MISSILE DEVELOPMENT AND SPACE SCIENCES

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C., Monday, February 2, 1959.

The committee met in the caucus room, Old House Office Building, at 10 a.m., Hon. Overton Brooks (chairman) presiding.

The CHAIRMAN. The Committee on Science and Astronautics will please come to order.

Now, gentlemen of the committee, this morning we have just a little bit of official committee business. So I am going to suggest to the committee we go into executive session for about 5 minutes. I think 5 minutes will dispose of what we have, and during that time I regret to say that we will have to exclude everybody from the meeting. And then we will reopen in 5 minutes with the regular list of witnesses that we have this morning, beginning with Dr. Glennan.

I hope you will bear with us in that respect.

Will the committee please come to order?

If there is no objection, we will clear the room and go into executive session.

(Whereupon the committee proceeded in executive session, thereafter reconvening in further public proceedings, as follows:)

The CHAIRMAN. The committee will please come to order.

Gentlemen of the committee, this is the first public activity of the newly constituted Committee on Science and Astronautics. It is interesting to note that the action creating this committee in the House of Representatives, and a parallel action creating a Committee on Aeronautical and Space Sciences in the Senate, represents the first such addition to standing committees of the Congress since 1892, two-thirds of a century ago.

The House of Representatives has recognized that changing times have brought new and grave responsibilities to the Congress, including concern with the larger role for science and the new dimension to human affairs in outer space. Speaking as chairman, all of us appreciate the importance of assignment to membership on this committee, and we will do our best to discharge our duties in service to the Congress and to the American people.

This committee has already held organizational meetings in executive session. This morning we are opening our first hearings. They represent but the first step in an orderly and comprehensive plan of study and investigation during the coming year.

The purpose of these hearings is to present to the members of this committee and, insofar as security regulations permit, to the public at large a picture of the situation as it exists today in the fields of science and astronautics. Although perhaps the principal focus of the hearings for the next several days will be on astronautics, it is important to recognize that this committee is concerned with scientific research across the board. Later work of the committee will explore many areas ranging beyond astronautics.

As indicated in the press release of the committee, the initial phase of the hearings will last for 4 days, to hear from the National Aeronautics and Space Administration, and from each of the three armed services.

As I have previously stated to members of the committee in executive session, this committee has too important a role to fulfill to be influenced by partisan considerations. We shall expect to work cooperatively with agencies of the executive branch of Government to advance programs vital both to the national welfare and to national security. We shall also consider legislation referred to the committee, and shall conduct such inquiries and investigations as may be necessary.

I wish to say that in recent days I have read many conflicting statements by eminent authorities concerning the progress that the Nation has made in the missile program. The more I read, the more confused I become about one thing: They all seem to agree upon the fact that the United States lags behind Russia in the development of the missile program. The degree of lag is dependent upon the authority quoted. The public is confused. These hearings, if they do anything, should clear up this confusion among authorities. We are definitely behind Russia in the development of the intercontinental ballistic missile, so important to our survival. We must overtake and surpass Russia in this respect, and I am sure this committee is resolved to do everything within its power to encourage and stimulate our leaders to reach the goal of overtaking and surpassing Russia in this part of our national defense.

This is no time for kid-glove conversation, but it is a good time to present to the public the plain and unvarnished truth.

This morning, members of the committee, the Administrator of the National Aeronautics and Space Administration is going to begin the presentation for that agency, and he will be followed by various technical experts and division heads to sketch the general outlines of their work and interests.

Our first witness this morning is Dr. Glennan, who is the Administrator of the National Aeronautics and Space Administration.

Doctor, we apologize for holding you there. If you will come forward and have a seat.

Before you start your statement, my colleague from Pennsylvania has a short statement to make.

Mr. FULTON. We on the Republican side want to join with our chairman and the majority leader in looking into these programs to see just where the United States does stand at the present time.

I don't think that I personally can go along with any blanket statement as to who is ahead, either Russia or the United States, because that is the purpose of our investigation. Obviously, they are ahead in some fields and we in the United States, from my own experience, are ahead in other fields.

The question then among authorities is: How important are those fields, first, to our national safety and security, and, secondly, to scientific advancement?

For my part, I put the programs on ICBM's, as well as the other missile and guided space vehicles, on a much broader basis than their military use or their place in competition with Russia. I believe we have many economic gains to be made, such as weather control, weather prediction, peacetime television, operating the Post Office Department, maybe, in the period of an hour, through having 20 to 30 missiles in the air, from which we either send or receive messages. The field is much broader than a race with Russia, and we in this committee, I hope, on the Republican side, will see that the implementation is given for broad scientific advances, not only for our security in a race with Russia but for the benefit of all mankind.

Lastly, I believe we on this side want to see these scientific advances made available for the whole world—all the scientists—so that every people, that is, our allies as well as the people behind the Iron Curtain, can move ahead, raise their standards of living, and arrive at a peaceful world.

Thank you very much.

The CHAIRMAN. Thank you, sir.

Now Dr. T. Keith Glennan, Administrator of National Aeronautics and Space Administration.

Doctor, you have a prepared statement. We will be glad to hear you as our first witness in the first session of this committee. I think this is an historic occasion.

STATEMENT OF DR. T. KEITH GLENNAN, ADMINISTRATOR OF NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. GLENNAN. Thank you, Mr. Chairman.

I am delighted to have an opportunity to appear before you and to see so many of the committee members in attendance this morning.

Before I do read this statement, I would like to introduce to the committee a man who I guess is known to most of you, Dr. Hugh Dryden, the Deputy Administrator, and Dr. Homer J. Stewart, who is Director of our Office for Programing, Planning, and Evaluation.

Now, if I may proceed.

Mr. Chairman, members of the committee and counsel, several days ago I was privileged, as indeed were some of you, to attend the ceremony at which the Army presented to the Smithsonian Institution on the first anniversary of its historic flight, a replica of Explorer I, the first U.S. earth satellite.

As I sat there, recollections raced through my mind of some of the many things that have happened in the year since we began our scientific exploration of space. Four additional U.S. satellites have been sent into orbit, carrying instruments for producing new scientific information of great importance. Two U.S. space probes have been launched to a maximum distance of 71,300 miles from the earth. In that same 12-month period the U.S.S.R. has launched an additional satellite with a very large payload and has sent the first probe beyond the moon and into orbit around the sun.

During this same period much more has happened. As a Nation we have been engaged in the most sober and intense assessment of where we stand in space technology, space science, and space exploration; we have pondered where we want to go in those areas, and what we must do to reach our goals.

We have faced up to the fact that we shall have to make the most earnest effort if we are to reach the goals we have set for ourselves. We have had to understand, also, that this is to be a continuing competition on a variety of fronts, scientific and economic as well as military.

As Dr. Hans Selye, director of the institute of experimental medicine and surgery of the University of Montreal has written:

> We must educate our children to understand that from now on man's great wars will not be fought with muscle. His battles will not be won by the glorious, intoxicating, momentary courage to face danger and die for a cause. Our children must learn that the great victory in peace and war will be won by warriors of a different stamp, men of intellectual vigor, and by the sober, persistent dedication of their entire lives. They will have to learn that it is far more difficult to live than to die for a cause.

A principal reason I am here today is because the Congress and the executive branch were in agreement that, and I quote from the Space Act of 1958, "activities in space should be devoted to peaceful purposes for the benefit of all mankind." In my opinion, as Americans we can be rightly proud that our country for the past year has led in efforts to establish a climate of international opinion that will give real meaning to the principle that space flight is, or at least should be, inherently international and peaceful in its intent.

As you know, the Space Act requires that—

> activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the defense of the United States) shall be the concern of the Department of Defense.

There are large areas of space activity where there may be a duality of interest, both civilian and military. On May 21, last, the Select Committee on Astronautics and Space Exploration of the House, in its report, "The National Space Program," recognized this duality of interest and use. In such instances, and I quote from the report:

* * * their primary purpose should be declared civilian. If we do not do this, we automatically commit the world of the future to the same stalemated life in armor which is lived by the world of today. If the very efficiency of current weapons virtually denies the practicable possibility of total war, further strides made in our rocket development would probably intensify this denial. The entire purpose of our effort should be to insure that the peaceful uses of these devices prevail. This is the stated philosophy behind our space exploration. It is the philosophy of this country.

The probable material benefits of space exploration are both direct and indirect and may be applicable both to civilian and military activities. The first practical applications appear to be those of satellites to the problems of worldwide communications and of meteorological research and weather forecasting. The last satellite launched by the United States, the Atlas, demonstrated in dramatic fashion some of the potentialities of a communications satellite. This accomplishment is but the first step in a development expected to lead to an economically-sound, wide-band, reliable worldwide communication system. Such a system would permit the transmission of television programs, if the use of the system for such a purpose were considered desirable.

A meteorological satellite would enable worldwide observation of clouds and other aspects of weather as suitable methods and instruments are developed. At present there are available weather observations from a limited number of stations on the land masses of the globe and from a few ships at sea. The much greater amount of information from the worldwide coverage of the satellite would, when suitably processed, increase the accuracy of weather forecasts. Economic studies have shown very large dollar savings from relatively small improvements in accuracy. More accurate forecasts have tremendous economic implications for agriculture, food-processing industries, public utility companies, and numerous other industries.

There are other applications of satellites to more special uses such as navigation and geodetic measurements. Beyond these we enter the realm of speculation and prophecy. We do not know the ultimate role of space vehicles in transportation any more than the few spectators of the early flights of the Wright brothers knew of our present jet transports which make the world a neighborhood. Some speculate that the moon and the planets represent a vast new physical frontier, a source of new material wealth, but at present this cannot be demonstrated. Suffice it to say that there are some clearly-seen material benefits to human welfare from space exploration, and that there are others, probably more significant, hidden from our view. I am personally convinced that these now-hidden gains that will accrue from our national space programs represent future payoffs of incalculable value, very possibly outweighing greatly the investments that will be required.

I have referred to the goal of our national space programs as the opening of space to mankind. Such an aim embraces the many interests of man himself, the material and the spiritual. To explore space to gain additional knowledge about the universe in which we live, to open space to the travel of man, himself, to open space as a demonstration of one's mastery of advanced technologies, all these reflect as in a mirror the insatiable curiosity of the human mind.

Our space science program is already providing much new knowledge about space which has led to the postulation of new theories about the earth and the environment surrounding it. And we have only begun to accumulate this new knowledge. High priority is being given to the study of energetic particles. In the immediate program, the interactions of high energy particles with the earth's atmosphere and field will be studied intensively and the types and energy of such particles and their spatial distribution will be measured.

Of specific interest are the measurements of cosmic-ray intensity in interplanetary space; of time and latitude cosmic-ray intensity variations; of composition and spatial extent of the great Van Allen radiation belts around the earth; of the cosmic-ray energy and charge spectrums, and of the nature of the particles producing auroras. Measurements will be extended as far as possible toward the sun and toward the outer reaches of the solar system, including the interactions of energetic particles with the atmospheres and fields of the planets.

These are but the an indication of the broad program that must be undertaken in the years to come. In our selection of the scientific space experiments to be conducted, we look for advice to the Space Science Board of the National Academy of Sciences. This board of 16 scientists is headed by Dr. Lloyd V. Berkner. It has already been helpful with reference to the immediate program for scientific exploration of the space environment. It also has in preparation a comprehensive report on the longer range scientific objectives with respect to the study of many physical phenomena relating to the moon, planets, and interplanetary space.

So far, my discussion has been focused on the objectives as expressed by the administration and the Congress, that our space programs shall be peace-oriented. Others appearing before your committee will deal with military interests in space technology.

Now, I want to speak about the National Aeronautics and Space Administration.

The Space Act provided expressly that NASA should become operative 90 days after its enactment, July 29, or on any earlier date that the Administrator might determine. We shortened this 90-day period of preparation by one-third, and as of the close of business, September 30, last, NASA was in operation.

To get going, we have had to organize with one hand, while, at the same time, we are trying to operate with the other. This, we all know, is not the most efficient way to do business. There was not then, and there is not now, time for us to proceed in the most orderly fashion.

At NASA we have accepted the realities of the situation. We have improvised task-force teams that by brute effort could get done as quickly as possible what had to be done. We recognize, however, that for the long pull, we must accomplish proper organization of our people to insure that they function smoothly as an efficient team. This we are doing at the fastest possible rate.

Fortunately, it was not necessary for NASA to begin from a standing start. The Space Act provided for transfer to NASA of, and I quote, "all functions, powers, duties, and obligations, and all real and personal property, personnel (other than members of the Committee), funds and records" of the NACA, the National Advisory Committee for Aeronautics.

In the transfer, the important item was not the $350 million value of the finest of research facilities or even the comprehensive flight research programs of the NACA that ranged all the way from problems affecting vertical takeoff and landing aircraft to those peculiar to satellites and space probes.

