GOVERNMENT GRANTS AND CONTRACTS

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Presented at the ARS Anatomy of Manned-Space Operations Conference, Dayton Biltmore Hotel, Dayton, Ohio, October 10-12, 1960

THE ARMY MEDICAL CONTRACT, GRANT, AND RESEARCH INTEREST IN THE BIO-SCIENCE AREA

By

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The Army Medical Research Program is designed to meet the responsibilities of The Surgeon General to protect the soldier, improve his mental and physical capacity to fight and survive, and when necessary provide treatment for casualties in the most stressful situations known to our nation--war. A broad basic medical research program has been developed through the recent years, aware of demonstrated causes of disability and mortality in recent armed conflicts and mindful of continuing military developments. Much of the fundamental knowledge gained from this program is relevant to the national space effort.

As you recall, in May 1959 the Army Medical Service in cooperation with Navy medical scientists, the National Aeronautical and Space Administration, and the Army Ballistic Missile Agency, Huntsville, Alabama, successfully recovered Able and Baker, two primates, following a ballistic missile flight. Since then the Army Medical Service has continued to support the national space effort by providing professional personnel to the National Aeronautics and Space Administration in support of Project Mercury and by making available pertinent information from the broad research effort. At the present time the Army has no bio-sciences program in space medicine or bioastronautics as such. Although certain studies in this area concern other technical services of the Army, the largest interest lies with The Surgeon General.

The research and development activities of the U.S. Army Medical Research and Development Command are centralized in the Office of The Surgeon General, with a command relationship with eleven research institutes, laboratories, and units, in addition to contractual medical research supportive of our mission. An extensive basic research program is carried on through approximately 150 institutions, mostly universities. Most of the research has been directed toward recognized medical problems of warfare, specifically, surgical problems of acute trauma, shock, wound ballistics, blood and blood substitutes; medical problems of acute communicable disease, immunization, tropical medicine, entomology, environmental medicine, and nutrition; neuropsychiatric and psychological problems of combat; and the biological effects of ionizing radiation.

The research contracting program utilized by the Army Medical R&D Command is accomplished exclusively by negotiation. Grant authority is restricted to support of basic scientific research with non-profit institutions of higher education or organizations whose primary purpose is the

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Given at the "Anatomy of Manned-Space Operations Conference" of the American Rocket Society, October 12, 1960, Dayton, Ohio

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conduct of scientific research. The vast majority of research proposals received by this Command are unsolicited. The evaluation of all proposals, whether for contracts or grants, is uniform. Professional advice is usually obtained from civilian advisory committees or boards, such as the Armed Forces Epidemiological Board, the National Research Council, or the various Advisory Committees of The Surgeon General. The final evaluation is a function of the Proposal Review Committee of the U.S. Army Medical Research and Development Command, acting for the Commanding General. Reports of research investigations are usually required annually, but this may vary due to special circumstances. The services of the Armed Services Technical Information Agency are utilized. Contracts and grants are used primarily to supplement the research activities of the in-service units.

The following current projects or tasks having application to the National Space Program are believed to be of interest. At the Walter Reed Army Institute of Research, Washington, D. C., these include research on chemical protection against total body radiation, with efforts taken to develop anti-radiation drugs which could be taken before exposure to reduce the biological effect of ionizing radiation. Such a drug would be of direct value in passing through the Van Allen belts and possibly of greater importance to clinical medicine. At the present time we have many contracts with industry and universities to synthesize specific potential compounds for testing, not unlike the program during World War II and Korea to obtain effective anti-malarial drugs, which resulted in Primaquin and Chloroquin.

In addition, the Division of Neuropsychiatry at the Walter Reed Army Institute of Research has a multi-disciplinary program to determine the widespread effects of stress on the physiological functioning of the soldier, the search for constructive means to modify these effects and thus to prepare for more effective performance. Here we have studies being conducted on conditioned avoidance techniques in primates, the complicated effects of stress as measurable in the various body fluids, and the influence of sleep loss, sensory deprivation, and fatigue. The results of the work being done on communications in small groups, although oriented to problems of ground forces, should be of interest. A considerable contractual program supports this effort.

At the Army Medical Research Laboratory, Fort Knox, Kentucky, studies related to man's senses may be useful. Vision and perception tasks have been designed to gain knowledge on the adaptation of known human perceptual abilities.

Another task entitled "Sound and Hearing in Relation to Performance" has as its purpose the determination of the limits and variations in psychological and physiological capabilities under the wide variety of noise environments found in a military situtation. The fact that high

intensity noise environments can be hazardous is well-known and our focus here is on procedures for attenuating the noise environments which diminish the performance of the soldier. Other studies of motion, balance, and vibration related to performance are being carried out. Finally, a task to study the basic physiological mechanisms involved in cold and heat adaptation may be of interest to space exploration.

The U.S. Army Medical Research and Nutrition Laboratory at Fitzsimons General Hospital, Denver, Colorado, is the only Department of Defense laboratory devoted to fundamental research in the medical aspects of nutrition. Studies related to the lowest level of nutrients at which man can function effectively and the possible utilization of algae as food source have been vigorously pursued with human volunteers.

The potential medical problems with future warfare are immense. Our current medical research and development effort including facilities, qualified technical manpower, and funds is directed to support programs designed to improve the combat effectiveness of the Army. Whenever research provides advances in basic knowledge or application to space medicine, the scientific information is being made available to those physicians responsible in our National Space Program.

BIO-SCIENCE RESEARCH CONTRACT PROGRAM OF THE DIVISION OF BIOLOGY AND MEDICINE OF THE ATOMIC ENERGY COMMISSION

M. R. Zelle
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Broadly speaking, the Division of Biology and Medicine has four major responsibilities in the life sciences research area: (a) To understand the effects of radiation on biological systems ranging from biologically important molecules to entire ecological systems. (b) To solve problems arising directly from AEC operations including studies of chemical toxicity of various materials encountered in such operations, the effects of a wide range of fissionable materials and radioactive isotopes, and including such problems as the biological aspects of the disposal of radioactive waste. (c) To develop knowledge and methods of combating the detrimental effects of radiation including both chemical and biological procedures. (d) To exploit radiation and radioisotopes for beneficial applications in medical and biological sciences.

In order to fulfill these responsibilities, the Division of Biology and Medicine supports research in the following fields: 1. Radiation biology. The response of tissues, organs, organ systems, and organisms to radiation from both external and internal sources. 2. Radiation genetics. Studies of the effects of radiation on the heredity of man, animals, plants, and microorganisms. 3. Radiation protection. Studies of the modification and treatment of radiation effects and the control and removal of radioactive materials affecting living systems. 4. Molecular and cellular level studies. Studies in biochemistry, biophysics and cell physiology as related to radiation. 5. Terrestial ecology. Studies of plants and animals in relation to radioactive materials introduced into their environment. 6. Marine sciences. The transport, distribution, and cycling of radioactive materials in the ocean including the food chain. 7. Atmospheric radioactivity and fallout. The measurement of the transport and distribution of radioactivity in the atmosphere and its subsequent distribution in the biosphere. 8. Radiological physics and dosimetry. Improved methods and procedures for predicting and detecting the health hazards from external and internal sources of radiation. 9. Radiation instruments. Design, development, and evaluation of radiation detection and measuring instruments. 10. Cancer research. Studies of the development, diagnosis and treatment of cancer using radioactive isotopes and special radiation sources. 11. Selected beneficial applications. Agricultural studies, food irradiation, and other special research activities utilizing unique applications of atomic energy.

Approximately two-thirds of the Division of Biology and Medicine research program is carried out in our intramural laboratories all but three of which are operated through contracts with various universities. The remaining one-third of our program is carried out largely in universities by means of research contracts which are of two types. The vast majority are cost-sharing, lump sum contracts which in many respects achieve the same results as research grants.

These are almost always initiated by an investigator in a research laboratory interested in a problem which is also of interest to the Division of Biology and Medicine. In general, the research is of a somewhat more basic nature and less narrowly oriented to programmatic requirements of the Commission than the research supported in our intramural laboratories or by the other type of research contract, the cost reimbursable contract. This latter type of contract is employed for larger projects which are somewhat more programmatic in nature and which in many cases are stimulated through the efforts of the Division of Biology and Medicine staff.

Although the Washington headquarters staff is responsible for the scientific direction of the research program, the contracts are actually negotiated by the appropriate AEC operations office. Proposals for a research contract can be received at any time. Generally about three months is required before a contract can be negotiated in case the proposal is approved. Copies of a Guide for Preparation of Research Proposals can be obtained by writing to the Division of Biology and Medicine, U. S. Atomic Energy Commission, Washington 25, D. C.

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PUBLIC HEALTH SERVICE GOVERNMENT GRANTS AND AWARDS

Ernest M. Allen

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It is a privilege to be here today to speak to you about the grants and awards programs of the National Institutes of Health and of the opportunities they offer in the areas of special interest to you. Many of these reflect the trends and the rapidity of today's scientific progress.

