DIVISION IS TO OPERATE A BIOLOGICAL HOLDING LABORATORY TO SUPPORT RANGE USERS IN CARRYING OUT THEIR SPACE RESEARCH PROGRAMS.

SLIDE NO. 12 - PHASE V

MASTER PLAN. DEVELOP A LONG RANGE MASTER PLAN, REFLECTING ANALYSIS OF BIOMEDICAL REQUIREMENTS OF EACH GUIDED MISSILE, SATELLITE AND SPACE VEHICLE PROJECTS SUPPORTED BY THE RANGE, AND PROGRAM FOR FACILITIES REQUIRED TO CARRY OUT THIS PLAN.

THIS PLAN IS BEING DEVELOPED FOR THE PACIFIC MISSILE RANGE BY THE BIO-SCIENCE OFFICE AS RAPIDLY AS POSSIBLE.

SLIDE NO. 13 - PHASE VI

OPERATIONS. WORK OUT THE ASSIGNMENT OF MONEY, PEOPLE AND RESOURCES AT ALL LEVELS WITHIN THE RANGE ORGANIZATION IN SUPPORT OF AEROSPACE MEDICAL RESEARCH.

SLIDE NO. 14 - CONCLUSION

THE OPPORTUNITY TO LINK BASIC AEROSPACE MEDICINE RESEARCH TO APPLIED RESEARCH BY EFFICIENT UTILIZATION OF OPERATIONAL TESTING AT THE NATIONAL

MISSILE RANGES SHOULD NOT BE NEGLECTED. A COMBINED MILITARY-CIVILIAN EFFORT TO EXPLOIT THIS OPPORTUNITY TO ITS FULLEST WOULD GIVE STRONG SUPPORT TO THIS NATION'S SPACE EFFORT.