What was really important in that transfer was the group of nearly 8,000 scientists, engineers, and supporting personnel that we inherited from NACA. Last August at the confirmation hearing when I was asked what I thought my job called for, I said, "It isn't just a matter of the money that is involved, but it is a matter of the people involved and how one best can motivate the people to highest performance." I have had no problem providing the motivation to obtain highest performance from these people. They believe very earnestly in what we are trying to do. They feel the urgency with which we must do our work. They are experienced and talented people who are contributing effectively to the national space effort.

In this manner, we were provided with first-rate research activities on a broad front in both aeronautical and space. There were, however, other research, development and operational areas in which NASA had to become deeply involved to accomplish its total mission. These included electronics, guidance, rocket systems, and so forth.

There were two possible, obvious solutions. One was to begin selecting sites, constructing and equipping new facilities, and then undertaking the painful process of staffing the new laboratories. Such a solution would have been very expensive. It would have required the raiding of staff from other organizations. Most serious of all considerations, it would have delayed our progress very materially.

The other solution, and the sound one, I believe, was to acquire facilities already doing outstanding work in the required areas. This is the course we have been following.

The President, on December 1, transferred to NASA from Army jurisdiction the Jet Propulsion Laboratory at Pasadena, Calif., operated under contract by the California Institute of Technology. By this action, NASA acquired a high order of capability in electronics, propulsion, systems analysis, and in tracking and telemetry.

We requested also that the Army transfer to us a portion of the Army Ballistic Missile Agency at Huntsville, Ala. Such a transfer would have given us an imaginative, competent engineering and design group capable of serving in the planning and executing of both short- and long-range programs in the development of boosters and vehicular systems. Such a group would have served also to monitor contracts with other governmental agencies and with industry, to provide a necessary ground testing and assembly capability, and to supervise all launching operations for NASA.

The Department of Defense determined that the Army Ballistic Missile Agency's special talents were necessary to the accomplishment of certain missile projects vital to the Nation's defense posture. We did not wish, of course, to interfere in any way with our defense effort, and, in fact, had included this proviso in our original request. Although the Department of Defense was unable to agree to the transfer, arrangements were made for ABMA to be "completely responsive" to requests of NASA for the performance of such work as we desired and the Army felt could be done without interference to its military projects. It is too early to say if this arrangement will be adequate for our needs. The Army has assured us of an earnest desire to be fully cooperative within the framework of existing limitations, and we intend to make the fullest use possible, under these circumstances, of the ABMA capabilities.

The Presidential order of October 1 transferred certain programs and projects already underway. These actions included, for example, a study contract the Air Force had with Rocketdyne Division of North American Aviation to determine the feasibility of undertaking development of a single-chamber rocket engine in the 1½-million-pound-thrust class. Included also in these transfers were the Vanguard project and several Air Force and Army space probes then under the administration of the Advanced Research Projects Agency of the Department of Defense.

The President has assigned to NASA the development of the national space program. In this effort we are working, of course, in closest cooperation with all other elements of our Government, particularly with the Department of Defense. Our method has been to deal substantively with each of the major elements of the problem.

We have had to face up to the fact that we do not have available booster rockets sufficiently powerful to put into orbit or send on long journeys into space, the size payloads required to obtain the scientific information that is needed. This fact is made no more palatable by realization that today and for some time to come the Soviets have rocket boosters permitting them to send into space payloads heavier than we can manage.

We need a whole family of new rocket boosters and upper-stage rockets that, used singly or in combination, will give us the amounts of thrust we need to accomplish our missions in space. Because these boosters of varying capabilities are necessary for both civilian and military space programs, NASA undertook the development, with DOD, of an integrated program aimed at correcting this situation as soon as is humanly possible.

This program is based on a minimum number of rockets that will be used as building-block units in combination to meet expanding mission requirements. By midsummer of next year or shortly thereafter a new, second-stage rocket engine, when used with an Atlas, will permit us to put approximately 6,000 pounds of payload into orbit, or send about 1,000 pounds of payload as far as the moon. Another rocket engine now being developed, also for use as the second stage of vehicles using the Atlas or Titan booster, will have been completed by early 1961—little more than 2 years from now—which will enable us to put 8,000 pounds of payload into orbit, and send a 2,000-pound payload to the moon. NASA and DOD are working together in the development of these and other upper stage rocket motors.

Clustering existing big rocket motors will provide a first-stage booster having a thrust of 1½ million pounds by 1962. Engines of this cluster, procured under DOD auspices, are now in production, and the engineering on the total power package is well advanced. It will permit us to put 10 tons of payload into orbit and to send 2 tons of payload into deep space, for beyond the moon.

Development of a single-chamber rocket booster designed to deliver 1 to 1½ million pounds of thrust is also being pushed, to bring it to a stage of usefulness inside of 4 years. Within 2 years thereafter, we believe we will have learned how to cluster four of these giant rocket motors, to provide a first-stage booster with 6 million pounds of thrust. It will lift 75 tons of payload into orbit.

Another problem area—that of guidance and control—requires particularly heavy emphasis both in planning and implementation. Development of midcourse and terminal guidance systems is clearly also necessary. Above all, simplicity and reliability must be built into these systems. Our principle task at the moment is to acquire information about the space environment—and this calls for reliability in getting our instruments aloft, whenever and wherever we may want to make our measurements.

Still another problem—to expand our capacity for tracking and data acquisition—is now well on its way to solution. Additional stations will be established in this country and abroad. These stations may be manned, in some instances, by nationals of the countries where they are to be located. Still further expansion of these networks will be required, as time and our programs move forward together.

Perhaps the most difficult of our problem areas is our understanding of the capabilities of man himself in this new and exciting adventure into space. While much progress has been made, intensive effort is required to assure us that the men who volunteer for space flights possess the physical and mental capabilities to withstand the rigors of flight into space.

Whatever the problems we may encounter in this particular area, I find it difficult to believe that we shall fail in our efforts to surmount them.

To focus all of these research and development activities, and give them real meaning—to sharpen the determination with which we tackle these problems—we have undertaken Project Mercury, an attempt by this Nation to send man into space. Last month, NASA chose the McDonnell Aircraft Corp. of St. Louis to design and produce the prototype of a capsule to carry the man in this project.

Selection of the pilot astronauts has already begun. Initially, we will need a dozen men, chosen with greatest care from a group of volunteers. The group will be totally involved for many months in a program of rigorous training for the first orbital space flight.

Although this first orbital flight by our modern Mercury will surely be a pioneering venture, we are determined that the risks to the pilot will be no greater than those experienced during the first flights of a new, high-performance airplane. As in such airplane flights, the astronaut will play a vital role in the Mercury project. Repeated flights of the space capsule, first carrying only instruments, and later animals, will have tested and proven the practicability of the final phase of Project Mercury—manned satellite flight—before it is undertaken.

I have referred to one other aspect of Project Mercury as being, in my opinion, of the utmost importance. Sending man safely into space is an arm-stretching, mind-stretching undertaking that thrills every one of us, and demands from every one of us the very best we can muster. It is a focal point for all our energies, all our enthusiasms, all our determination. It will result in much earlier development of the technology needed for other difficult space missions.

Ever since I took this job as NASA Administrator—it is now 5 months ago—I have been saying that our space mission is so vital that we must carry it forward with the same sense of urgency we had during the war. I have made this comment so many times that some people might think that this phrase is becoming a cliche. But I know of no better way to say something that all Americans must believe and practice if we are to make maximum progress in this field.

We have the resources. We have the intelligence and the technical skills. We certainly have the necessary wealth. What we have to decide is—do we have the determination, the willingness to roll up our sleeves and get the job done?

As I see it, success of our national space program depends upon three factors: Time, money, and effort. We are behind the Russians on the time scale because they have bigger boosters. We shall have to spend large sums of money and work harder to attain our space goals as soon as we want.

This past year, we have shown we can move, but we have only started. The need is for urgently sustained effort for years to come. If our space programs are to be run on an off-again, on-again basis, zigging and zagging with the turn of every new year, then we'd better spend our money buying telescopes to watch the Russians pioneer in space.

The Chairman. Thank you, Doctor, for your very strong statement. The last part of the statement is the portion of it which impresses me most. The part in which you state that "we can whip this problem, given the time, money, and effort. What we need is the determination." I think the American people have the determination now. With your help we ought to be able to go ahead and catch up and pass the Russians.

I read your speech, Doctor, given before the Institute of Aeronautical Sciences in New York City. You begin that speech by referring to misunderstandings. I think you state there is a misunderstanding in the short-range program and in the long-range program of your administration.

Now, will you explain to this committee, what you have in mind by short-range program and long-range program?

Dr. GLENNAN. I would be very glad to, Mr. Chairman.

This misunderstanding came about, if I may be permitted to explain it, as a result of the use, shortly after the first of the year, of a very short clip from a recording that was made rather early in November last year when I had been on board about a month. And I was asked whether we had a long-range program and I said that this was one of our first tasks, the implication being that we did not have a long-range program. That indeed might be said to be partially true, because it takes time to develop a long-range program, and it is very easy to quibble about what is a short-range program and what is a long-range program. We have developed, and it is supported by our budget, actually, a well-rounded program for the next 2 or 3 years, including booster development, Project Mercury, space science activity and a variety of activities. We have undertaken, area by area, the development of a long-range program for the Nation which would extend over a period of 5 to 15 years.

This will be done in the areas of guidance, in the areas of payloads, in the areas of booster, in the areas of tracking, et cetera.

The CHAIRMAN. I have read a series of stories recently, Doctor, in reference to Mechta, I believe the Russians call it, the project which they sent up to probe the moon, but which they say bypassed the moon and went into orbit arount the sun.

I have also read that this was a hoax and that this missile did not bypass the moon, did not get into the sun's orbit. Have you any comment you would like to make in reference to that?

Dr. GLENNAN. Mr. Chairman, I would like to make a comment, then I would like permission for Dr. Stewart to comment on the technical aspects of this. It seems to me we do ourselves no great good by doubting the statements of our Russian competitors in fields of science when they say they have accomplished something. I have had personal experience in visiting Russia and seeing the results of some of their activities and I have respect for their scientific accomplishments.

I think that we can—we ought really not to kid ourselves about their abilities in the scientific fields. Now if I might ask Dr. Stewart to speak on this point.

Dr. STEWART. Mr. Chairman, I think the best way to answer this——

Mr. McCormack. Will you speak up so all members can hear?

Dr. Stewart. All right. I think the best way to answer this question is to describe some of the activities that went on at the Goldstone tracking station operated by the tracking laboratory, part of the NASA establishment, on the evenings after the Russian launching was announced. They had no prior warning, of course, so that there was no way to assemble the highly sensitive specialized equipment that is normally used for this kind of purpose.

However, they did hear the Russian announcements on the frequencies on which they were operated and they did assemble the best qualified commercially available equipment that was on hand and set out to try to see what they could do in the way of tracking the Russian vehicle.

The first night they had no particular success. During the Saturday following they worked over the equipment, found some areas where, in the haste to assemble it, things hadn't been done quite as well as they might and significantly increased the sensitivity.

On the second night they did receive signals over a period of several hours. They were not high quality signal reception, in that the signals were noisy, but they did have them good enough so that they could lock on intermittently for several hours.

If you take the information that was obtained this time with regard to the pointing angles of the big dish and plot it on a curve which corresponded to the kind of expected course you would have if the Russian announcements were indeed correct, there was reasonable verification.

So in view of this, I think that there is no reason whatsoever to doubt that the signals were indeed coming from a vehicle in free space following a path very close to what the Russians had announced.

Mr. McDonough. Will the gentleman yield?

The Chairman. I yield to my friend.

Mr. McDonough. Were the impulses which you received on the same cycle as those of the existing Russian satellite in orbit at that time?

Dr. Stewart. There were signals on several frequencies. The Russians announced their signals on several frequencies. Two or three of these, as I recall, were in the neighborhood of 20 megacycles, quite close to that of Sputnik III.

Mr. McDonough. Wasn't the tone similar to Sputnik III?

Dr. Stewart. As a matter of fact, this is one trouble they had. They several times thought they were tracking it and it turned out it was Sputnik III they were tracking. However, the particular items that I was referring to a few moments ago were on a much higher frequency, I believe it was 183.5 megacycles, which was not used on Sputnik III and which thus is rather independent of this particular question.

Mr. Fulton. Will the gentleman yield?

The Chairman. I yield to my friend from Pennsylvania.

Mr. Fulton. As a matter of fact, on Russia's deep probe shot, what really happened was that there was just a lack of signals after a certain point, so we don't know what happened to it. There is no verification, is there, other than an assumption, that that shot is now orbiting the sun?

Dr. STEWART. The period in which this tracking that I referred to was accomplished was the period in which the rocket was in the general neighborhood of the moon. Having come close to the moon in that short a period, I think there is no reason to doubt—it has to be orbiting the sun, it just can't do anything else.

Mr. FULTON. But we have no signals or no method of practical knowledge through instrumentation that such is the case?

Dr. STEWART. This is true, we have no further indication beyond that.

The CHAIRMAN. We have the last signal—the last signal we got from that missile was when it was in the vicinity of the moon. We assume that it is therefore orbiting the sun, because we don't know anything else.