President Eisenhower, addressing the Symposium on Basic Research in May 1959, said "In our lifetime greater advances have taken place in science and technology than in all previous history . . . These advances and changes have had a profound effect on Government and on our national policy."

One of the notable changes is the expanding role of federal support of scientific research. Twenty years ago federal support of all science was 100 million dollars. Today it is approximately 8 billion dollars.

This substantial increase is due to congressional appreciation of our national needs. The Congress, realizing that maximum achievements in any single field of science would ultimately depend upon correlating knowledge from many fields, has wisely provided for the equitable growth of all sciences.

Consequently, today as we push back the frontiers of the unknown, scientists working in different fields both in and outside of government find themselves at home with each other exchanging information and sharing many instruments such as the electron microscope and the ultracentrifuge. These interchanges are valuable channels of communication. In addition, there are advantages in the often unexpected discovery of common denominators wherein sciences of seemingly little kinship stimulate and complement each other.

Mention is made of this common meeting ground of the sciences because its proportions are governed by the spectrum of fundamental research. In the medical sciences, as in the physical sciences, the further the horizons of research are extended, the more fundamental are the studies required and the more instrumentation is needed to conduct investigations of such minute life forms as the components of a human cell and the filterable viruses.

While the mission of the National Institutes of Health is interpreted as the study of the diseases and impairments of man, we are fully cognizant of the fact that achievements in these areas are greatly dependent upon a continuing emphasis on basic research.

The Public Health Service programs conducted and administered by the National Institutes of Health, representing about 85 percent of the medical research funds appropriated for the Department of Health, Education, and Welfare, have become a primary force affecting the nature and direction of medical research in this country.

The present grants program began in 1946 when, following World War II, the National Institutes of Health was given the responsibility for continuing some 50 incompleted medical research projects previously supported by the Office of Scientific esearch and Development. The framework of the present centralized research grants program evolved from the pattern set by the Division of Research Grants in administering this initial small program of $780,000. Later the program was enlarged to include various types of grants and awards intended as a means of increasing the medical manpower and the facilities necessary for an expansion of the nation's research in the health sciences. These combined grant activities are referred to as the extramural programs.

Although research grants under the extramural programs are available from the seven categorical institutes and the Division of General Medical Sciences, all applications are received by the Division of Research Grants which is the central point for the administrative coordination of these programs and which provides the initial scientific and technical review of each application. Applications are made upon special forms which are provided by the Division of Research Grants.

I will not attempt to go into all the details but I do wish to give you a brief outline of our grants procedure and

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a short description of the types of grants we support. Essentially all applications receive a dual review. The initial review is made by one of the 36 study sections -- panels of authorities in the medical and biological sciences. The recommendations of the study sections are in turn considered by one of the ten National Advisory Councils which are established by law and made up of eminent nonfederal scientists and civic leaders from all sections of the country. Grant awards are made by the Surgeon General upon the advice of these Advisory Councils.

The principal types of grants and awards available are research grants, research fellowships, training grants, and health research facilities grants.

1. Research Grants represent the largest area of Public Health Service support of scientific investigations. This program is competitive in the sense that anyone is free to apply for a grant. Grants may be made to universities, hospitals, laboratories, public and private institutions, and to individuals for support of research projects in the medical and biological sciences. The program was set up to aid investigators who seek to add to the scientific knowledge in the medical and related biological sciences. It has enabled hundreds of institutions to initiate research or increase their research activities. It has provided on-the-job training for from 10,000 to 15,000 scientists employed in research projects, and it has permitted the opening up of new fields of investigation not before touched upon. Grant funds may be used for salaries, equipment, supplies, travel, and other expenses such as renovation and alteration of existing facilities. There is no limitation other than that of practicality, on the number or size of grants which may be made to any one investigator or to any one institution in a fiscal year, nor is there a limitation on the number of years a specific project may be supported. Some investigators are in the 14th year of uninterrupted research support.

To encourage early and adequate exchange of information among investigators, numerous conferences, seminars, and symposia are supported in connection with the grants program. Many of the meetings are initiated and sponsored by the advisory study sections of the Division of Research Grants.

For example, a four-week Study Program in Biophysical Sciences at the University of Colorado in 1958, was sponsored by the Biophysics and Biophysical Chemistry Study Section. This meeting was attended by more than 100 scientists in physics, biology, chemistry, medicine, mathematics, biophysics,

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physiology, engineering, and botany. Some of the research problems presented concerned cellular biology; physical-chemical behavior of macromolecules; biological effects of radiation; energy coupling and transfer; enzyme action; fine structure and function of cells, proteins, and nucleic acids; genetics; muscle and nerve structure and function; sensory reception and signal processing; and homeostasis.

The basic philosophy of the research grants program is to provide the investigator maximum freedom from control, regimentation, and outside interference by giving him stable support along with the greatest flexibility in determining the direction of his own research.

During the fiscal year 1960 this program, which began with the 50 transferred projects of 1946, awarded 11,572 research grants for $198,719,397 to 973 institutions in this country plus 150 abroad. The average size of these grants is approximately $17,000 a year and the average length of support recommended is 3.2 years.

2. Research Fellowships - Seven types of research fellowships are available: (a) Predoctoral Research Fellowships are awarded to qualified persons who hold a Bachelor's degree or equivalent training. Fellows are expected to carry on studies oriented toward graduate training in fields related to the biological sciences. Stipend rates are $1,800, $2,000, and $2,200 for the first, second, and third years, respectively. In addition to allowances for tuition and travel, $500 is given for a dependent spouse and each dependent child. (b) Postdoctoral Research Fellowships are awarded to qualified persons holding a Doctor's degree. Stipend rates are $4,500, $5,000, and $5,500 for the first, second, and third years, respectively. In addition to allowances for tuition and travel, $500 is given for a dependent spouse and each dependent child. (c) Special Research Fellowships are awarded to qualified applicants who have demonstrated unusual competence for research, or who require specialized training for a specific problem. Appropriate stipends are established on an individual basis. (d) Senior Research Fellowships are granted in support of investigators between the completion of postdoctoral training and eligibility for permanent academic appointment. The awards are made for 5-year periods, are renewable, and provide a salary which is appropriate and in accord with institution policy. Senior Research Fellows may also apply for additional support for their research needs. (e) Postsophmore Research Fellowships are designed to support students in schools of medicine and dentistry who wish to obtain research training prior to completion of their

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professional degrees. The stipend is set by the school in an amount not to exceed $3,200 annually. (f) Student Part-Time Research Fellowships are designed to give students in schools of medicine, dentistry, nursing, and public health an opportunity to explore the research field in the hope that many of those supported will enter into full or part-time research work. Units of $600 are provided for part-time research work during the school term or for full-time research for two months during any time when curriculum work is not scheduled for the student. (g) Foreign Research Fellowships are awarded to a limited number of highly qualified scientists from outside the United States for work of one to two years in the medical and biological laboratories of this country. Appropriate national research organizations of the country of origin serve as national nominating committees and may obtain applications and instructions from the National Institutes of Health. The stipend for the foreign research fellowship is $4,500 for the first year, supplemented by a $500 allowance for each dependent, and a travel allowance of 6 cents a mile for the initial trip to the United States and return.

3. Training Grants are awarded to public and private nonprofit institutions interested in providing special training for researchers, teachers, and prospective practitioners interested in public service. These funds may be used to improve facilities and to provide salaries for faculty, staff, and trainees, along with necessary supplies and materials. Institutions receiving undergraduate and graduate training grants have the responsibility for determining the most appropriate use of the funds.

4. Health Research Facilities Grants - Under the Health Research Facilities Act, July 1956, the Congress authorized the establishment of a program to assist in constructing, altering, renovating, and equipping facilities for the conduct of research in the sciences relating to health. Health research facilities grants provide matching funds up to 50% and may be made to public and private nonprofit institutions where health related research is being conducted. The program has an annual appropriation of 30 million dollars.

I have mentioned that these programs are competitive. It is true that applications must compete for available funds in terms of their "scientific merit", but this is a broad concept and the competition does not mean that one project is compared with another in the course of its review. Many factors enter into the recommendation for approval or disapproval of each proposal by the advisory groups. Consideration

is given to the research design of the project, the training and competence of the investigator, the availability of competent ancillary staff, the adequacy of facilities, the relationship of the proposal to existing knowledge and current research being conducted in the same field, the desirability of encouraging research in given geographic areas or small institutions where little research is going on, and sometimes the stimulatory effect an award might have on a given individual or institution.

Our analyses of health research trends, based on the disciplines represented in the applications we receive, show an increasing number of requests for research which will be of common interest to both the health sciences and the physical sciences. If we assume that medical schools will soon have departments of space medicine, then we may anticipate a still greater increase in research projects falling into this category. Examples of such projects currently being supported will perhaps be of interest.