Dr. STEWART. It would be very difficult to conceive of any situation which would permit a missile to come close to the moon, that fast, and not end up by orbiting the sun. This is what—it might have run into the moon, conceivably or be otherwise destroyed.

The CHAIRMAN. You don't think there has been any hoax put over on the American people.

Dr. STEWART. I have no reason to suppose that that is the case.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. Then the statement by an individual and several individuals that there had been Russian satellite or sputnik signals from a point beyond the moon—both in this particular case and on a previous case several weeks before—were not accurate?

Actually what they may have been were reflections from their sputnik which was already orbiting, is that not right?

Dr. STEWART. I am not familiar with the particular episode you are referring to, Congressman.

Mr. FULTON. There was a gentleman of some authority who came to Pittsburgh and stated that there had been signals received from outer space from a Russian instrument much before this particular instance we are speaking of. Was that not a case merely of the reflection of instrumentation signals from already orbiting sputniks?

Dr. STEWART. I am not familiar with the episode so I can't say. I might add, though, which may have some bearing on this report, that one of the greatest difficulties that the boys at Goldstone had in this tracking episode that I referred to was the confusion with various kinds of radio signals reflected from the moon.

Mr. FULTON. Possibly Dr. Glennan or Dr. Dryden know of that instance.

Dr. GLENNAN. I personally have no knowledge of it, Congressman Fulton.

Dr. DRYDEN. I have no knowledge.

Mr. FULTON. Thank you.

The CHAIRMAN. I have some other questions. I am going to ask you one or two more questions and then I am going to yield, because the time is getting late, but we will be in session this afternoon and

I want every member in the committee to have an opportunity to ask questions.

I want to ask you this: You referred to the urgency of the program, Doctor, but it is on a crash basis at this time?

Dr. GLENNAN. By a crash basis, Mr. Chairman, I presume you mean that all caution is thrown to the winds and we just spend money very, very loosely. The program is not on the crash basis under that definition.

The CHAIRMAN. Well, that is not quite my definition, but how close would you go, in the efficient use of money, and the proper use of public funds, toward putting this program on a crash basis? That is, an all-out basis to get something accomplished?

Dr. GLENNAN. We are doing just that, Mr. Chairman. We are working as diligently and effectively as we can. We have brought into the program substantial numbers of very able people. We have added to our organization, the Jet Propulsion Laboratory and other elements of other laboratories in other parts of the Government. I think—I would describe our activity as one being pursued with a very great sense of urgency.

The CHAIRMAN. Would you say it is a crash basis with the waste of funds absent, the efficient use of funds present?

Dr. GLENNAN. I would say it is under the very greatest head of steam we can muster at the present time.

The CHAIRMAN. When are we going to overtake Russia under that head of steam?

Dr. GLENNAN. I don't think it is possible for anybody to make a prediction as to when we are going to overtake Russia.

Mr. ANFUSO. Would you yield at that point?

The CHAIRMAN. I yield to the gentleman from New York.

Mr. ANFUSO. Mr. Glennan, you have made certain estimates as to when we can expect to develop certain rocket engines necessary in the exploration of outer space for both peaceful purposes and the security of our country.

Can you tell us what can be done to reduce the periods given by you? Are you saying now to the chairman and to this committee that nothing can be done to reduce those periods?

Dr. GLENNAN. Mr. Congressman, I think that we have those booster programs under as heavy a head of steam as we can get them. It would be possibly, I presume, I am sure of it, as a matter of fact, to perhaps have greater assurance that one would be successful in the programs we undertake by spending substantial sums of money beyond those which we have now programed. But to shorten the period is not, in my opinion, a matter that can be speeded very much.

Mr. ANFUSO. Mr. Glennan, under those estimates, by the time we reach them, Russia will be far ahead of us and they will be so far in front that we could never catch up the rate that we are going. That is the point that I am trying to get at. Is there anything that can be done by way of money, by way of manpower, to increase the pace that we are going in order to catch up with the Russians and finally pass them?

Dr. GLENNAN. Mr. Congressman, this program doesn't hinge, alone, upon our ability to get the heaviest possible payloads into space. We, I think, as a nation, are being deluded a little bit into pinning the total program on the thrust of the boosters that we use.

The program which we have underway today in acquiring new scientific information is the important program here; it is what information we can get back from outer space that is important.

We will have the boosters in time that will allow us to make multiple observations during a single satellite flight or a single polar flight. Now your specific question about trying to get a bigger booster in a shorter period of time, I would think it reasonable for me to state that we have laid on the program that we believe will get us with assurance the booster in the shortest possible time.

I would ask my colleague, Dr. Dryden, if he might want to comment on that.

Dr. DRYDEN. I think, Mr. Chairman, that the experience in this field has taught that it takes a certain amount of time to begin from scratch with an idea, and produce hardware of an assured performance. I can only repeat that we believe that we have set forward a time scale which can be accomplished with all the pressure that can be put behind it, that the use of more money could result in starting parallel programs, to give greater assurance of success, but we are not sure that this would reduce time.

In fact, the division of management over two programs would not guarantee that the time would be reduced.

Mr. ANFUSO. Mr. Chairman, I haven't gotten clearly an answer to any question and I would like to get it.

What this committee, I believe, wants to know, and what I think the American people want to know, what the entire free world wants to know is: Can we catch up with the Russians, and how fast? Now, if you can't give us an estimate as to what we can do now, will you please come back at some other time, as soon as possible, and tell us? I am sure that there must be something more that we can do. And if there is something more that we can do, I think that the American people want to know that, and they want to know it now.

Mr. MILLER. Mr. Chairman.

The CHAIRMAN. Mr. Miller from California?

Mr. MILLER. Dr. Glennan, isn't this just the old frustration that overtook us at the outbreak of World War II, when Congress appropriated money for 20,000 antiaircraft guns and the American people then said: "Where are the guns?" 2 weeks later.

Dr. GLENNAN. There is a certain element of that in it, Mr. Congressman.

Mr. MILLER. In other words, we are not dealing with a commodity on the shelf that money can go in and buy, isn't that true?

Dr. GLENNAN. That is quite true.

Mr. MILLER. So that it isn't a question of giving you more money, it is a question of letting you get these teams dovetailed and working together, the NACA, the Jet Propulsion Laboratory and so forth.

Frankly, I think the Army's failure to turn over its facilities to you is not contributing to the solution of this problem. Is that true, that getting the scientists together, getting them working together to eliminate those who are not making the contribution is the big thing that you are up against right now?

Dr. GLENNAN. There is—you are quite right. There is no other way to do this.

Mr. MILLER. And you are pursuing this program now to the best of your ability, and those associated with you, to do this?

Dr. GLENNAN. That is quite correct, sir.

Mr. MILLER. As far as I am concerned, the only thing we can do is put our faith in these people. I don't know of any other way that we can hope to meet the——

Mr. ANFUSO. Well, Mr. Chairman. May I say this: Believe me, it is not the absence of faith that prompted my questions. We must rely on faith, we must rely on you people. All that I ask, I am sure every member of the committee is interested in it, is, Are we doing the best we can? Can we do more? And if we can, let's tell it to the American people.

The CHAIRMAN. I have one more questions to ask now and then I am going to start alternating and I will ask the committee to bear with me until I get this question out of the way.

Doctor, you all testified that a million-and-a-half-pounds-thrust engine was 5 to 8 years away.

Now, you testified, I think, in the Senate, that such was possible in a shorter period of time.

Now, is it your idea that you are correct, and Dr. York is correct, or that in following the line of these questions—we could do something additional to speed this up and get a million, million-and-a-half-pound-thrust engine in a shorter period of time? That is what we really need, a stronger booster.

Dr. GLENNAN. To get heavy payloads into orbit we need greater thrust. The clustered engine utilizing pieces of hardware that presently exist is under development, design, development and construction, actually, at ABMA at the present time and one hopes that a flight article, that is a useful vehicle, will be ready sometime in 1962.

Now, the statement made by others relating to the single-chamber million-and-a-half-pound-thrust engine, where we, I believe have said we expect, within 4 to 6 years, not 5 to 8, but rather 4 to 6 years, will be available, I think here you are in this realm of speculation where honest men may differ.

I would like to get on the record one particular point: One of the things that has impressed me about the groups that we have brought into this organization and particularly NACA, is that they are groups of people who understand the word "integrity," and my purpose is to be just as factual and straightforward as I can and to maintain the integrity of NASA, in its dealings with you and with the American people.

And we are not going to go out on a limb and make promises that we cannot support. We may be wrong, but we will be wrong because we are honest in our estimates.

The CHAIRMAN. Mr. McCormack?

Mr. MCCORMACK. No, I will pass.

The CHAIRMAN. I understand Mr. McCormack has to go to the floor. So I am asking him at this time. If he has no questions at this time, I yield to Mr. Fulton——

Mr. MCCORMACK. I will ask one question which occurs to me. Of course, the propulsion power is a matter of primary importance.

Dr. GLENNAN. Yes.

Mr. MCCORMACK. You can't downgrade that.

Dr. GLENNAN. No, sir.

Mr. MCCORMACK. That is vitally important in sending up larger vehicles or satellites, instruments, call them whatever you want, and to get scientific knowledge that is not available now, even on the small satellites that we are sending up. How far ahead of us would you say the Soviets are in propulsion power, in the development—let me ask you this question: What propulsion power did it take to send their last instrument up into space?

Dr. GLENNAN. Here again I think that honest men differ in their estimates of this. Dr. Stewart, who can speak for himself, says that if they are very sophisticated in their use of these devices, that it might take only 250,000 to 500,000 pounds of thrust. Others have graded this up from half a million to a million pounds of thrust. I expect I am a little bit in this latter camp.

Now, we ought to be, as I think I have testified, in a position within some 18 months, 18 months to 2 years, to send into orbit the sort of payloads and even more than they presently have done.

Mr. McCORMACK. Where do you expect they will be then?

Dr. GLENNAN. I expect if they think it is important to increase their payloads, I would expect that they should have progressed as well. But it seems to me, Mr. McCormack, that the genius of this Nation has been in its industrial development, in its ability to get on with jobs of this kind. What has been done in this past year is little short of miraculous, from a standing start, in effect. And I have no hesitancy in predicting, if I may use that term, that we will close this gap. But not knowing what pace the Russians are operating at, except that I think they are diligent about it, I don't presume to be able to guess that we will be matching them, if indeed we should be matching them within 3 years.

Mr. McCORMACK. I will agree that we shouldn't follow them. On the other hand, you can't ignore what they are doing. Is that right?

Dr. GLENNAN. Under no circumstances.

Mr. McCORMACK. It is a relative situation.

Dr. GLENNAN. That is right, sir.

Mr. McCORMACK. Right across the board.

Dr. GLENNAN. That is right, sir; and in many other fields.

Mr. McCORMACK. Have you any expectation they will send a man into space this year?

Dr. GLENNAN. I just don't know.

Mr. McCORMACK. Beg pardon?

Dr. GLENNAN. I just don't know, sir.

Mr. McCORMACK. You wouldn't——

Dr. GLENNAN. I wouldn't put it past them.

Mr. McCORMACK. In other words, you wouldn't be surprised if they did?

Dr. GLENNAN. No, I don't think I would.

Mr. McCORMACK. Our program for that is several years off, isn't it?

Dr. GLENNAN. Yes, it is.

Mr. McCORMACK. That is all for now.

The CHAIRMAN. Mr. Fulton.

Mr. FULTON. Following Mr. McCormack's line of questioning, obviously when there are so many fields of various kinds, it is like comparing horses and rabbits and chickens and ducks and saying, overall, which is the best species or which is—or which is most advanced in the development of intelligence, is that not right?

Dr. GLENNAN. Yes, sir.

Mr. FULTON. So that it is not really logically or intellectually possible to say who is ahead between Russia and the United States, or the free world, unless you say what kind of a program is involved and what the object is, is that not right?

Dr. GLENNAN. That is right, sir.

Mr. FULTON. And on many programs we are very much ahead of them because we have very sophisticated instrumentation and have done a lot more than they have?

Dr. GLENNAN. That is right.

Mr. FULTON. While on others we have not emphasized weight and things of that type; is that not right?

Dr. GLENNAN. That is right, sir.

Mr. FULTON. Then can you give us some estimates on worldwide television, for example. How soon will we have that for peacetime uses or military uses?

Dr. GLENNAN. Mr. Fulton, could I ask Dr. Dryden to speak to that?

Mr. FULTON. And Dr. Stewart, anyone of you.

Dr. DRYDEN. This, again is a——

Mr. FULTON. If you would give your estimate first and then explain, because I have four questions on this point. You just give an estimate as to your programing, and then the explanation about it, really very briefly.

Dr. DRYDEN. A guess, and it is hardly more than a guess, would be 4 or 5 years.

Mr. FULTON. No, I want your estimate. How about you, Dr. Stewart.

Dr. STEWART. Well——

Mr. FULTON. I am talking of your long-range program, so I don't want guesses.