One is a study of the effects of long continued low supranormal gravitational forces on the growth of tissues and cells of both plants and animals.

Another study attempts to determine whether a subnormal concentration of carbon dioxide has any influences on resistance to bacterial or other types of inflammation. Rats will be studied during and after acclimatization to high altitude in a specially constructed chamber. Comparisons will be made with a control group subjected to high altitude carbon dioxide deficiency.

There is also a study concerned with the changes in cells induced by an inadequate supply of oxygen.

Another project will seek to determine the site of the blood producing substances which appear in the milk of lactating goats exposed to high altitudes. On the basis of these experiments it will be possible to evaluate and compare the goat with other animals as a source of these substances.

The role gravity plays in the control of growth is the subject of another study. Experiments on mice have shown that these animals can continue to survive and develop even during a year of continuous centrifugation at a pressure of 5 G's.

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Several methods of harvesting algae are being investigated. Approximately ten species of fresh water and marine algae will be tested.

NIH-supported investigators are not neglecting the stress produced by isolation. One project explores the psychological and physiological response characteristics of individuals subjected to stress by experimental isolation and defines the variables influencing response to such isolation.

Closely related to this is a study of human beings under various conditions of sensory deprivation and the effects of drugs on the behavior of individuals under sensory deprivation.

Other typical studies include investigations of the role of the chemoreceptor mechanism in adaptation to an inadequate supply of oxygen; the comparative physiology of circulatory adaptation to altitudes; the production, prevention, and delayed effects of decompression sickness; the cardiac output in man in circumstances where rapidly changing cardiac output is to be expected, i.e., in the first half hour after blood loss, during exposure to gravitation stresses, and after the administration of drugs with transient effects.

The National Institutes of Health shares with you the excitement of feeling that many of the scientists supported are on the brink of great discoveries. We know how vital these discoveries will be to the advancement of other space-age sciences and we look forward to the contributions which will be made by the Public Health Service grantee investigators.

THE ANATOMY OF MANNED SPACE OPERATIONS

AIR FORCE R&D IN THE LIFE SCIENCES

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Abstract

Contract and in-house research and development required to optimize the human factor in Air Force systems and operations are accomplished at eight different agencies in ARDC; in addition, major basic and applied research programs are carried out at the Arctic Aeromedical Laboratory (Alaskan Air Command) and the USAF School of Aviation Medicine (Air Training Command). Work is done in numerous divisions of biological and behavioral sciences, as well as in many interdisciplinary areas between the life sciences and the physical sciences. The applications of such studies to design and development, and in system integration, are also stressed. The management of R&D activities in ARDC is briefly described in this article, and a source list of technical guidance documents available to science and industry for their information is furnished.

Introduction

Responsibility for research and development in the USAF, with a few exceptions, is concentrated in the Air Research and Development Command. The exceptions are of two kinds: The first is made up of certain classes of basic and clinical research in aviation medicine and arctic medicine carried out by the Aerospace Medical Center of the Air Training Command and the Arctic Aeromedical Laboratory of the Alaskan Air Command. The second exception consists of a diverse collection of applications engineering, operational testing, and requirements study activities which go on in almost every one of the major commands, aimed toward the clarification of each one's peculiar problems and the improved efficiency of its own unique operation.

The life sciences research and development program includes the research activities going on in aviation medicine -- or as some have begun calling it, "aerospace medicine" -- as well as in arctic medicine; it will therefore be immediately clear that important work being carried on outside the program of the ARDC will have to be considered under the title of this report.

The following list of agencies includes all those which perform R&D or test activities in one aspect or another of the Air Force life sciences program:

AIR RESEARCH AND DEVELOPMENT COMMAND	Telephone Number
Aeromedical Field Laboratory Air Force Missile Development Center Holloman AFB, New Mexico	Alamogordo, NM Granite 3-6511 Ext 662609
Aerospace Medical Division Wright Air Development Division Wright-Patterson AFB, Ohio	Dayton, Ohio Clearwater 3-7111 Ext 22232
(Under the Aerospace Medical Division come three laboratories:	
Behavioral Sciences Laboratory	Ext 36101
Biomedical Laboratory	Ext 20174
Life Support Laboratory	Ext 38115
Biophysics Division Air Force Special Weapons Center Kirtland AFB, New Mexico	Albuquerque, NM Chapel 7-1711 Ext 3254
Directorate of Bioastronautics Projects Air Force Ballistic Missile Division Air Force Unit Post Office Los Angeles 45, California	Inglewood, Calif Orchard 0-1444 Ext 2971
Human Engineering Laboratory Rome Air Development Center Griffiss AFB, New York	Rome, NY Rome 3200 Ext 6114
Human Factors Branch Air Force Flight Test Center Edwards AFB, California	Edwards, Calif. Clifford 8-2111 Ext 38121

Human Factors Office Air Proving Ground Center Eglin AFB, Florida	Valparaiso, Fla Crestview, Fla Eglin AFB Ext 29200
Life Sciences Directorate Air Force Office of Scientific Research Air Force Research Division Washington 25, D. C.	Lincoln 6-5650 Ext 358
Office of the Staff Surgeon Air Force Missile Test Center Patrick AFB, Florida	Cocoa Beach, Fla Ulysses 7-4622
Operational Applications Office Air Force Command and Control Development Division L. G. Hanscom Field Bedford, Massachusetts	Bedford, Mass Crestview 4-6100 Ext 2910
Personnel Laboratory, Det. No. 1 Wright Air Development Division Box 1557 Lackland AFB, Texas	San Antonio, Tex Walnut 3-3411 Ext 2110

AIR TRAINING COMMAND

School of Aviation Medicine Aerospace Medical Center Brooks AFB, Texas	San Antonio, Tex Lehigh 2-8811 Ext 4218

ALASKAN AIR COMMAND

Arctic Aeromedical Laboratory
(Ladd Air Force Base
Fairbanks, Alaska)
P.O. Address: APO 731
Seattle, Washington

The activities of the various laboratories and offices in the Air Research and Development Command are managed and coordinated by the Assistant for Bioastronautics and the Deputy Chief of Staff/Research and Engineering at Hq ARDC. The entire Air Force program is coordinated and controlled at Hq USAF level by the Human Factors Division, in the Directorate of Research and Technology, under the Deputy Chief of Staff/Development.

The objectives of this report can be achieved without giving much consideration to the programs of those organizations in the foregoing list which do not customarily procure research and development assistance from civilian scientific or industrial agencies. Three of them fall almost wholly inside this category. They are: the Human Factors agencies at Edwards and Eglin, and the special group in the Office of the Staff Surgeon, AFMTC, at Patrick.

The Human Factors groups are units which work intimately in the test programs identified with their centers, examining the problems of crewmen associated with the weapon and supporting systems their centers evaluate for ARDC. When they discover a crew problem requiring further R&D effort or in need of an engineering solution they bring it to the attention of the system project office or the appropriate ARDC laboratory.

The unit at Patrick exists primarily to plan and coordinate Department of Defense biomedical test support to NASA's Project Mercury. All three of these units work closely with the life science laboratories, both within and without ARDC, in order to keep abreast of their programs; but they do not, in general, conduct research on their own behalf.

Functions of the Life Science Laboratories

A brief description of the research missions of the other laboratories and units may be of some assistance to potential contractors interested in locating a point of contact within the life sciences research and development complex where their ideas and skills might be desired.

Aeromedical Field Laboratory, AFMDC

This unit was converted in 1952 from a detached field test station of the Wright Field Aero Medical Laboratory into an independent laboratory in charge of its own scientific effort. Initially its program consisted of studies of animal exposures to cosmic radiation, conducted with the assistance of the high altitude balloons which were then being launched at Holloman. Later these space biology activities were expanded to include human high altitude balloon flights, such as the Man High project; and a program of biodynamic research was added, taking advantage of the track facilities existing at Holloman. At the present time the laboratory is tending to de-emphasize balloon platforms for its animal test work, and is moving toward a program of support to ballistic and orbital missile shots in which its contribution will be an

appropriately trained, instrumented primate ready to act as a biological probe in unexplored, potentially dangerous environments. The development of improved human and animal track testing procedures and instrumentation will of course continue, as will also the program to determine human physiological tolerances to abrupt deceleration applied in various ways.

Aerospace Medical Division, WADD

Behavioral Sciences Laboratory: This new laboratory was established in 1960, as a part of the reorganization of Wright Air Development Division, by breaking out the groups formerly known as the Human Engineering and Training Branches of the old Aero Medical Laboratory and the Simulator Research Section of the Training Equipment Branch of the old Equipment Laboratory. This major new unit exists to study problems of human performance and efficiency in relation to the operation of advanced and futuristic aerospace vehicles. Its program will include studies of human factors in the handling of nuclear weapons and the operation of nuclear powered vehicles; studies of the practice and learning requirements to be satisfied by, and the design characteristics to be built into, new training devices and simulators; studies of methods of predicting the quantitative and qualitative personnel requirements imposed by new and unconventional hardware systems; studies of the interaction of engineering design and the psychophysiological capabilities and limitations of those who will operate and maintain it.

Biomedical Sciences Laboratory: This new laboratory was also established in 1960, by combining the Bioacoustics and Biophysics Branches and parts of the Physiology Branch of the old Aero Medical Laboratory. Its program will include research on the physiological responses to and tolerances for altered physical environments; studies of toxicity and other health hazards of materials and radiation; research on the effects of vibration and acceleration in flight, as well as on methods of controlling acoustic energy; analysis of nervous system functions and synthesis of functional analogs of living systems; and investigation of protective principles against the hazards of space flight and isolation.

Life Support Systems Laboratory: Like the other two laboratories in the division, this one was established in 1960, in this case by pulling together the Engineering and Development Branch and certain parts of the Physiology and Aircrew Effectiveness Branches of the old laboratory. Its function will be to devise new methods of protecting and sustaining the

crewman in hazardous and inhospitable environments, and to demonstrate their feasibility by designing techniques and devices in the field of personal and survival equipment. The laboratory will also explore new methods of providing closed and semi-closed environments for man through applied research employing and advancing the state of the art in the physical, biological, and engineering sciences appropriate to this goal.

Arctic Aeromedical Laboratory, AAC

This agency was organized in 1947 as the 1st Central Medical Establishment at the USAF School of Aviation Medicine, at Randolph AFB,Texas. After a period of individual training of personnel it was transferred as a unit to Ladd AFB, Fairbanks, Alaska. The laboratory's principal function is to explore and establish technical requirements arising out of the effects of arctic environments on USAF personnel. Its program includes studies of arctic acclimatization, physiological and psychological problems of arctic survival, personal equipment and clothing, human problems at remote sites, and various special problems of weapon handling and use in various arctic environments. Its capability to develop materiel is limited, but it often acts as a test agency for items developed at other laboratories.

Biophysics Division, AFSWC

The Biophysics Division was organized at the AFSWC in 1954, and assigned to the Research Directorate. The nucleus of the group had been reassigned to Kirtland when the old Atomic Warfare Directorate was closed out at the Air Force Cambridge Research Center. The mission of the Division is to determine the effects of ionizing radiation on personnel and develop a philosophy of operation which will allow the Air Force to remain operational in spite of a nuclear environment. The Division performs work in areas not solely identified with biomedical interests, but its relevant activities in this latter area may be summarized as: delineating personnel hazards associated with airborne reactors; investigating and acting as the ARDC repository of information about ionizing radiation in space; continuing research on nuclear weapons effects; and performing such research, development, and evaluation as is necessary to standardize radiac instrumentation for USAF use.

Directorate of Bioastronautics Projects, AFBMD

This unit was established in 1958 to plan and act as the office of technical management for all biological space flight

programs which might be assigned to the Air Force Ballistic Missile Division. In practice, this has meant that the group has planned, coordinated, and supervised the design and test of several types of animal capsules and biological packages intended to be carried into orbit by vehicles in the Discoverer program. This activity is expected to continue.

Human Engineering Laboratory, RADC

This group was established in 1951 as the Human Factors Office to provide direct assistance to design engineers on problems caused by or related to the use of human beings in the operation and maintenance of ground electronic equipment and systems. The laboratory now supports engineering research and development activities at its Center in such areas as control and guidance, communications, and intelligence and electronic warfare. This support takes the form of consultation; participation in design, development, and test; contract monitoring; and performance of applied and basic research in the areas of display design, visual image interpretation, development of symbologies, information processing as a function of sense modality, and data presentation for various purposes.

Life Sciences Directorate, AFOSR

This agency was officially established in 1956, although the Human Factors Directorate of ARDC Headquarters had performed its de facto functions for the AFOSR since 1952. With a new staff and a revitalized program, it has contained since 1956 two divisions, the Biological Sciences Division and the Behavioral Sciences Division. The Directorate of Life Sciences has as its mission the development, through a contract research program, of knowledge which will be useful to the Air Force in the field of improved human performance, and through the application of biological knowledge to the development of better Air Force systems. The purpose behind their research is to develop knowledge which will permit identification, analysis, and prediction with regard to those aspects of human nature and behavior which are critical to the effective use of human operators in the Air Force now and in future air and space assignments. The frontiers of knowledge in the disciplines of physiology, biochemistry, pharmacology, and other biological specialties and in the fields of psychology, anthropology, sociology, and psychiatry are explored to produce information vital to the solution of Air Force human factors problems.

Operational Applications Office, AFCCDD

This unit grew out of the Aviation Psychology Program of World War II, and passing through several commands, undergoing several name changes in the process, took up its present mission when it was assigned to the former Air Force Cambridge Research Center in 1954. Major emphasis in this organization is on system support of the ground electronic environment systems which the Air Force Command and Control Development Division is charged with building, such as SAGE and its "follow-on" system, for example, and the Tactical Air Control System. This support takes the form of applying human engineering techniques to these systems, monitoring contracts associated with them, participating in system and subsystem testing, and conducting laboratory experimentation calculated to improve designs and techniques related to such equipment. The Office also performs a certain amount of basic and applied research work, both in-house and by contract, in the areas of human performance and surveillance. Included here is work on such general topics as threat evaluation and action selection, data processing techniques for recognition and detection, information processing through visual displays, communication in noise, and man-machine system integration principles.

Personnel Laboratory, Det. No.1, WADD

Like the preceding group, this unit has operated continuously under one Command set-up or another since shortly after World War II, and grew directly out of the Psychological Research Units established during the war for the purpose of selecting and classifying aircrewmen. It has been in ARDC since 1954, and assigned to WADD since 1958. The Laboratory's mission is to conduct research and development in support of the operation and qualitative improvement of the Air Force Personnel System. To this end it performs psychological research on occupational analysis methodology and on actual Air Force jobs; on selection, classification, and evaluation devices and on proficiency tests; and on motivation, morale, aptitude, situation, and personal factors related to personnel use, retention, and performance. Work is also done on the statistical, mathematical, and computational methodology needed to accomplish the primary research and development goals.

School of Aviation Medicine, ATC

The School was activated in 1918 and has borne its present name since 1922. After occupying quarters on several different bases, it was finally moved in 1959 to its present

multi-million dollar plant on Brooks Air Force Base. Together with the USAF Hospital on Lackland AFB and the USAF Epidemiological Laboratory on Randolph AFB, it comprises the Aerospace Medical Center. Although the School maintains its position as the outstanding educational institution of its kind in the free world, the lion's share of the space in its new Brooks AFB facilities, and the majority of its technically trained staff are devoted to research activities. The School conducts a broad program of contract and in-service research, both basic and applied, in such main categories as aeromedical training techniques and devices, perceptual problems of flight, patho-physiological aspects of flying safety and aircraft accidents, Air Force clinical and preventive medicine, medical standards in aviation, radiation biology, aviation physiology and biophysics, bio-instrumentation, and air evacuation. A Department of Space Medicine was established at the School in 1948, and out of this has recently grown, in addition to the other research areas mentioned above, an aggressive program of laboratory work in both the basic and the developmental aspects of bioastronautics.

Life Sciences R&D Planning and Management

The managerial and coordinating role of the Directorate of Life Sciences at Hq ARDC for those programs and laboratories within ARDC has already been mentioned, as has that of the Human Factors Division at Hq USAF for the entire Air Force. Guidance, supervision, and control of the manifold research and development activities of these laboratories and agencies described in the preceding section are mediated by means of a directive and reporting scheme made up basically of three types of documents.

The first type comprises requirements documentation: the description passed on by the higher headquarters to the lower one telling what needs to be done, and by when. These pieces of paper come under several different names, and the names change from time to time; for the most part these requirement papers are of little concern to the general public, and are not available to it. One important group of these documents, however, is available to that portion of the public which is in a position to do something constructive about them, and this group is described more fully in subsequent paragraphs.

The responses the laboratories make to these requirements statements are covered, in the main, by the other two types of documents mentioned, and consist of, first, a research and development plan for satisfying the need described by the

requirement paper; and, second, a series of periodic reports describing the progress being made and the major problems being encountered. These documents are usually not available to the public.

The documentary group within the requirements category mentioned as being obtainable by such institutions and companies as possess some degree of competence in the field of work involved describes the nature of the effort needed in all of the basic and applied research areas in which the Air Force realizes it has an interest. Within the applied research area is included a large amount of technical or "state-of-the-art" development work, leading even to prototypes or working models, not specifically identified with the design or operational support of any actual system under current development. This set of documents was invented precisely in order to inform the Nation's scientific and technical groups what assistance the Air Force would like to get from them.

It is made up of two main types of information. The first type is that which is contained in the Research Planning Objectives (RPO); this material is incorporated in a brochure entitled "Basic Research in the Air Force," which has been distributed by Hq ARDC in the past, on request, to interested members of the scientific community in order to acquaint them with the general kinds of basic research ARDC is prepared to sponsor by contract or by grant. In the future this same document will probably be distributed for ARDC by the new Air Force Research Division, whose headquarters is also in Washington, D. C.