Dr. STEWART. To answer your question, I must do it in two pieces. First is the program we are starting which does call for some initial tests, hopefully within a year of this date.

On the other hand, there is a lot of work to go on and I think the 4- or 5-year number is a reasonable estimate of the time at which this might become of practical significance.

Mr. FULTON. So that experimentally within a year and practically within 4 to 5 years on radio and television worldwide communications?

Dr. STEWART. The problems are the same in both. With the approach we are using, the same equipment applies to both problems.

Mr. FULTON. Will that come earlier than the worldwide television programs?

Dr. STEWART. The particular approach which we are taking here handles both of them in the same manner and one will come just as quickly as the other.

Mr. FULTON. All right. On hurricane and weather predicting, how soon will you have that for a 30-day period in advance?

Dr. STEWART. This is a very long-term problem. It may be a very long-term problem.

Mr. FULTON. All right. Will you tell me the time and then explain?

Dr. STEWART. I would say there is a very real question as to whether 30 days may ever happen. I taught meteorology for a number of years through World War II.

Mr. FULTON. I have just finished a course of it in the Navy. So I am curious——

Dr. STEWART. And we used to discuss with the students the problems of forecasting and we recognized then that one of the greatest deficiencies of forecasting came from the fact that we had no detailed knowledge of the outer structure of the earth's atmosphere and then in addition we had defective knowledge of much of the surface conditions.

Mr. FULTON. To clear it up, we have already had some forecasting, because we have found some incipient hurricanes forming and told the people about them. How quickly will you put into practical use what you have now?

Dr. STEWART. Again an initial experiment is scheduled for the Vanguard.

Mr. FULTON. When is that?

Dr. STEWART. Within the month, we hope.

Mr. FULTON. So that we will very quickly be putting into practical use experiments on weather forecasting, particularly with regard to hurricane development, is that right?

Dr. STEWART. But the problem——

Mr. FULTON. Just answer the question, please.

Dr. STEWART. Yes, this is right.

Mr. FULTON. All right. Man in space—when will the X–15 be in actual flight operation under its own operation and not just a drop? When is that scheduled for? Give me the time and then explain.

Dr. DRYDEN. The X–15 is always dropped from an airplane.

Mr. FULTON. I understand that. But it is going to be without power to begin with.

Dr. DRYDEN. The first power applied is March or April; I don't have the dates in mind.

Mr. FULTON. Would you put that in the record?

(The requested information is as follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
Washington, D.C., February 20, 1959.

Hon. OVERTON BROOKS,
Chairman, House Committee on Science and Astronautics,
House Office Building, Washington, D.C.

DEAR MR. BROOKS: During the testimony given by personnel of the National Aeronautics and Space Administration before your committee, additional information was requested by Congressman Fulton on the X–15 flight schedule. The information answering these questions is as follows:

The tentative flight operation for the X–15 to be dropped without power is tentatively set for March 10; subsequently dependent on the satisfactory operation of previous tests, the first test of the X–15 for a power drop is tentatively set for April 1.

During the second day of the hearings, February 3, Congressman Fulton requested additional information with respect to NASA's budget and programs. That information has been collected and is enclosed herewith.

I want to express again my appreciation for the opportunity of informing the members of your committee of the program of the National Aeronautics and Space Administration and the progress made in connection with it.

Sincerely yours,

T. KEITH GLENNAN, *Administrator.*

Dr. DRYDEN. Yes.

Mr. FULTON. When is the drop without power?

Dr. DRYDEN. It is very shortly. It is scheduled very shortly.

Mr. FULTON. I understand it was scheduled for last Saturday. Has it been postponed?

Dr. DRYDEN. Yes, postponed for a time, yes.

Mr. FULTON. To what date?

Dr. DRYDEN. A couple of weeks, I don't remember exactly.

Mr. FULTON. All right. Will you put that in the record? All right. On man in orbit, what is the date you expect to put a man in orbit?

Dr. DRYDEN. When we are convinced we can get him back safely. It will be within a few years.

Mr. FULTON. All right. Give me the time, as a time. When do you program it? I am talking of your long-term programs, now, as to your timing.

Dr. DRYDEN. We program many orbital flights of the capsule. We will not at this time program the specific time when a man will go up there, because we must first be sure we can recover and locate the capsule, itself, with instruments, perhaps with animals, before we are willing to put a man in it. I cannot tell you when that will be.

Mr. FULTON. All right. The 6,000-pound payload you will have next year. Could the man be in there if you had these other things ready? Is that enough thrust to begin with and enough carrying capacity?

Dr. DRYDEN. We do not intend to wait for that. The booster in the first instance will be an Atlas booster.

Mr. FULTON. When do you expect to put a man on the moon in your long-range programs? Give me the date and then explain. By 1964, 1975, and could he be in the 2,000-pound payload to the moon, if other factors are favorable, by early 1961?

Dr. DRYDEN. 2,000 pounds to the moon and back would be very marginal to put a man in.

Mr. FULTON. So we really have to wait for the 10 tons of payload in orbit in 1962 and the 2 tons of payload in the deep space program?

Dr. DRYDEN. You will have to wait for probably 6 million pounds thrust to do this with assurance.

Mr. FULTON. Now, give me the date of that?

Dr. DRYDEN. 10 to 15 years.

Mr. FULTON. So that would be 1969——

Dr. DRYDEN. Before you venture onto the moon; yes.

Mr. FULTON. Before we attempt to put a man on the moon? Could you speed that up?

Dr. DRYDEN. We have a program which leads to this. There are many things that have to be done before you put a man on the moon, as you know.

Mr. FULTON. I am afraid if you get a man there, there is going to be someone already there, and if he asks if he can get on the moon, this man is going to say "Nyet" to him, he is not going to be able to get on.

Dr. DRYDEN. I don't think the problems are different anywhere in the world. We do have a program looking toward landings on the moon. We have not attempted to date this out month by month for 15 years. May I use an example? The very first satellite that we sent up discovered a new phenomenon in a world we never knew before, the existence of a radiation belt which would give problems to man passing through it and to instruments used in it. We didn't know this before. This changes the whole aspect of the problem. Because if a man stays there very long, we must provide him with adequate shielding. Before we provide him with adequate shielding, we must know the composition of this radiation, how much of it is soft X-ray, how much hard. Now we expect as we go out into space we will discover other things, which must be taken into account before we send this man to the moon. I don't believe anyone can give you a certain date 15 years in the future.

Mr. FULTON. Thank you very much, all I wanted was target dates. That is all.

The CHAIRMAN. Thank you. I am going to call on Mr. Miller next, because I am going to ask him to go over to get permission for this committee to sit while the House is in session.

Mr. MILLER. No questions.

The CHAIRMAN. Mr. McDonough.

Mr. McDONOUGH. Dr. Glennan, in reference to this question of a race with Russia, shouldn't we have to take into consideration the fact that we are operating as a democracy while they are operating as an autocracy or dictator-type of government in which they can demand from their scientific team certain target dates for things that we can't do in this country in the same manner?

Dr. GLENNAN. I think this is true, Mr. McDonough. We do believe, however, that once started, we really can move faster than they.

Mr. McDONOUGH. In other words, you are confident that we have the industrial capacity to produce the hardware once we write the specifications and know what we want?

Dr. GLENNAN. And the scientific talent to get on with the job.

Mr. McDONOUGH. Could you inform the committee your schedule of probing shots, a variety of them, that you have scheduled for this year?

Dr. GLENNAN. We have scheduled about 40 sounding rocket probes that will go some distance into space for a variety of environmental measurements.

We will probably launch as many as a dozen satellites or space vehicles, space probes, in this calendar year, and there may be double that number in 1960.

Mr. McDONOUGH. Now, what is the variety of the thrust used? Are these lightweight probes?

Dr. GLENNAN. These are all lightweight probes, using the boosters that are available to us at the present time, the Thor, and the Jupiter, and the Atlas in one or two instances.

Mr. McDONOUGH. Did you learn enough from the lunar probe that we sent up to—what was the maximum, 89,000 miles?

Dr. GLENNAN. 71,300.

Mr. McDONOUGH. Did we learn enough from that to be confident that the next shot will be successful? Was it a question of thrust or what was the failure?

Dr. GLENNAN. No. I think we learned a good bit from that experiment, and one always hopes that one can correct the things that went wrong. In this instance, as I recall it—well, I don't recall it very well.

Homer Joe, do you recall it?

Dr. STEWART. Yes.

The particular difficulty in the first probe was that the accuracy with which the rocket was held on course in its intial course in flight wasn't quite—it was off by about 3°.

Mr. McDONOUGH. Was that a fault of the guidance system?

Dr. STEWART. It was a fault of the guidance system.

Mr. McDONOUGH. In other words, do you believe with the next shot, with sufficient thrust, that you can orbit the moon and return to the earth?

Dr. STEWART. The most likely expectation is that it will pass in the neighborhood of the moon, if the equipment works properly. It will go into the neighborhood of the moon and go on into deeper space.

Mr. McDONOUGH. Are we in position to anticipate orbiting the moon and the return to space of a satellite?

Dr. STEWART. Return to earth?

Mr. McDONOUGH. Yes.

Dr. STEWART. That is a more difficult problem, and very likely will not be successfully accomplished. The first thing that we can expect to accomplish in this line is a flight similar to the one the Russians have just completed, going in the neighborhood of the moon and passing on into an orbit about the sun. That is the simplest deep-space mission to perform.

Mr. McDONOUGH. Do you have any other manned space vehicle under consideration at the present time, beyond the Mercury that you have now under contract with McDonnell?

Dr. DRYDEN. There are wind-tunnel experiments and planning gong on with respect to the followup vehicle; yes, sr.

Mr. McDONOUGH. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Teague.

Mr. Teague is gone.

Mr. Chenoweth?

He will be back at 2:30.

Mr. Anfuso?

Mr. ANFUSO. Mr. Glennan, to touch on a lighter subject, but nevertheless just as important, do you believe that the fullest exploration of outer space can make possible in the future a world of abundance so as to remove the basic causes of conflict and war?

In other words, what I am thinking of, for example, is this weather control. You probably can bring rain in desolate, dry areas and bring productivity there, isn't that correct? Isn't that all within the realm of future possibility?

Dr. GLENNAN. I think that our friends in the weather business would shudder a little bit at the use of the term "control." I think they might accede to modification. In this sense, yes, I think that one has a right to hope and probably to expect that there will come from this kind of activity benefits which would ease the tensions of the world.

Mr. ANFUSO. Now, in this exploration of outer space for both peaceful purposes and for the security of our country, do you think that we ought to get the cooperation of scientists from any country in the world, provided they meet a security check?

Dr. GLENNAN. I think we ought to cooperate with scientists the world over in this activity.

Mr. ANFUSO. I believe I have heard you say, and I think you said it in one of your speeches, that you believed in the free exchange of research information and the pooling of ideas wherever possible.

Dr. GLENNAN. This is the way science makes fastest progress.

Mr. ANFUSO. Now let me ask you this: Do you foreclose the possibility of working with the Russians?

Dr. GLENNAN. Not at all, sir.

Mr. ANFUSO. I would like to ask this question because Mr. Khrushchev made a very fantastic remark that he saw no angels in the heavens.

Do you see any challenge to God in this venture to outer space?

Dr. GLENNAN. No, sir.

Mr. ANFUSO. May I ask you why this McDonnell Aircraft Corp. of St. Louis was selected to design and produce the prototype of a capsule to carry man in this project?

Dr. GLENNAN. Under a very well-developed selection system in which we separate out the technical qualifications from the business qualifications of the competing concerns, boards of selection sat for as much as a week, as I recall it, in reviewing the various proposals made. They finally then reported to another board, which was to sit over them, and that board finally, to me, to Dr. Dryden, and the selection of McDonnell Aircraft came out of that process.

Mr. ANFUSO. Now, my final question, Dr. Glennan, is by way of making a statement and clarifying my own position on this committee.

I sincerely believe that the American people want to know the facts. I sincerely believe that the American people at the present time are not getting all of the facts. I sincerely believe that the American people are not realizing the danger that this country is in, the danger that this free world is in. And because I strongly believe in that, I believe that we must do somethiing to arouse the American people, and the best way I know of arousing the American people is by telling them in cold facts, "Yes, we are in danger of being destroyed. We are in danger of destroying New York Harbor. We are in danger of destroying the west coast. We are in danger of destroying the greater part of the wealth of America." And I believe that if you told that to the American people, the reaction would be so great that they would rather spend $10 billion in addition, now, than to have to spend $100 billion later on, which may get us nowhere.

Do you agree with me or do you not, Dr. Glennan?

Dr. GLENNAN. I would have to plead to that question that the information on which one bases one's evaluation of danger of the type that you mentioned is perhaps not wholly available to me. I think it is clear, however, that people only fear that which they don't know. Thus, I find myself in agreement with you that to the very greatest extent possible people ought to know facts.