The second type of information is the Technical Objective Document (TOD), furnished by Hq ARDC. The latter pertains to the applied research programs of the entire Command; which of the Divisions or independent centers is responsible for the particular research or technology concerned is also shown in these documents. Of the two the TOD is the more intricate in its construction and in the amount of detail it includes. A brief explanation of its derivation and content is therefore included here.

The basic requirements document in the applied research area is not the TOD itself, but another set of documents entirely, known as the ARDC Planning Objectives. These express a unified Command effort to foresee, as far into the future as possible -- and in any case for at least ten years ahead -- what kinds of major capabilities ARDC is likely to require in order to perform its military R&D mission.

Thinking regarding these capabilities is organized around two major concepts: first, "hypothetical" or possible systems with a potential military role; and, second, "technological capabilities" which, though not constituting complete systems in themselves, would have conspicuous and probably general usefulness of a high order. The objective is not to obtain a completely designed and developed system by the time specified, but rather to possess the capability of designing and building the system if there does indeed still appear to be a verified requirement for the actual hardware by the time the "know-how" needed to build it has been acquired.

When these unified major capability goals have been set down for the entire Command to study, the next phase of the planning operation is carried out by the laboratories and working level scientific personnel of the Divisions and Centers. At this stage each scientist analyzes the entire requirement for the problems implicit in it for his own technical specialty. He attempts to spot the information gaps where nothing, or not enough, is known; he tries to visualize the obstacles to accomplishment of the job professional engineers and scientists will have to be able to do if the total capability is to be achieved. And when he determines what he is going to need to know how to do in his own area, that he cannot presently do, he writes his own specific requirement for the information. This requirement for information is called an Applied Research Objective (ARO), and makes up one of the subordinate goals within the over-all goal of the Planning Objective.

When this second stage has been accomplished, by technical area, it will be appreciated that it would immediately be possible to construct an elaborate table showing all the ARO's in each of the Planning Objectives for all of the Technical Areas. A small piece of it might look like Table I.

Obviously, it would also be possible to assemble all the ARO's written for all PO's in any one Technical Area and put them out as one document describing the state-of-the-art advances desired in that particular area. This, in fact, is what the Technical Objective Document is, and it is intended to apprise civilian scientific agencies as to exactly what Air Force scientists think they need to know in order to carry out their future functions.

Table I

Technical Areas	Planning Objectives *					
	62-P	62-D	63-Q	65-U	67-F	70-O
780 A	-	ARO	ARO	ARO	-	-
780 B	ARO	-	ARO	-	ARO	-
780 C	ARO	-	-	ARO	ARO	ARO
780 E	-	ARO	-	ARO	-	ARO

*NOTE: The above PO's are fictitious. Their appearance, however is accurate: The number indicates the year the design or development capability is desired; the letter signifies the particular system or technology within that year.

Research Planning Objectives, by comparison, are relatively straightforward narrative documents describing simply and generally where the Air Force anticipates it may be wanting to go in 10 to 20 years and what main categories of scientific information it thinks may turn out to be useful in getting there. These objectives will be issued by the Air Force Research Division for the guidance of ARDC Laboratories and the Air Force Office of Scientific Research. As in the case of the Planning Objectives for applied research, the Command does not intend to distribute the basic requirement documents for basic research, either; although they at one time were furnished to the public. What is going to be released is a fairly thick brochure containing under one cover all the significant material concerning research requirements under all of the RPO's.

How Science and Industry Can Obtain Guidance Regarding Air Force Research Goals

If the individual scientist or research organization is interested in submitting an unsolicited proposal with the thought of seeking a contract or a grant in one of the basic research program areas he should request the brochure entitled "Basic Research in the Air Force." These are distributed with a minimum of strings and formality. To request copies write to the following address:

Headquarters
Air Force Research Division
ATTN: RRRTA
Washington 25, D. C.

The Technical Objective Documents which have been described are released by Hq ARDC to potential contractors, although this step is not taken without completion of several preliminary steps. To initiate participation in the Release Program covering these documents, persons desiring information should write to the following address:

Headquarters
Air Research & Development Command
ATTN: RDR-121
Andrews Air Force Base
Washington 25, D. C.

The laboratory or organization should request the document entitled "ARDC Technical Objective Document Release Program." This is up-dated annually, and briefly describes the latest available TOD's by technical area. In reply to this request ARDC Headquarters will supply the necessary information and forms for participation in the program, and will furnish the requestor the name of the ARDC Regional or Liaison Office to which his request for specific TOD's should be directed. The organization or individual concerned then indicates which technical area documents and the number of copies desired and submits the request to the designated Regional or Liaison Office, along with some other data outlining the capability which can be brought to bear upon the technical problems involved, as well as information concerning current security status.

If the potential participant in ARDC programs feels he needs additional guidance on the preparation of short- or long-form unsolicited contract proposals, or on base or Air Material Production contracts, R&D Source Information, Bidders Mailing List information, and similar matters he might well consider asking for another brochure entitled "Research and Development in the United States Air Force," issued by ARDC as a guide to contractors. This brochure can usually also be obtained from the ARDC Regional or Liaison offices previously referred to; or it can be requested from the Hq ARDC address already given.

One final information source deserves mention, and that is a good-sized book entitled "Basic Research Resumés," which contains a write-up of every in-house and contract effort going on in the basic research program area in ARDC. Government departments and laboratories can obtain copies of it from the Air Force Research Division address previously mentioned. It is available to Department of Defense contractors on the "area of interest" registers through ASTIA, and other non-governmental agencies can obtain copies of the "Resumes" from the Office of Technical Services in the Department of Commerce for the sum of $5.00. The current issue is dated December, 1959, but the AF Research Division expects to up-date the volume annually, with the new edition appearing around the first of the year. The reference numbers for the current book for each of the sources from which it is available are as follows:

AFRD -- AFOSR TR 59-204
ASTIA -- AD-2-329-33
OTS, Depart. of Com. -- PB 161297 ($5.00)

Neither the School of Aviation Medicine nor the Arctic Aeromedical Laboratory publishes brochures or other forms of technical guidance regarding the general program areas within which they are prepared to consider unsolicited proposals. The general areas described in the early part of this paper, however, are those covering their primary research interests; and a letter of inquiry addressed to the Director of Research of either organization, outlining informally the proposal an agency had in mind and the resources it could bring to bear on the problem would suffice to establish contact with them.

Laboratories and institutions desiring to place themselves on bidders lists maintained for these organizations could contact them directly, or could submit the necessary capability and field of interest information to the ARDC suboffice which carries out procurement actions for these two agencies, as well as for the Personnel Laboratory. The address of this office is as follows:

San Antonio R&D Procurement Office
Wright Air Development Division
Box 63
Lackland Air Force Base, Texas

The ARDC document release program was organized for the sole purpose of providing science and industry with specific background and guidance on future Air Force needs. The

hopeful objective of the program is to stimulate scientific and industrial organizations to participate in Air Force research programs. It should be of assistance to such groups in carrying out research and development planning, inasmuch it provides broad technical guidance not normally available by other means. And, not of least importance, it should aid them in formulating more realistic solicited or unsolicited technical proposals.

Goals of the Life Science R&D Program

It will not be feasible to convey in this summary paper any comprehensive picture of everything that is contained in the Air Force Life Sciences R&D program. The most recent count of projects in the field numbered 41 -- and in our terms each of these projects is not really a discrete experiment, but rather a far-reaching, major program of research in its own right. Under each of these projects there are usually several tasks -- at the last count there were a total of 350 approved -- and even these are not experiments in the accepted laboratory sense. Often a single task will be supported by work going on in-house and under several different contractors, each one working on a different phase, or exploring a different approach to a solution. When a solution must be had by a given date several unique bets are more likely to bring home a winner on time.

In terms of the Applied Research Objectives which have been supplied to the Divisions and Centers as guidance under the new Planning Objective system, still another figure will give some notion of the scope and variety of the program. There are 161 ARO's within the four Life Science Technical Areas which support various ones of the Approved Planning Objectives. The bare facts on these ARO's are covered in 78 typewritten pages of the four TOD's.

It should be clear, therefore, that a presentation the length allowed here could do very little to enlighten the public as to the details of the program of the Air Force in the Life Sciences. The available Technical Objective Documents are the only reliable source for this information.

It may be possible, however, to convey some idea of the total breadth of the program, and of the kind of guidance available in the major documents, by describing them briefly and citing specific examples from them.

At the present time, although some minor reshuffling in the technical areas is contemplated for FY 1962, there are four Technical Areas encompassed within the Life Sciences program. They are shown in Table II, and described briefly in the following paragraphs.