I spoke a moment ago about the aspect of this organization of mine which is most precious to me, its integrity. I cannot compromise my own principles. If I don't know a fact, I can't tell it. I can give estimates based upon information available to me, and I am quite willing to do this when I have enough data or facts on which to make an estimate. But otherwise I shall have to plead off. I still feel that fundamentally your statement is correct that people should know as much fact as we have.

Mr. ANFUSO. Would you agree with me, Dr. Glennan, that the paramount question of the day is not balancing the budget but rather getting this country on a safe path for the security, not only of this country, but for the entire free world?

Dr. GLENNAN. I am not in a political job, sir.

Mr. ANFUSO. We don't expect you to answer that question politically, sir.

Dr. GLENNAN. Well, I have always found that I have to pay my bills, and the day I don't pay my bills, I suffer some sort of a loss of standing in the community.

I think that in a time of prosperity, such as we are experiencing, one has to look at problems of balancing the budget. But I will never place my country in jeopardy in taking that look.

Mr. ANFUSO. In other words, if it was necessary to spend more money, to make our country secure, then you would overlook the idea of balancing the budget; you wouldn't classify that as the most important issue of the day?

Mr. McDONOUGH. Will the gentleman yield to me?

Mr. ANFUSO. Yes.

Mr. McDONOUGH. I think some of the questions you are asking Dr. Glennan could best be answered by the military men coming before the committee.

Dr. Glennan represents a civilian scientific organization. And the danger of destroying the west coast or New York Harbor is a responsibility of the Defense Department.

Mr. ANFUSO. I wasn't particularly referring to that. I was referring to the general picture.

Dr. Glennan is connected with a very important part of this whole picture, and I say this right now, gentlemen, that if need be, I am perfectly willing to vote more money, if that will make our country more secure than merely attempting to balance the budget.

Mr. FULTON. Would the gentleman yield?

Mr. ANFUSO. Yes; I will.

Mr. FULTON. I believe Dr. Glennan's field is the budget in his own agency. From what he has stated, it would seem that he would run a businesslike agency first. Secondly, I think the question is: Will you, if the public and country's security require it, come in and ask us for more money for programs which you have already evaluated and programed?

Dr. GLENNAN. On that you may be certain that I will.

Mr. FULTON. Thank you. That is all.

Mr. ANFUSO. I am satisfied with Dr. Glennan's statement before, that he places security above balancing the budget.

The CHAIRMAN. Now, gentlemen, it is past 12 o'clock.

Here is the program of the committee: We have a heavy schedule of witnesses today, and every day of this week through Thursday. We plan not to meet Friday, but to let the Members get away for a long weekend, if they wish to. We plan to meet in the afternoons to finish up our daily list of witnesses. We plan to meet this afternoon at 2:30.

I would like to ask the witnesses, however, who have come this morning, will it be satisfactory that you return at 2:30? Can you make it back then?

Dr. GLENNAN. Yes.

The CHAIRMAN. At that time we will give every Member an opportunity to ask questions.

If there is no objection, we will adjourn until 2:30 this afternoon.

(Whereupon, at 12.13 p.m., the committee recessed, to reconvene at 2:30 p.m. of the same day.)

AFTERNOON SESSION

The committee met at 2:30 p.m. in open session in the caucus room, Old House Office Building, Hon. Overton Brooks (chairman) presiding.

The CHAIRMAN. The committee will come to order.

Off the record.

(Discussion off the record.)

The CHAIRMAN. At the time we recessed we were calling the roll of those members that had questions they wished to ask. I think I had missed Mr. Teague of Texas. He told me he was leaving.

Mr. TEAGUE. Mr. Chairman, I would like to pass for awhile.

The CHAIRMAN. He passes for the time being.

Mr. Chenoweth?

Mr. CHENOWETH. Yes; I would like to ask some questions. Are you ready for me now?

The CHAIRMAN. Yes.

Mr. CHENOWETH. Dr. Glennan, as a new member of this committee, I wish to state I was very favorably impressed with your statement this morning and your appearance. I never had the pleasure of meeting you before. You are going into a realm which of course is entirely new to many of us on this committee, particularly those who are new members.

The people of this country of course are very much concerned and interested about this program.

Just what would you say we are seeking to accomplish now in this space program? We have lived on this planet for a number of years now pretty well, got along all right. What is it we are seeking to do out in space? What is to be accomplished? Is it a military objective? Is it something that is going to add to our own welfare and happiness at home, or is it just an experiment? Are we speculating as to just what is out there? Just what are we seeking to accomplish? I know you could express that in a few words much better than I can, and I know you know what I mean. I would appreciate just a brief statement from you.

Dr. GLENNAN. Yes, Mr. Chenoweth. Man has always sought information about the unknown and, basically, these explorations which we will undertake should return to us a great deal of knowledge about the cosmos, about the space about us, and ought to make possible the enlargement of our knowledge about our own world as we look at it from outside of the atmosphere. Whether or not the information which we obtain is used for destructive or constructive purposes is largely up to us as individual citizens in the expressions we make of our own wills.

Mr. CHENOWETH. There seems to be great stress laid on the fact that Russia is ahead of us; they are putting up something heavier than we are putting up.

Does that have any real significance so far as our security is concerned? Or is it just a matter of them perhaps having achieved something a little faster than we have, something perhaps they have worked harder at and perhaps have placed more emphasis on it. Is there anything that we should really be concerned about from a military or security standpoint?

Dr. GLENNAN. I think in the broad aspects of the national security which involve our posture, worldwide, our relationships with our friends or near friends, that any achievement which we may make becomes important in the maintenance of our national security. Whether or not this is a field in which tremendous values lie in a military sense, I think I would rather leave for the people from the Military Establishment to answer.

Mr. CHENOWETH. You don't care to go into the military aspects of it?

Dr. GLENNAN. No. I think they are better able to do this. This is a responsibility of theirs. What we are seeking in the way of information undoubtedly will be useful to them, as indeed we hope the results of some of their experiments will be helpful to us.

Mr. CHENOWETH. Now, then, there has been some stress laid upon the question of who is going to put a man on the moon first. What significance would that have, as to who put a man there first? Would it be of any particular value to either Russia or ourselves to do so?

Dr. GLENNAN. I think from the standpoint of national prestige it would have very substantial value.

From the standpoint of the scientific evidence or scienitfic information returned, it would have value.

Mr. CHENOWETH. I would like to ask the Doctor about the organization that you head.

I think you mentioned here in your statement that some 8,000 scientists, engineers, and supporting personnel were taken over from NACA.

Dr. GLENNAN. That is right.

Mr. CHENOWETH. Is that your staff at this time? Has that been augmented or increased in any way?

Dr. GLENNAN. No. We have augmented that staff somewhat.

As I recall it, our planned figure for the end of this fiscal year, June 30, is about 8,900.

Mr. CHENOWETH. How much?

Dr. GLENNAN. About 8,900.

Mr. CHENOWETH. Yes.

Dr. GLENNAN. And one must remember as well that we have acquired under contract now a staff of some 2,300 at the Jet Propulsion Laboratory, approximately half of whom are involved in—engaged on space projects at the present time.

Mr. CHENOWETH. Where is that laboratory?

Dr. GLENNAN. That is at Pasadena, Calif.

Mr. CHENOWETH. Pasadena.

While we are on that subject, Doctor, I would be very much interested, and I am sure other members of the committee, particularly those who are new on the committee, as to just where your operations are at this time.

This chart was prepared by you, was it? [Indicating.]

Dr. GLENNAN. Yes, sir, Mr. Congressman.

Mr. CHENOWETH. Would you just give us a brief summary?

Dr. GLENNAN. I would be glad to do this.

I believe it is planned that another member of the staff is to give you a complete briefing on that in a few moments.

Mr. CHENOWETH. I see. It would be all right if you would rather wait for him.

I think that is all the questions I will ask.

The CHAIRMAN. Mr. Osmers?

He is gone.

Mr. Sisk?

Mr. SISK. Mr. Chairman.

Dr. Glennan, I would like to direct a few questions here, which I would like to have Dr. Dryden, possibly, join in.

They go back to some of our past experiences.

I am sure, Dr. Dryden, you will recall the feeling of a great many in the development of the legislation to prepare for the new agency or to make it possible to have a new agency, that I had some concern, as others did, about whether or not we were simply changing the name of a group of people and dressing it up a little bit, but we would be doing business as usual, at the same old stand. I think you and I discussed that at that time.

Now, after having some months of experience in the new NASA, I would like both of you gentlemen's appraisal as to what progress you feel we have made from a comparative standpoint. Have we actually accelerated our program? Was the intent and objective of our establishment of the new agency, has it been achieved, or at least are we going in the direction of achieving that objective?

Dr. Glennan, first, if you would make some comments. I realize that is rather broad. But to me that becomes the important thing here.

Dr. GLENNAN. Mr. Sisk, as I understand the situation, and what you are after in setting up this law, I think we have made very great progress, actually, toward the objectives which you were hoping to attain. The development of a headquarters staff organization, capable of directing this program, I think, is well underway. We have been in business, as I think I indicated this morning, 4 months, I having been in Washington, myself, 5 months, as of the ninth of this month.

We have managed in this short period of time to develop the specifications for and select a contractor for and negotiate a contract and sign a contract for the development of the million-and-a-half-pound single-chamber rocket engine.

I believe this set somewhat of a record, as a matter of fact, in negotiating and placing under contract an activity of this kind which is to involve the expenditure of perhaps as much as $200 million before we are finished.

We have organized and got under way Project Mercury, under the very highest priority.

These are but two examples of the progress that I think has been made.

Now, it is a little self-serving in my sense to answer this question. I think that Dr. Dryden, who has been on both sides of this line of demarcation, October 1, last, perhaps can give you a different answer or a better one.

Mr. Sisk. I might say that I appreciate your comments, Dr. Glennan.

I am glad to have an opportunity to hear your comments on it, Dr. Dryden, because, as head of NACA, where you did an outstanding job, and I know a lot of progress was achieved, I am curious as to your evaluation now as to what extent the new agency has enhanced our opportunities in this field.

Dr. Dryden. Yes, Mr. Sisk.

I am the first one to say that the NASA is a quite different organization from NACA in a number of respects, in the kind of work that we have to do, and the urgency with which we have to do it. The existence of NACA made it possible to start with a number of people from the NACA staff. Project Mercury was organized in speedy time because we could dip into the existing NACA staff of qualified people. We added to them some new people. We secured a detail from the services of experts in the aeromedical and space field who are located at Langley as members of this task-force group.

In other words, we did not wait for a permanent organization of the other side of the space agency; we started this project immediately.

Dr. Glennan has already referred to the million-pound rocket engine. We inherited a study contract. We held a competition, evaluated the results, and signed a contract, not a letter of intent, but the definite contract has been worked out and signed. This in very fast time. In a similar way, on Project Mercury a competition was held for the capsule, and this contract, which is in process of negotiation, will be signed very shortly.

The existence of the people in NACA, plus the existence of people in Vanguard, who were transferred, plus the very capable staff of the Jet Propulsion Laboratory, have enabled NASA to get off with a running start in the space development and operational projects which are a completely different activity from the supporting research and development carried on in the NASA research center. This program is being backed up in the research, of course, by the work done at the centers. In a similar way, on one of the high energy booster stages, a task force at the Lewis Laboratory was very quickly organized to back up the program in this field.

We also have been able to pool together teams to study the national booster program, teams on which people from defense were also participating.

We pooled together teams to study a coordinated plan for the additional tracking facilities needed for the programs that are coming up.

I feel that, being able to start with a pool of people, and with facilities, has very greatly accelerated the time in which we could get such a program moving.

One other remark: The bulk of our program is being carried forward by contracts or agreements with existing agencies. We have placed orders with ABMA for a considerable number of boosters. They will be responsible for doing engineering for us, and the firing of those boosters. In a similar way, we have made agreements and allotted funds to the Ballistic Missile Division, for projects which use the Thor and Atlas boosters.

And, in general, we are relying on contracting with existing organizations rather than building up a very great force of people within the Government, on the Government payroll. We are building up a large enough personnel to monitor these projects, to integrate them and direct them in a national program. But the carrying out of the program will be done by the resources of the country.

Mr. Sisk. Then to sum up, Dr. Glennan and Dr. Dryden, you both feel, then, that much was accomplished in the establishment of the new agency and that it is, in essence, carrying out the objectives which were before us at that time?

Dr. Glennan. Yes, sir.

Mr. Sisk. Now, Dr. Dryden mentioned that you were contracting with ABMA at the present time. I wanted to ask about your relationship with ABMA, and the overall operation at Redstone. Is that working successfully at the present time, in your opinion?

Dr. Glennan. Yes, I think it is, Mr. Sisk.

The orders which we have placed there for supporting activities, supporting certain of the space probes and the firings which will be necessary in the program of Project Mercury, are going very well, indeed.

Mr. Sisk. The reason I asked that question, Dr. Glennan, is that I found myself in somewhat disagreement at the time discussions were underway about this transfer, which you recall, last fall. I had a little disagreement with my colleague from California. I was somewhat concerned about that, over the possibility of any interference with the Von Braun team. Of course I was very interested to learn, as I understand it, a satisfactory working arrangement has been worked out.

Now, I will go one step further: Do you feel that under the proposal which you made last fall that it could have been advantageous to NASA, over and beyond what the present relationship is?

Dr. Glennan. Yes, Mr. Sisk. I felt it at that time, I still feel it just that same way. But we believe, I believe, and my organization, I am sure, believes that we should not interfere with any of the Nation's missile programs and the Defense Department, Department of the Army, stated that they did have missile programs with which there would be interference were this transfer to be accomplished.

Under those circumstances they volunteered the fullest cooperation in undertaking particular tasks for us, and we agreed—I agreed that this was a reasonable solution of the situation at the time.

There is to be a review of the effectiveness of the operation within a year from the date of the signing of those documents which I recall as being December 3, last year.

Mr. SISK. Then along the same line, have you, so far, in the operation of your agency, developed any controversies or any overlapping jurisdiction where you feel it might cause substantial problems with reference to ARPA's operation? I am asking this in light of attempts, of course, to write into the enabling act, which set up your agency, provision for settling any of these types of controversies that might arise. I am curious to know whether they have been tested at the present time and if so how those provisions are standing up under the test of time.

Dr. GLENNAN. I say, Mr. Sisk, it has not been necessary to call into operation any of the provisions in the law. We have been able to sit down and discuss with the officials in ARPA and Mr. McElroy any of the problems which seemed worth discussing, where there was—I don't like to use the term "controversy," but let us say there was some difference of opinion as to the organization which should carry out this or that job.

Much of this, of course, was considered at the time of the preparation of our budgets, because we did coordinate our budgets so that these things did not appear as duplications and we were able without too much difficulty to allocate prime responsibility in every instance.

Some of those——

Mr. SISK. Let me ask you this, Dr. Glennan: As I understand, the X–15 program is under the jurisdiction of your agency, is that right?

Dr. GLENNAN. The technical direction of it is under NASA, and the research activities which will be undertaken with the X–15 will be under the direction of NASA, using both our own test pilots and some from the services.

Mr. SISK. As I recall the roll-out of the X–15 was last October. Which, by the way, I was happy to have an opportunity to observe. So far, what has been accomplished, if anything, with the X–15?

Dr. GLENNAN. The X–15 has not actually been flown, as yet. There have been test flights with the mothership, just testing the configuration that is necessary to carry the X–15 aloft.

The actual first drops, which will be unpowered drops, will take place within a 2-week period, as I recall it.

Dr. DRYDEN. May I just add, Mr. Sisk, that this time has been taken with ground testing of the systems, running the powerplant on the ground, the installation of instrumentation. In other words, the project has been moving forward in ways that do not appear on the surface, but are necessary before you put the machine into the air.

Mr. SISK. I have no criticism, Dr. Dryden, of the fact that it has not been flown. I was just curious about how that program was coming along. I have one other question in connection with that.

Now, primarily what do you hope to attain in the way of an objective in the overall space program from the X–15? I mean you must have one, two, three, or four objectives in mind.

Dr. DRYDEN. Yes.

Mr. SISK. As to how it can affect or how it can aid in, as I understand, the attempt to man a space vehicle?

Dr. DRYDEN. Yes. This was a research airplane to explore about three specific problems. In the first place let me say that this is a winged vehicle in which we hope to be able to control much more accurately than we can in Project Mercury the exact point of landing. In other words, it has wings so that there will be more control of the path after reentering the atmosphere. This airplane has a capability of pulling up steeply and sort of jumping out of the atmosphere to a fairly high altitude.

One of the problems which this will check out is the control of the attitude of the airplane, where there is no air to work on the usual aerodynamic surfaces. It is fitted with a reaction type control system which will be needed on all space vehicles, whatever their future character. So there will be some experience with piloting a machine in which the attitude is controlled by reaction controls.

Second, of course, it gives a period of weightlessness for man of 8 or 10 minutes, whereas heretofore we have only been able to get about 1 minute or this order by taking an airplane in a parabolic path so there will be somewhat longer experience of this unknown factor of weightlessness. The third and most important one will be the checking out of our techniques, dealing with the problem of aerodynamic heating.

It would be possible with this airplane to get into attitudes and situations where safe reentry is not possible. We must work within the flight envelop of this, to study the boundaries and conditions under which we can hope to get such an airplane back safely into the atmosphere. For this purpose, it is of course instrumented with a great many temperature measuring devices, with attitude measuring devices, so that the whole performance of the airplane is recorded on the ground.

These are the—I might include in the control problem the stability problem, because this is also involved.

The X–15 is really not a space vehicle, except in the sense that it can jump into space for a brief period and then reenter again.

Mr. SISK. Just one concluding question, and this has to do with quite a bit of the discussion, I might say, that has taken place this morning, and of course, quite a bit of the discussion that we hear and read about in the newspapers and on television and so on.

I do not know quite how to word this to get it over: I am interested in the relationship between our advancement in propulsion, thrust, as against our progress in fields that I might call payload. In other words, we are all concerned, of course, as has been indicated and is indicated every day, about the rapidity with which we are progressing.

Now, I think that certainly there is a relationship, that there is no point in being way ahead, in other words having a 6 million pounds thrust engine, unless we have something to put into it, or some useful purpose to put it to. Now I am curious to know as to the relative progress in the field of need for thrust as against our ability to produce the thrust?

Dr. Dryden. Yes. This is a problem, of course, with which we are very much concerned. At the present time the payloads are in the nature of scientific instruments. The heaviest scientific payload is perhaps a large telescope for astronomical purposes, which may be in the order of a ton or something more.

The really large payloads are needed as we go to much more difficult scientific machines, and, in particular, when we involve man in the process.

If I may illustrate this a little bit, the same cluster that we were talking about might put 10 tons or so in orbit, would put perhaps 1,700 pounds in soft landing on the moon. The more and more weight that you want to put far out into space, the bigger the booster you have to start with, because you have to lift the extra stages. You have to provide, in some cases, retrorockets to slow the vehicle down, to make it orbit about a planet.

In the case of the moon, a soft landing on the moon, we think it is not too early and we have some plans to start work on apparatus that you might put on the moon, what kind of measurements would you make on the surface of the moon. You have to have a payload that does something for you, analyzes the rock, sees what the atmosphere is there, shows you a picture back, or what not.

The development of such a payload is quite a complicated task. You can do a certain amount of testing of such a payload by dropping it out in New Mexico, perhaps, and trying these automated devices out.

Now when you come to include man, then you have all the problems of his sustenance, of landing him softly, getting him off again. These are the kinds of missions for which we need the very large payloads. In general, the ones which go to large distances in our solar system and the ones which involve man. These are the two—well, I might also mention communications.

In some of the more advanced communication satellites we will want a fair weight of complex apparatus, repeaters. We will have to deal with the supply of power that will last for a considerable time, because you do not want to have to replace this satellite every 6 months. This means the development of probably nuclear reactors as a source of the power, the devices for converting this into electrical energy to operate all the gadgetry in the payload. All of these things will take weight.

If you put a man in, I have already mentioned shielding which runs up the weight. These are the kinds of payloads for which we need much greater weight.

Mr. Sisk. That, of course, was the point I had in mind, that there is certainly a relationship. Thrust alone is not the whole story.

Dr. Dryden. Not the whole story.

Mr. Sisk. In other words, we have got to have some need for it and be able to put it to useful purposes or else just building a 10 million pound thrust engine wouldn't be worth a great deal unless we could recover something and we had the adequate type of payload to go along. That is all.

The Chairman. Mr. Van Pelt.

Mr. Van Pelt. No questions.

The CHAIRMAN. Mr. Mitchell.

Mr. MITCHELL. Dr. Glennan, first I would like to commend you on your attitude in your statement concerning our not underestimating the present progress and the potential progress of the Soviet Union in this field. I feel as you do, and I feel that both Doctors Stewart and Dryden—they have not stated it—but I think they reflect your attitude, as I do. I think it certainly would be dangerous for the American people and the Congress to underestimate at any time their potential.

Now, in line with—somewhat in line with the questions of Mr. Sisk, is there a priority project? Do you have a single priority, top priority project in existence at this time? Is thrust a prime project at this time?

Dr. GLENNAN. Project Mercury is really the project on which we lavish our top priority, and following that the million-and-a-half pound single-chamber rocket.

Mr. MITCHELL. That leads me to another question. You have mentioned the propulsion by a cluster of rockets. Now what is the peculiar advantage or particular advantage to the single-chamber type propulsion rather than the cluster?

Dr. GLENNAN. The ability to cluster it, finally, to get substantially larger thrusts.

The clustering today of the rocket engines available to us will give us propulsion in the neighborhood of 1 million to 1.5 million pounds of thrust. The single-chamber rocket will give us a million and a half pounds of thrust when it is fully developed. We cluster four of these and get 6 million pounds of thrust, and this is the type of thrust that will be needed when you send a man to the moon and get him back.

Mr. MITCHELL. Earlier today, I believe in our chairman's questioning, you stated that there was no—you are not in a crash program. And I have the same definition of a crash program as the chairman. I am not referring to a large amount of money being wasted. Do you have the money that you need?

Dr. GLENNAN. At the present state of our development I think we have the money to carry this program through on an urgent basis, which I take to be the basis which you really meant. And I have stated in the Senate hearings that if, as this program moves—and it is moving very rapidly—there appears to be a need for additional money, I shall have no hesitancy in going through the proper channels to ask for that money.

What I have said to you, of course, presumes that the Congress will approve the budget which was presented late last month.

Mr. MITCHELL. In line with that, Doctor, are there any projects that you—and I would like to have the comment of either of the other gentlemen, both to your right and left if they so see fit—are there any projects now that may be in the drawing-board stage that you feel should be be put into effect if you had the money today?

Dr. DRYDEN. Well, I cannot think of any one, again emphasizing that we received this approximately half a million dollars that is before the present Congress. We have provided for initiating the projects that we feel have reached this point of practical initiation.

Now, before the year is over I am sure that we will be moving on into others. As the program develops, each of these projects that we start is going to cost more than it is costing this year. The availability of money is a time phase thing. We have to believe that you gentlemen will supply the money as it is needed, as the program develops, rather than saying that we can put in the bank once and for all the amount necessary for the next 5 years.

Mr. MITCHELL. Then do I gather, Dr. Dryden, at this point you feel that there is no project that you need additional money for?

Dr. DRYDEN. I think that is a fair statement.

We of course are receiving proposals from very many sources for almost identically the same projects. This is what is happening all around.

We are trying to, and have, picked out—take Project Mercury, I think you will find a very general agreement among all contractors who studied it, that the quickest way to get a man into space is through the use of the so-called drag-type vehicle, that it would take much longer to develop a winged vehicle. Therefore we have taken Project Mercury, made this the highest priority, we went through a competition to select the design and carry forward.

Mr. MITCHELL. In submitting your budget did you eliminate any proposed projects that you felt might expedite this program?

Dr. DRYDEN. We certainly did not eliminate any that we had proposed. I think there have been—there are proposals from outside for a very great many projects. They differ very little in objectives from the objectives of the projects that we have initiated.

Mr. MITCHELL. Do you feel the same way, Dr. Stewart?

Dr. STEWART. Yes.

The CHAIRMAN. Mr. Baumhart?

Mr. BAUMHART. No questions.

The CHAIRMAN. Mr. Quigley? Mr. Bass? Mr. Hall?

Mr. HALL. Mr. Chairman.

Mr. Glennan, I am David Hall from North Carolina.

The President in his statement made the statement that each one of these vehicles cost approximately $35 million. I have seen reports from other sources that would lead me to believe that the cost of these vehicles did not come near that figure.

Now, has your agency or administration set up any means for the dissemination of information to the public?

Dr. GLENNAN. Oh, yes. We have a public information office, if that is what you mean.

Mr. HALL. Yes.

Dr. GLENNAN Yes, sir

Mr. HALL. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Riehlman?

Mr. RIEHLMAN. General—Doctor, rather, Glennan. I am used to talking to military so often that I forget we have civilians before us on the committee.

I am vitally interested to know what arrangements you have with the three military services to coordinate this whole effort that we are vitally interested in?

Dr. GLENNAN. There is provided in the law a committee known as the Civilian-Military Liaison Committee, which is chaired by Mr. William Holaday, on which sit four members of staff. These are our top staff. Dr. Silverstein, Dr. Dryden, Mr. Stewart, Mr. Abbott. Mr. Hyatt is an alternate. And a representative from each of the armed services and from the Secretary's Office, also.

This Committee meets upon the call of the Chairman and they will provide a channel for interchange of information. But this isn't all.

We have established 13 committees which are advisory to NASA in a variety of fields, technical fields. Here again military members sit on those committees, as well as representatives of educational institutions and industrial companies.

Finally, at all levels through the organization, the working levels in these programs, our people are interchanging daily information on the programs.

Mr. RIEHLMAN. Do you feel that you are getting a free flow of information from the military side as to their progress?