Table II

Technical Area number	Title of Technical Area
780 A	Biologistics
780 B	Biomechanics
780 C	Radiobiology
780 E	Human Performance

Biologistics encompasses the research (with the exception of radiation exposure research) that is done to identify the physiological criteria and the ecological requirements which must be applied to penetration by human beings of the hazardous environments accompanying Air Force flight operations; it also includes development of the principles and solutions which are needed to design logistical systems capable of protecting and sustaining men in such environments to the extent necessary for them to continue to operate successfully. The physiological effects of such hazards as low ambient barometric pressure, oxygen lack, temperature extremes, and intrinsic and extrinsic toxic factors are considered within this area, as well as protective, preventive, and therapeutic measures which might be devised to cope with such hazards. Also covered in this area are the requirements for food, water, rest, and waste disposal, and the development of techniques and devices necessary to meet these requirements.

In general, solutions to the above problems cannot be adopted as if they were isolated factors within the situation. The interplay between the environmental conditions, the vehicular performance characteristics, and the physiological responses dictates that the logistical solutions considered to satisfy these biological requirements are interdependent and must be integrated.

An example of an Applied Research Objective in this area is hard to supply, because most bear a classification related

to the potential system they support. Here is an unclassified objective, however, achievement of which is desired by the end of the 1962 fiscal year: It states that it is necessary "To provide criteria and performance parameters for the development of devices, instrumentation, and other equipment for the control of toxic chemical hazards (oxidizers and fuels) at static testing and missile or vehicle launch sites." Some further detail is given.

Another unclassified objective, to be attained by the end of FY 1964, says that we need "To establish bioastronautic criteria and parameters for the development of a personal protective assembly to provide for extra-vehicular operations such as inspection, repair, transfer, and other activity for periods up to six hours."

Biomechanics incorporates the research needed to elucidate the responses of cells, tissues, organs and the entire body to the application of mechanical forces; and development of both tolerance criteria for exposure and the principles, techniques, and devices necessary for prevention of the undesirable operational results, as well as the irreversible physical disablement, which may be caused by such mechanical forces. The personal hazards, disabilities, and losses of kinetic effectiveness considered within this technical area are the direct result of operationally induced environments, such as unusual acceleration situations, weightless and near weightless states, fields containing high levels of acoustic energy -- either vibratory or sonic --, and the extremely high and abruptly applied force fields characteristic of impact, blast, and shock wave phenomena.

Somewhat remote from the central concerns of this technical area, but still handled in it have been such matters as the possible applications of ultrasound to biological research; body measurement, sizing, and kinetics; physiological optics, the protection of the eyes, and the provision of aids to vision; and the evaluation of combined multiple environmental and operational stresses, such as escape and survival, or isolation, disorientation, and sensory deprivation.

Also in the area on an interim basis, although the formation of a new technical area is under consideration, is a new interdisciplinary field, sometimes called "Bionics," which looks toward the production of engineering prototypes of sensing, problem-solving, and self-organizing control devices based upon biological models. Other ARDC technical areas not a part of the Life Sciences program are also deeply involved

in this new field, and this fact is what underlies the thought being given to a new technical area and other possible approaches to coordination of the work.

An instance of an Applied Research Objective in the Biomechanics area is afforded by this unclassified example, to be accomplished by the end of FY 1962: "To assure that auditory and non-auditory effects of uninterrupted or briefly interrupted exposure to relatively low level but steady noise and vibration fields for periods of four to ten days neither affect crew performance adversely during the mission, nor cause permanent physiological or psychological after-effects."

Radiobiology includes the research, analytical studies, and field tests and measurements needed to establish the radiological criteria used as a guide in the unavoidable operational exposure of human beings to ionizing radiation. It includes, as well, the establishment of principles and the devising of means which can be used to minimize exposure, or the effects of exposure, and protect the human beings involved from the radiation hazards associated with Air Force operations, such as those present in ambient space and those resulting from induced nuclear reactions.

Also administered in this technical area is the program of research on the biological effects of microwaves. Projects in this area are conducted to determine what gross or cellular phenomena may result on either an acute or a chronic basis from the effects short-term or long-term microwave radiation. Although hazards other than the obvious ones associated with over-heating of tissue have not been demonstrated, this form of energy appears to possess considerable intrinsic interest as a research tool whose potentialities and versatility we may be only on the threshold of realizing.

This is an unclassified ARO presumably realizable by the end of FY62: "To provide design criteria for instrumentation which can precisely identify, measure, and analyze ionizing radiation in biological equivalent terms, suitable for incorporation into vehicles and space or lunar stations."

Human Performance encompasses a very broad program of research in the engineering and behavioral sciences aimed toward increasing the effectiveness of Air Force personnel in the execution of their duties. It includes within its research objectives the goals of improving the predictability, the precision, and the reliability with which crew member

performance can be controlled, whether one is considering an individual or a team member, an operator or a maintenance man, a man in the aerospace environment or one on the ground.

This area includes within its purview the research and development necessary to (1) design appropriate and effective training equipment, simulators, and training techniques, capable of instilling the required skills in operators, controllers, and maintainers of advanced and futuristic systems or subsystems; (2) provide techniques of improved efficiency and validity for use in the selection, assignment, evaluation, promotion, retention, and retirement of Air Force personnel; (3) optimize the physical and functional relationships between the dynamic characteristics of men and those of machines at the interfaces between them, to the end that integrated man-machine systems may perform with the best attainable efficiency and reliability; (4) improve the speed, accuracy, and reliability of information sensing, processing, and communication mediated with the assistance of human operators in Air Force systems.

The following are two unclassified ARO's in this technical area believed to be achievable by the end of FY62: First, "To determine the quantitative influence on speech intelligibility of such communications techniques as frequency limiting, compression, clipping, and time sampling in order to guarantee the usefulness of speech communications (intelligibility and information capacity) under conditions wherein maximum use of bandwidth and time must be employed;" and, second, "To develop the necessary design techniques for equipment to train ground and airborne personnel in a complex controlled training environment. The equipment will record and process data, will display measurements of student performance, and will provide feedback information for the controlling or programming of the training equipment." Some additional details are furnished.

Conclusion

It is the writer's hope that this over-view of the R&D agencies, programs, and technical guidance methods in the Air Force will serve the purpose for which it was intended, namely, to convey to the scientific and industrial community some idea of the scope of our life science programs, and the opportunities which exist for cooperation between us in it. Since it is the business of the Air Research and Development Command "to accelerate the timely translation of science and technology into militarily useful systems" in order to assure our

national security, it is the earnest desire of our Command to join forces with the national scientific and industrial community to keep the United States ahead in military R&D.

The role of the human being in these systems is certain of becoming more and more critical, and in fact human judgement and skill may well become paramount in insuring their successful performance. As we move out into the aerospace regime and toward systems of greater and greater complexity the interjection of human functions into these systems will be effective only if it is planned with great care. Under these circumstances the acquisition of the knowledge which will be required will be possible only if every resource we have is fully exploited. This is the challenge to the Life Sciences in our country.

1 TALBOT

Government Grants and Contracts Panel, Symposium on the
Anatomy of Manned Space Flight, American Rocket Society
Remarks by Colonel John M. Talbot, Office of Science, ODDR&E

Ladies and Gentlemen, it should be made clear at the outset of my remarks that, with only a few exceptions, all the Department of Defense contracts and grants in the life sciences areas of interest are contained in the research, development, test, and evaluation programs of the three Military Departments. That is to say, the Army, Navy, and the Air Force have the programs and the program funds to support them. In contrast, the Office of the Secretary of Defense, the research and development part of which I represent today, has no separate program nor separate funds to support research and development.

Some exceptions to this statement may be found in the activities of the Defense Atomic Support Agency and in the Advanced Research Projects Agency, both of which are responsible directly to the Office of the Director of Defense Research and Engineering. These exceptions I shall describe in a moment. It should be understood then, that the Directorate of Defense Research and Engineering, which is the research and development staff organization of the Secretary of Defense, does not normally engage in direct contractual or grant programs; instead, it depends upon its principal agencies, the three Military Departments, and its two special agencies, the ARPA and the DASA. It may interest you to know that a current listing of military laboratories and research offices whose programs are either principally or indirectly in support of aerospace life sciences matters shows a total of 31. Of these, 10 are completely devoted to aerospace life sciences; the others, such as the Naval Medical Research Laboratory at the Submarine Base, New London,

have programs that yield knowledge and developments that may be of great interest to the aerospace life sciences.

The Office of Science, which is one of the 14 technical offices of the Directorate of Defense Research and Engineering, includes professional staff divisions in the physical sciences, the geophysical sciences, the biological and medical sciences, and the psychological and social sciences. My office is the Biological and Medical Sciences Division of the Office of Science. The mission of the Office of Science is the promotion and support and coordination of basic research programs in the Department of Defense. Since ours is a management agency at the policy level, we do not ordinarily become involved in the technical evaluation and direct support of specific research proposals. On the other hand, on request of prospective contractors and grantees, we do occasionally participate in the review of specific proposal and are often asked for guidance as to where to send proposals for proper attention within the activities of the Department of Defense. Thus at times we can be helpful in securing the evaluation of proposals by representative research authorities of the Armed Forces and in guiding people to the proper research offices and laboratories within the broad Department of Defense comple While on the subject of organization and mission, I should add that we maintain an active liaison with the Office of the Assistant Secretary of Defense (Health and Medical) inasmuch as that office has top level responsibility for the professional medical support of military personnel and is therefore vitally interested in the products of life sciences research as well as in the content of the programs.

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The Advanced Research Projects Agency, although no longer directly in the space business, now has a sufficiently flexible mission to undertake the support of a wide variety of research and development projects. If you will refer to the ARPA brochure hand out, you will see examples of the present ARPA fields of interest and also, information regarding the submission of proposals to ARPA. At the present time, the only life sciences activity under ARPA management is the toxicology project through which centralized management of toxicological research services for the three Military Departments has been achieved. Although the life sciences are not currently included in the listed fields of interest for ARPA, it is possible that the ARPA mission may be expanded to include the life sciences. Thus, while it would be inaccurate for me to suggest that ARPA is a fourth Defense agency which sponsors contract and grant support of life sciences research, I recommend that you keep alert to the possibility that the life sciences may become one of the ARPA fields of interest in the future.

The last Defense agency that I would like to discuss is the Defense Atomic Support Agency, formerly known as the Armed Forces Special Weapons Project. This organization is of interest to your group because of its responsibility for parts of the military research program in the biological effects of radiation. Although most of its projects are closely related to the effects of nuclear weapons, the information coming from these investigations has many potentially valuable applications in space technology. The DASA has its own contracting operation, separate from those of the three Military Departments; hence, in the biomedical field of interest, the Office of the Surgeon, Defense Atomic Support Agency, receives, reviews, and

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reaches decisions on the support of research proposals in the general area of radiobiology. Therefore, it seems appropriate to suggest to this symposium that there is a fourth agency of the Department of Defense which sponsors a contract program in the life sciences, albeit in this case, a highly specialized segment of the broad life sciences area.

In summary, the major contract and grant programs of the Department of Defense are those of the three Military Departments; the Defense Atomic Support Agency has a contract program in certain aspects of radiobiology; and the Advanced Research Projects Agency, while not currently sponsoring life sciences research programs except in toxicology, should be watched for future possibilities in the life sciences area. The Office of Science, which is part of the Directorate of Defense Research and Engineering, will provide guidance to prospective life sciences contractors and grantees in terms of where to send proposals and whom to contact within the Department of Defense.

END

THE ANATOMY OF MANNED SPACE OPERATIONS

GOVERNMENT GRANTS AND CONTRACTS

S. R. Galler
Biology Branch, Office of Naval Research

Ladies and Gentlemen, I was pleased to accept your invitation to address this meeting of the American Rocket Society for two reasons: Firstly, it represents an opportunity to inform you regarding some of the interests of the Biology Branch of the Office of Naval Research and about some of our research activities. It is my hope that this information will be of some assistance to you in applying to ONR for financial sponsorship.

Secondly, this meeting provides me with the unique opportunity of meeting with a group of physical scientists and engineers in order to suggest for your consideration certain mechanisms whereby you, with your wealth of special skills and information, might be able to provide greater cooperation with the biological scientists engaged in fundamental investigations. In brief, I hope that this presentation will afford an opportunity for a give- and-take of ideas that will help strengthen the community of interests between the biologist engaged in basic research and the engineer engaged in applied research and development.

Let us begin with a factual statement of some of the general objectives and operations of ONR. The Office of Naval Research came into existence in 1946 by an Act of Congress under Public Law 588. It was established in order to provide the Navy Department with a basic research arm under the direction of a Chief of Naval Research. Historically, the ONR was the first formally organized basic research group connected with a U.S. military department to develop a broad spectrum research program in cooperation with universities and other academic and non-profit scientific institutions in the United States. At present, scientific activities sponsored in universities and related institutions continue to represent the "backbone" of ONR research operations. It is noteworthy, however, that a

significant percentage of our research budget is used to sponsor scientific and technological activities in industrial research organizations. ONR sponsorship of research projects in industrial laboratories may consist of direct contracts with those organizations or financial support may come available through subcontracts established to carry out a specific task in support of a prime contractor. Now, the Office of Naval Research is organized in the form of a number of research divisions and related organizational units which are responsible for the planning and implementation of research programs oriented towards the fulfillment of the Navy's interests. Let us examine one division of particular interest to this meeting; namely, the Biological Sciences Division of the Office of Naval Research. This Division, directed by Dr. Roger D. Reid, consists of five Branches as follows: Physiology Branch, Dr. Leonard M. Libber, Head; Biochemistry Branch, Mr. Leo Shinn, Head; Microbiology Branch, Dr. Charles D. Cox, Head; Medicine and Dentistry Branch, Dr. Joseph Saunders, Acting Head; Biology Branch, Dr. Sidney R. Galler, Head. The research branches may be considered as the primary research programming units of ONR.

In the Biological Sciences Division the research objectives and research program plans are conceived, initiated, and activated at the branch level. Within the scope of our interests we operate principally on the basis of activating research projects stemming from unsolicited proposals received from scientists located in universities and other non-profit scientific organizations and, to some extent, from industrial groups. These proposals, usually received at the divisional level, are assigned to the branches with programmatic interests most closely related to the research subjects of the proposals. The proposals are then reviewed and evaluated within the Office of Naval Research and, in addition, when appropriate, they are presented to one or more independent scientific advisory committees for additional review. I wish to emphasize the independent nature of our advisory committee structure. In the case of the Biological Sciences Division of ONR the advisory committees are organized and administered by the American Institute of Biological Sciences. Through the AIBS we receive the benefit of scientific reviews and recommendations from outstanding biological scientists on a completely impartial and independent basis.

All proposals received in the Biological Sciences Division must fulfill three general criteria before they can be activated. Firstly, they must be judged acceptable on the basis of the scientific validity of the proposal and the

competence of the scientist.

Secondly, they must be judged acceptable as regards their relevance to a research area of interest to ONR and

Thirdly, they must be considered acceptable as regards the budget requested for their support.

If a proposal meets these three criteria it is then considered eligible for support and the scientist is so informed. It should be pointed out, however, that financial support does not follow automatically since our program plans are tied to our pocketbook. Sometimes it is necessary to defer support to a subsequent fiscal year in the hope that funds will become available for the activation of a specific proposal. Assuming, however, for the sake of discussion, that adequate financial support will be available; the proposer should anticipate, on the average, a wait of four to five months from the date of submission until the actual activation of the contract.

There are a number of other administrative aspects which time limitations will not permit me to discuss at this time. However, if you are interested in obtaining additional background information, you may write for a copy of the Office of Naval Research publication ONR-1 entitled "Contract Research Program". This little brochure also contains a suggested guide for the preparation of research proposals which you will find helpful. Now, let us proceed with the second phase of our discussions oriented towards strengthening the relationships between the biological scientist and the engineer.

Allow me to begin by anticipating a question which is sure to be asked in the course of the discussion: Does the Office of Naval Research sponsor a program of bioastronautics research? We do not support a program of this type. However, I hasten to add, the ONR does sponsor a number of programs which are yielding information in the life sciences directly relevant to the man-in-space research and development activities. Let me cite a few examples chosen at random. The Physiology Branch is supporting a program in stress physiology which is providing basic information on the responses of the human organism to a wide variety of environmental and endogenous stresses many of which are likely to be encountered in the development and operation of a manned space vehicle. The Biochemistry Branch is sponsoring a program in toxicology which is aimed at resolving some of the toxicological hazards

encountered in submarine operations but which is pertinent to the design and development of any closed environmental system aimed at maintaining man in a functional condition for extended periods of time. In addition, the Biology Branch and the Biochemistry Branch are supporting basic research aimed at the development of photosynthetic gas exchangers for possible use aboard submarines and also of potential importance in the development of habitable space vehicles. The Biology Branch's program in biological orientation has furthered our knowledge of endogenous rhythms and "biological clocks", phenomena which must be taken into consideration in the design and development of closed environmental systems suitable for sustaining man for periods of many months and possible for years.

I could go on and mention many other examples of research programs sponsored by ONR which are providing basic information of considerable relevance to bioastronautics research and development activities even though these programs were conceived and activated with other objectives in mind. The truism that fundamental research yields information of potential value to a number of seemingly unrelated technological fields is certainly valid here.