Dr. GLENNAN. Yes, sir.

Mr. RIEHLMAN. And the military side is getting complete information from your organization as to what your scientists are developing?

Dr. GLENNAN. We are trying to; yes.

Mr. RIEHLMAN. And that there is no particular duplication of activity?

Dr. GLENNAN. I think that there is no particular duplication of activity which we have not agreed to be useful duplication.

Mr. RIEHLMAN. Does your organization have any direction at all over the military's activities in its research and development program?

Dr. GLENNAN. Not direction over them. They do carry out some of our research and development activities under our contract or under our technical direction.

Mr. RIEHLMAN. Your activities have not interfered in any way with the three military services?

Dr. GLENNAN. No, sir.

Mr. RIEHLMAN. And their activity.

Now, in respect to some of the questioning carried on by my colleague, Mr. Sisk from California, which is of terrific importance, that is the construction of engines to give us the thrust to put a payload into orbit. Naturally that is true when you are looking at it from your side and your activity, and that is for the welfare of humanity, that is where the big payload apparently comes in.

Now, is it not true that that is not as important when we come to thinking on the military side, if you would like to express your views one it, in carrying a payload of destructive power?

Dr. DRYDEN. The primary interest in the million and a half pound engine is for the space projects. We do recognize that this engine may find military applications, in military space projects. For that reason we have requested and there has been assigned to our organization an Air Force officer who will work with us in the direction of that project, to see that any military requirements are incorporated in the program.

Mr. RIEHLMAN. One other question, Dr. Glennan: You have something over 10,000 people under your Administration's activities. Where are they located throughout the United States?

Dr. GLENNAN. Mr. Siepert, of our staff, is going to give you a brief statement on the location of our particular organizations. But you will find them in California, in Ohio, in Virginia, and in—yes; I think those are the three principal locations.

Mr. RIEHLMAN. All right. Thank you very much.

The CHAIRMAN. Mr. Wolf.

Mr. WOLF. Mr. Chairman, Dr. Glennan, I am Leonard Wolf, of Iowa. Right or wrong, some people are saying what the Russian Communists really have in mind is to get us so wrapped up in this conquest of outer space that we are letting our national security lag. I am wondering if you might have an opinion on this at this time?

Dr. GLENNAN. I think I have said earlier——

Mr. WOLF. You have discussed it, I know.

Dr. GLENNAN. Yes. That we were attempting to be very careful to avoid interference with military programs, particularly in our discussions about the ABMA situation.

Mr. WOLF. You don't think there is any danger of part of our military security budget, then, being diverted to the space agency, in this question of the balanced budget?

Dr. GLENNAN. I think not.

Mr. WOLF. All right. The other question I would like to ask: You suggested that you have an education agency. Does your agency feel, in other words, to tell your story to the people, does your educational agency feel that the right story is being told to the people, or is this thing being glorified and glamorized out of its true proportion?

Dr. GLENNAN. Our NASA Public Information Office is under very strong compulsion, particularly from me, to make certain that what is being given to the public is factual information, it is not blown up and made a ballyhoo.

Mr. WOLF. Apparently I didn't make myself clear. I realize you are giving them the information you want to give them with all due respect to the press, but are they getting all that they should have?

Dr. GLENNAN. Through our organization, I think so; yes.

Mr. WOLF. The last question I have to ask has to do with Radio Free Europe and Voice of America broadcasts: Are we attempting through our broadcasting agency to tell these people behind the Iron Curtain of our accomplishments?

Dr. GLENNAN. Yes, sir; the United States Information Agency is working very closely with us on matters of that kind.

Mr. WOLF. I realize the Russian propaganda agencies are working in reverse. I realize the Communist agencies are working very hard to try and portray us as conquering space as a military thing and it is blown up out of its true proportion. I wonder if this is being done?

Dr. GLENNAN. I think we are working that out. USIA has a man detailed in our Public Information Office for just this purpose.

The CHAIRMAN. Mr. Karth?

Mr. KARTH. Mr. Chairman, Doctor, I am Joe Karth, from Minnesota. I have a question. I was a little surprised this morning in answer to a question by the gentleman from New York, Mr. Anfuso. He asked you whether or not in your opinion, if there was a greater amount of money spent, whether you felt this whole program in the field of space could be speeded up. If I recall correctly your answer was that you did not think so, you felt that it would create a paralleling program or paralleling programs, and that it would lead to, oh, giving some insurance for accuracy or correctiveness, rather than speeding it up. Is this your opinion, sir?

Dr. GLENNAN. At the present state of the art, that is my opinion; yes, sir.

Mr. KARTH. The reason I ask is because I find this quite different from the old concept that we have been led to believe, and accept as being true, in the theory of economics. I have always been of the opinion that competitiveness, for example, breeds creativeness, and that it motivates, shall we say, technological advancement—that it breeds inventiveness.

And so it seemed to me that if more money were spent, probably allowing for competitive parallel agencies, that this would, to some degree, advance and speed up quite considerably—depending upon the degree, of course, it was entered into—the answers to the questions, which we apparently do not have at the moment.

Dr. GLENNAN. We do have competition in some areas of our activity. Competition for the development of payloads, competition in certain areas of research where we do pursue parallel courses. We believe in competition, but I think the manner in which I took the question, at least, was: Can you really make a great deal more speed if you spend a great deal more money? Was that what you had in mind?

Mr. KARTH. As I understand it; yes.

Dr. GLENNAN. And my answer was that I did not think, with the present state of the art, that we would make a great deal more speed, that we would shorten the time scale very much, but that undoubtedly, if we did have a lot more money, we would initiate parallel programs which, if one failed, the other might have a chance of success, so that indeed we were then buying insurance at substantial cost.

Dr. DRYDEN. May I amplify this a little? I think in most of our previous discussions we have been thinking about major projects rather than the underlying research. We do propose to put more money into the research underlying advances into space, and to work in connection with electrical propulsion systems and to perhaps get more people interested in celestial mechanics, in some of the basic side of communication problems.

I think in this area we do want to get a lot of people working, but when we come to the major projects which cost several hundreds of millions of dollars, we do not see that putting another $2 million in a parallel project will really reduce the time.

Mr. KARTH. Doctor, one more question, please, in this same vein; If a paralleling agency could, on occasion, improve on the accuracy or eliminate mistakes, because we are delving in a field with so many unknowns in it, even the finding out, shall we say, or the discovery of a mistake, one particular mistake in this tremendous field of unknowns, couldn't that on occasion save you actually months and months of time?

Dr. DRYDEN. Yes. But I think we get this sort of thing in the elements that go to make up this major project. There will be many approaches to the heating problem, to materials problems, to research on combustion, and it is up to us, who are managing the project, to see that all of this information is brought into the agency carrying on the development.

But we do not see that a parallel complete engine development would necessarily reduce the time.

Mr. KARTH. Then you feel that the paralleling projects that have been entered into by the military services, for example, have been of no material value?

Dr. DRYDEN. I don't know of any paralleling projects.

Mr. KARTH. Haven't the military on occasions been all interested in the same project and one has come out with it substantially sooner than the other?

Dr. DRYDEN. You are thinking of other areas.

Mr. KARTH. Yes, sir.

Dr. DRYDEN. For example, where there may be three or four airplanes developed to meet the same requirement.

Mr. KARTH. Yes. Do you feel that this competitiveness on the part of the military has substantially led to a better airplane much sooner, much faster for the U.S. security, than we would have had, had there been no competitiveness between the military?

Dr. DRYDEN. I think it is very difficult to answer this question in compelte detail. I think it has given the opportunity to pick out the best of two or three designs, but I think that attention paid to the perfection of one design has paid off.

May I go back to the days of NACA? Our philosophy was that we would furnish all the information we could to all of the people who were entering the competition. After one of them had been selected or two of them had been selected, the job was to make that entry just as good as one could possibly make it by putting in all the resources that we had and other people had into the project.

I am not sure that the airplanes were gotten quicker by having several of them going at once. You can argue that you had the chance to pick the best two or three.

Mr. KARTH. Thank you.

The CHAIRMAN. Dr. Hechler?

Mr. HECHLER. Thank you, Mr. Chairman.

Dr. Glennan, I want to commend you for the statement that you made this morning on the freedom of scientific inquiry. I thought it was beautifully put.

Now this is the question I would like to ask you: In a very broad way and without getting into specifics, would you evaluate the usefulness of material which NASA is able to glean from Russian scientific journals?

Dr. GLENNAN. I think, if I may, I would ask Dr. Stewart, who has been quite close to this sort of thing, to give you an opinion on that.

Dr. STEWART. In some ways it is a little early to really give a definitive answer to this question.

The Russians, and ourselves, have agreed under the IGY program, for example, to have a complete exchange of the scientific information gained in the satellite launching programs.

In both our program and theirs, large quantities of information have been obtained and they have released some of it and we have released some of ours. It is factually true that neither of us have yet had time to release all of the information.

The information I have seen from the Russian work is good, good quality information. I know my friends that attended the last meeting in Russia in August or September, I have forgotten which it was, felt that the exchange of information was valuable and worthwhile.

Mr. HECHLER. Here is what I am getting at in asking my question: How do you feel about the scope and intensity of the review we are doing on Russian journals? Do you believe that we have adequate translation facilities and is the information of sufficient value so that we should step up such a program?

Dr. STEWART. There are new people doing these things every few months.

We do not yet have the capacity so that these Russian informations are translated and evaluated within a matter of weeks. But on the other hand they are generally available within a matter of months. We are doing fairly well in this problem.

Dr. GLENNAN. I would like to add to that answer if I may. I was very pleased in this field to see the President about 6 weeks ago, as I recall it, maybe 8 weeks ago, accept a proposal made to him by the Science Advisory Committee to enlarge our activities under the leadership of the National Science Foundation, indeed to provide in the budget some money to see to it that this coordination was undertaken and I believe that we are moving rather rapidly, as a matter of fact, into the field of enlarging and increasing our ability to translate and disseminate that information rapidly.

Mr. HECHLER. Thank you, Dr. Glennan. I am sure that this committee would be interested in hearing of any handicaps that you might suffer in securing information from Russian scientific journals in order to aid the progress of your work.

Dr. GLENNAN. Thank you, sir.

The CHAIRMAN. Mr. Daddario.

Mr. DADDARIO. Dr. Glennan, in the eighth page of your report, your prepared statement, you refer to asking the Army to transfer a portion of the Army Ballistic Missile Agency at Huntsville to your program. Then you say that this would provide the necessary ground testing and assembly capability.

Now what have you done to replace this type of program since the Army did not allow you to take that under your wing?

Dr. GLENNAN. We have not done anything as of the present time. This decision was entered into on December 3 of last year, and we are attempting to determine whether or not the use of such facilities under contract is a feasible thing to do.

Mr. DADDARIO. Well, you also, in that same paragraph referred to this, you say, "Such a transfer would give us an imaginative, competent engineering and design group capable of serving in the planning and executing—". What have you done to fill in that gap of imaginative, competent engineering personnel since that was not given to you by the Army?

Dr. GLENNAN. At the present time we are using people from our own staff and have not really moved into the area of developing a parallel organization. We are working with the ABMA people in the hope that we can get assistance that will be valuable to us in this area. But it isn't quite the same as having on your own staff, part of your own team, a group of people that are participating in the development of the total program of the agency.

Now we have to come to a decision on this matter within the next few months, as to which way we are going.

Mr. DADDARIO. Well in the last part of your statement you referred—you used three words as being those needed to build up your program, you say time, effort, and money.

Dr. GLENNAN. Yes.

Mr. DADDARIO. Would it appear that there should be another word added "cooperation"?

Dr. GLENNAN. I think we have reasonable cooperation at the present time, sir.

Mr. DADDARIO. Well then——

Dr. GLENNAN. I think your suggestion is——

Dr. DRYDEN. May I add just one detail to sharpen this up a little bit?

Mr. DADDARIO. Certainly.

Dr. DRYDEN. What we are doing is this, when we have a program which involves Jupiter, we can use the facilities of ABMA with this function. We cannot use those same people to do the same thing if it happens to be Thor or Atlas. We then use the facilities of the Ballistic Missiles Division. Neither one of these agencies are a part of NASA. Therefore, some people on our staff have to ride herd on these groups to see that what they do is consistent with the overall program.

In other words, we are meeting this function by contracting with some more limited supervision from members of the NASA staff. Now what we would like to obtain is a group within NASA who would deal with all of these programs in the same little group, regardless of what the particular booster happened to be.

Mr. DADDARIO. Would you feel that this has accelerated your program in the same fashion that it would have if this request had been acceded to? Are you as far ahead now as you would have been if this had been placed within the scope of your own program?

Dr. DRYDEN. I think we, timewise, are as far ahead. The problem is one of integration. The problem is: Can we use a contractor to an agency to supervise the execution of the contract? This is the problem, you see.

Mr. DADDARIO. Well, in both of these positions you use the word "necessary". Then the Department of Defense decided that its Army Ballistic Missiles Agency special talents were necessary to them. Who decided which of these two necessities took priority or which necessity became unnecessary?