However, the multipurpose nature of fundamental research programs results in an important dichotomy; the data obtained from such a program may be immediately recognized by the sponsor, i.e., the user, as being relevant toward the fulfillment of his objectives. But, all too frequently the probability of relevance recognition decreases rapidly as the communication links between "user" fields increase. Let me cite one example. For many years the Office of Naval Research has been supporting biological investigations designed to increase our knowledge necessary for bringing about improvements in submarine habitability. However, until recently only a small fraction of this information and "know-how" has carried over into the bioastronautics field. I am pleased to observe that the amount of "carry over" is now increasing very rapidly. It would be interesting albeit fruitless to conjecture how much further along in bioastronautics if the transfer of information from the basic supporting scientific fields had been immediate and substantial. However, I am very much concerned at the lack of rapport, the lack of informational coupling between the biologists on one hand and the applied scientists and engineers on the other. Not infrequently I receive visits from representatives of industrial research organizations seeking ONR support for their

research projects and I find to my increasing distress that often they support research approaches which have already been explored and discarded or present plans for development of systems which do not take into consideration a substantial body of relevant biological data. Please be assured that my criticism is not limited to the engineering community. On the contrary, quite often I discover that competent biologists may exhibit a profound lack of comprehension of even elementary physics or instrumentation technology necessary for devising equipment or systems investigating biological phenomena. Many of them are only superficially aware of the tremendous reservoir of engineering talent in the U.S. that could be brought to bear on their instrumentation problems. What are some of the reasons for this lack of idea and information coupling between the biologist and the engineer? There are several causes which suggest themselves.

A. Language Barriers: The biologist and the engineer communicate through separate and distinct languages. To date relatively little effort has been devoted towards the construction of a scientific "Esperanto" which would facilitate an exchange of ideas between biologists and engineers.

B. Separate Interests and Objectives: Usually the basic researcher is free to satisfy his intellectual curiosity through research without the necessity of finding applications for his results. The engineer, on the other hand, is devoted to research and development with practical end products in mind. As a result, each seeks a different path in fulfilling his objectives and frequently fails to appreciate the overlap of ideas and activities which could be of mutual interest and benefit.

C. Financial Support: Not the least important reason for the incomplete rapport between biologists and engineers is the failure to recognize the importance of providing the scientist with sufficient funds to enable him to invite the active cooperation of engineers in research.

As all of you realize, the cost of developing instrumentation is relatively high. It is a rare occasion indeed when the biological scientist finds himself with sufficient funds to enable him to add a competent engineer to his research team. By the same token, he finds it financially impossible most of the time to award a subcontract to an industrial organization for the purpose of developing research equipment needed for advancing his project.

Now, how can we help alleviate this situation? I would

like to suggest to you that the engineer and his industrial sponsors for the most part have been content to allow him to devote his energies to development projects. I realize in making this suggestion that such activities represent "bread and butter" objectives of industrial laboratories. Nevertheless, I feel that the ultimate interests of industrial laboratory would be advanced (and in turn the national welfare) if the engineer was encouraged to meet with biologists, develop a feel for their problems and interests and eventually participate in the planning and implementation of basic research rather than limit himself to being an intermediate user of fundamental data.

If we keep in mind that the engineer is a sort of catalyst, serving to accelerate the conversion of fundamental research results into development and application, we begin to appreciate how much more benefit could be derived if the engineer was in on the "ground floor" in the planning and conduct of basic research. Not only could he become a valuable member of the research team but his background and training would enable him to anticipate the practical value of the data and place it in the applied research and development system much earlier than occurs at the present time.

In addition, we must encourage the biologist to avail himself of the tools and "know-how" of modern mathematics, physics, and engineering in order to insure that the information which he produces will be useful to these three types of specialists.

In summary, both the biologist on the one hand and the physical scientist and engineer on the other hand must be "introduced" to each other. They must be encouraged to develop a mutual respect and sympathy for the activities of the other and, ultimately, efforts must be made to provide the additional support necessary to enable each group to afford the services and cooperation of the other. The result, in my opinion, will be an accelerated and more efficient utilization of the results of basic research in follow-up applied research and development.

QUIMBY

GRANTS AND CONTRACTS AT NASA IN THE OFFICE OF LIFE SCIENCE PROGRAMS

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The NASA, Office of Life Science Programs, plans to award contracts and grants in accordance with the following areas of interest: Flight Medicine and Biology, Space Medical and Behavioral Sciences, and Space Biology. The first category is concerned with in-flight operations --- biotechnology and biomedical experiments in space. By biotechnology we mean that area of research, development, test and engineering which deals with man-machine integration and instrumentation, stress tolerance and adaptation, protective equipment and escape devices, life support systems, crew performance, and public health and ground crew safety. The end goals of biotechnology are to assure man's protection and to assure his ability to perform in advanced space systems. This is required in order to provide the capability for manned exploration and exploitation of space. In this connection we have specifically in mind a near earth manned orbiting laboratory, the circum-lunar mission, manned lunar landings, and planetary exploration.

The second part of Flight Medicine and Biology; namely, biomedical experiments in space is concerned with studies of survival and performance in animals and with biologic investigations at the cellular and subcellular level. We want to know what the effects are of flight through space on living organisms. We want to know what the effects are of planetary environments as well as conditions in the earth's upper atmosphere, on living terrestrial organisms. We want to know whether or not life exists elsewhere in the solar system and if so to study it in detail.

The space conditions that seem to be of most interest at the moment are radiation and the altered gravity state. These are of particular interest at the cellular and sub-cellular level. Also of interest are effects of altered gravity on larger complex living systems such as altered distribution of blood flow to vital organisms and neurological consequences of weightlessness and sensory deprivation.

Biological studies conducted at a cellular and sub-cellular level in the extraterrestrial environment, in addition to those concerned with radiation and weightlessness, will include observations of the effects of high vacuum, temperature extremes, and the unusual combinations of elements to be found in remote planetary atmospheres and surfaces. These investigations can be profitably extended by spectroscopic studies directed toward more precise identification of extraterrestrial life supporting substances and development of instruments for use in collection and analysis of extraterrestrial organic compounds and possible life forms.

Most of the biomedical experiments in extraterrestrial environments will evolve from ground-based investigations with the full support of the scientific community for the origin of ideas. In general, until manned orbiting laboratories become available, these experiments will be conducted with recovery of exposed specimens for study, or, with telemetry of results from space probes.

The Space Medical and Behavioral Sciences category consists of ground-based research for long-range support of manned space flight missions. The program will be in the disciplines of radiology, metabolism, cardiovascular physiology, respiratory physiology, neurophysiology and psychology. The projects awarded must relate to space flight and exploration as the proposed contributions affect survival and performance. For example, metabolic requirements of animals and men in terms of energy exchange, heat transfer, and nutrition under the limitations imposed by confinement in an artificial space capsule environment present problems of a fundamental nature which require further study. Also chronic effects of physical stress on the vital organs and on total performance as well as the long-term cardiovascular effects of restricted mobility, are subjects for detailed scientific consideration as they relate to space. The problems of

artificial atmosphere, diffusion of gases, toxic substances, and chemical control of pulmonary ventilation and tissue respiration are legitimate fields of enquiry in the overall space program.

Solar flares, the proposed use of nuclear energy for auziliary power and for propulsion, and the projected manned space flight missions to the moon and planets make the study of radiation hazards a primary area of effort. Measurements of biological effects and the discovery of means of protection beyond conventional shielding techniques are a must. Therefore, we seek to stimulate interest and to mobilize talent for research in this area in particular the medical schools and other research institutions.

The category of Space Biology is defined at NASA as ground-based fundamental, biological investigations, principally at the cellular and subcellular level. Here we propose to study the effects of simulated extraterrestrial environments on living organisms; develop and apply techniques for sterilization of space-craft designed to impact or land on the moon or planets; acquire information concerning possible life-supporting or related substances on the moon and planets; develop means of identification and analysis of possible extraterrestrial life forms including remote examination and telemetry or direct laboratory study of returned samples. We are also interested under this Space Biology category in laboratory synthesis of primordial molecules which bear upon the problem of the origin of life.

We plan to manage contracts and grants and to handle unsolicited proposals much like the other Federal scientific agencies. Our system now, although it will not always produce a favorable decision, will produce a decision expeditiously. Proposals are reviewed by the staff at meetings specially set up for the proposal evaluation. The purpose of such screening by the staff is for the identification and selection of proposals for committee review and evaluation or the referral of proposals to individual special consultants. There are three standing advisory committees as follows: The Flight Medicine and Biology Committee, the Space Medical and Behavioral Sciences Committee, and the Space Biology Committee. The committees are composed of six to eight experts each and will meet three to four times a year for proposal evaluation and other business.

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The question of whether the legal vehicle will be a grant or a contract is generally easily resolved. If you propose to plow the back 40 and do so by one or more of a variety of means -- horses, tractor, or shovel -- it would be a grant. If you propose to plow in accordance with a prescribed number of horses shod as required by the Space Agency, it would be a contract. If the work consists of hardware drawn to specification, if it is to provide specific data or answers, if it is to follow a rigid time schedule, if it does not allow for all contingencies and has a kind of open-ended character -- it would be a contract. Otherwise, it would be a grant. The overhead, incidentally, in either case would be that overhead audited for your institution.