Dr. GLENNAN. Our agency believes that the missile program should take priority over the space program. Thus, the determination on the part of the Secretary of Defense that the facilities, capabilities of

ABMA should be retained in the missile program, seemed to us to be conclusive. We do not have means of determining for ourselves, nor would it have been our business.

Mr. DADDARIO. Do you believe, even though it is too early to say, that this arrangement will be adequate, that you will be able to carry out your own capabilities——

Dr. GLENNAN. Sir, we have to.

Mr. DADDARIO. With this cooperative type of program, rather than setting up one of your own?

Dr. GLENNAN. It is too early to say. We have to keep this under continual scrutiny. We must not let anything stand in the way of our moving ahead just as fast as we can, other than interference with a missile program.

Mr. DADDARIO. And this decision will not be made for a year; is that correct?

Dr. GLENNAN. We are to come back to the President and the Space Council within a year to report on the extensiveness of the success of this collaboration and cooperation and with any other proposals that may be necessary. Should I find it necessary before that time to again raise this question, you may be certain I will.

Mr. DADDARIO. If you feel that within the year that this should be done, then you will speak up.

Dr. GLENNAN. I will, sir.

The CHAIRMAN. Mr. Moeller?

Mr. MOELLER. Yes, Mr. Chairman.

Dr. Glennan, turning briefly from the technical and the administrative side of this, this morning you were asked a question by the colleague from New York, I think, whether or not you felt that the program as you have it projected here might invoke the displeasure of Almighty God or in defiance of God's will, to which you, in my opinion, rightly, answered "No."

However, I notice on page 4, the last paragraph, in fact, line 24 of that page, you speak of some of the objectives or some of the goals or the aims, and you inject the spiritual, the satisfaction of the spiritual. Would you be inclined to elaborate on that for just a moment, please? I must protect my professional colleagues here, too.

Dr. GLENNAN. I understand, sir. I think in this sense, that I am speaking of the releasing of man from any bondage here on earth, that he is a creature with a mind of his own and instead of just worrying about, "Can we have a man flying around in space?" What we are trying to do, it seems to me, and what will be the great gain of this program, will be the release of man from another set of fetters, his being bound to terra firma here.

Mr. MOELLER. I didn't get that last statement.

Dr. GLENNAN. His being bound to the earth, to the ground, as it were.

Mr. MOELLER. Well, there is then the probability that through your operation here we might develop a new system of philosophy, maybe, a new system of theology, could all of this come out of this, too?

Dr. GLENNAN. I don't believe I am competent to comment on that, sir.

Mr. McDonough. Will the gentleman yield to me at that point?

Mr. Moeller. Yes.

Mr. McDonough. There have been observations made by the top theologians of the world, and I have read the opinions of many of them, that the searching for this additional scientific information in the universe is an obligation of mankind, and it is not by any means a violation of the fundamental dogma of any religious belief.

Mr. Anfuso. Would you yield to me? I might add to that, that Pope Pius the 12th, last year, issued a similar proclamation.

Mr. McDonough. And similar expressions have been made by other leaders of church groups and great theologians.

Mr. Moeller. To that, Mr. Chairman, I would like to add this: I think there is, in the realm of possibility here, much to add to the strength and the conviction that religion already holds with respect to some of the areas of which the church, Christianity in particular, speaks about. So I am looking forward to the day when you are going to bring further information that we will be using in years to come.

Mr. McDonough. Will the gentleman yield further. I think this is a contradiction of the statement that was made and referred to this morning by one of the members, that Khrushchev sent his satellite into orbit beyond the moon and they didn't find any angels up there.

The Chairman. Well, if you ask me, I don't think Khrushchev or any of those Communists were looking for angels.

Mr. King?

Mr. King. Dr. Glennan, I am David King from the Second District of Utah.

A few days ago Dr. Levitt of the Fels Planetarium, as I recall, is quoted as having said in a national press release that within 20 years it would not be too much to imagine that we may not only have reached the moon, but we might be living there, transplanting segments of our society and existing under a large plastic dome, and grinding up rock and other materials to be found on the moon to create atmosphere, water, and so on and so on?

Would you care to comment on that?

Dr. Glennan. I leave this to my scientific colleagues.

Dr. Dryden. Well, I mentioned before, that the landing of man on the moon is forecast somewhere 10 to 15 years from now. I think that Mr. Levitt, whom I know very well, is letting his imagination roam somewhat very far into the future.

I don't think we have enough information about the chemical composition of the moon to know whether it is feasible to set up an economy there independent of materials supplied from earth.

I think that the first travelers to the moon are going to have to depend on their—make sure that they take the oxygen and water and food that they need from earth, that they have a system of resupply.

As we know more about what is on the moon, it may be possible to work out procedures for living off the land, so to speak. But I don't think we have enough knowledge now. We know so little about the surface of the moon and its chemical composition. There is no trouble building vacuum chambers, no trouble with air conditioning on the moon, I think, provided we have sources of energy. But whether we can depend on the local sources of chemicals and power and so on, we just don't know at the present time.

Mr. KING. Then you are saying at least it is conceivable?

Dr. DRYDEN. It is conceivable.

Mr. KING. That within the foreseeable future there might be colonization on the moon in sufficient quantities that it would have some practical impact on our own economy and our own sociological problems, rather than just as a novelty?

Dr. DRYDEN. I don't know how we can tell. If we look back to the time that Jules Verne wrote his books, they, of course, were pure fiction. Now we think he was a wise forecaster; he knew what was coming. It may be that Mr. Levitt is quite as competent of looking into the future and predicting as Jules Verne was. But I think the reasoning is on the same basis as Jules Verne wrote his story. They are the enlightened imagination of a man trying to figure out how certain problems would be solved.

Mr. KING. Thank you. I am quite interested in our educational preparation and background for this great challenge that you have been telling us about today.

I would be interested in knowing whether you feel that your program has been handicapped in any way by a lack of available scientists, of such depth and preparation and scholarship and aptitude and so on, that can step into this program and fulfill their function? Or, on the other hand, do you feel that there may be a basic lack in the training that our young people are being given and that you feel the impact of that lack when they step into your program?

Dr. GLENNAN. I think it is reasonable to say that we haven't felt any real difficulty as yet. But looking years ahead, I am not so certain. The important activities of this country in the next 20 years are going to involve more and more scientists and technologists in almost every field. And I doubt very much—as you know, I spent some time in the educational field—I doubt very much that we are paying as much attention to the development of well-trained scientists and technologists and, indeed, specialists in every field, as we should in this country.

Mr. KING. You would look with favor, I take it, then, in a renewed emphasis on the scientific program as we have heard so much about in recent months?

Dr. GLENNAN. I would.

Mr. KING. Thank you.

The CHAIRMAN. Mr. Roush?

Mr. ROUSH. Mr. Glennan, I am Ed Roush from the State of Indiana.

Mr. King here took my question, but I want to pursue it one step further. It seems that we must have an emphasis right now on our present program, and in the course of my reading over the weekend I read in one of these many reports that have come across my desk where there are many scientists outside of this country who can do nothing more than theorize and think about these problems, because their own country, because of its economic conditions, cannot permit them to build the hardware and to perform the necessary experiments.

I am wondering if there is anything in our program at the present time to utilize the talents of these great scientists of the free world.

Dr. GLENNAN. We have set up an Office of International Cooperation and are in the process of staffing that office, having already brought on board a director. We hope to engage in that kind of activity and bring into our program both in their own countries and by bringing some of those people over to this country, and enlarge the number of scientists that are active with us, particularly to bring some of the foremost scientists effectively into the program.

Mr. ROUSH. Going back to a question which was asked of you many times this morning along the same line: When will it be that we will be able to bring those scientists to America and utilize those talents? How soon?

Dr. GLENNAN. I hope that we will have before this year is out more than one international cooperative program.

Mr. ROUSH. Thank you, sir.

Mr. WOLF. Dr. Glennan, I asked about this question of education before. You told me that you have a committee or commission or some other agency that handles these things——

The CHAIRMAN. Gentlemen, I will say this in response to Mr. Osmers there: He asked to be called on. We do have—I don't want to rush anybody, but we have five more witnesses this afternoon.

Mr. KARTH. This calls for a yes or no answer.

Mr. WOLF. This calls for a yes or no answer.

The CHAIRMAN. We are going to let you go ahead. In the future I suggest that as we call the turn, the members get into their questions quickly. We will continue until 5 o'clock this afternoon, and everybody will get a chance.

You have a question?

Mr. WOLF. Is your education agency working with the high schools and the colleges to kind of demonstrate to them, to help them to better prepare themselves to step into the space field?

Dr. GLENNAN. This, sir, is a problem that the National Science Foundation is covering rather well. We, ourselves, have not entered into this activity. We really haven't had much more than enough time to get the office reasonably well organized.

Mr. WOLF. Thank you.

Mr. ROUSH. I have no further questions.

The CHAIRMAN. Mr. Osmers, we missed you in the first go-around.

Mr. OSMERS. Mr. Chairman, I will not ask Dr. Glennan my customary question about what will happen if the moon shoots back. [Laughter.]

However, I wanted to go right to the subject of education. It was 5 years ago this month that I introduced a bill in Congress providing for scientific scholarships, which was ignored and scoffed at by educators and Congressmen alike.

I want to ask you a question that seems quite appropriate: On the first day of the hearings of this committee we are in a "Wright brothers" era, at the moment, as far as space is concerned, and several of the latter questions here have pecked away at the subject.

I would like to ask you whether in your opinion, Dr. Glennan, or Dr. Dryden, does the United States at the primary, secondary, and university level, have a scientific education program sufficient to meet the needs of the Nation?

Dr. GLENNAN. My answer is "No."

Dr. DRYDEN. Same.

Mr. OSMERS. That is my only question, Mr. Chairman.

The CHAIRMAN. Now, Mr. Ducander, do you have any questions?

Mr. DUCANDER. Mr. Chairman, in the interest of getting along I think I ought to waive these questions. We have so many—you only read the witnesses on the first page there.

The CHAIRMAN. Oh, I read five on the first page and I quit. But that is true, there are two on the second page. We had better plan on running a little longer than 5 o'clock.

Do you have a question?

Mr. FULTON. Yes.

In the case of the exploration of the moon or other heavenly bodies, Dr. York said to us:

> In the case of the Moon, a manned exploration could take place in just about 10 years (perhaps in as little as 7, if a very high priority were placed on this goal). In the case of Mars and/or Venus, manned exploration will not take place until a few years after 1968 (but could perhaps be done in just about 10 years if a very high priority were placed on this goal).

Will you correlate to me your statements that it would take 10 to 15 years to get to the Moon with Dr. York's statement that we would shortly after 10 years be on even Mars or Venus?

Dr. DRYDEN. This is a case where honest men differ.

I think in the publication put out by the committee, Dr. York's estimate is the lowest of any in there. There were others who estimate longer than the time that I gave.

Mr. FULTON. How much money would you need to get us on a program that would make us even with Russia on our space program, and probably leapfrog them in these various fields?

You see, my point is this: I want to be the firstest with the mostest in space, and I just don't want to wait for years. How much money do we need to do it?

I might say to you further, when you were before us, Dr. Dryden, on August of last year, I was one who said let's get along with these programs. In fact, Jerry Ford and Mr. McDonough had spoken then too about the necessity of getting moving on the programs, and we thought you would immediately come here for more money from us as of January 7, didn't we, Mr. McDonough? And there has been no request yet.

Dr. DRYDEN. Yes, there is a request——

Mr. FULTON. Likewise, I understand you haven't even programed all your present budget. You have $200 million not even programed.

Dr. DRYDEN. There is a request before you for $50 million supplemental.

Mr. FULTON. But isn't there $200 million that you haven't yet programed or planned on your current budget?

Dr. DRYDEN. I know that we have programed—we have obligated something more than $200 million in 4 months. And I think that this is a fairly fast rate of obligation.

Mr. FULTON. Out of $408 million?

Dr. DRYDEN. Out of $300 million.

Mr. FULTON. Isn't the total——

Dr. GLENNAN. That is next year's budget.

Dr. DRYDEN. You are talking about next year's budget.

National Aeronautics and Space Administration

Summary, research and development programs, fiscal year 1959

[In millions of dollars]

NASA total	Allotments	Obligations		Unobligated balance	Pending commitments	Uncommitted balance	Expenditures		Unexpended balance
		1959	Total				1959	Total	
Aircraft, missile, and spacecraft research:									
Support of NASA plant	0.39	0.28	0.28	0.11	0.02	0.09	0.16	0.16	0.23
Support of JPL plant	8.16	8.16	8.16	----	----	----	.60	.60	7.56
Research contracts	5.50	.11	.11	5.39	----	5.39	----	----	5.50
Scientific investigations in space:									
Sounding rockets	5.00	1.90	1.90	3.10	1.12	1.98	----	----	5.00
Earth satellites	43.95	21.15	21.15	22.80	3.52	19.28	----	----	43.95
Lunar probes	20.02	4.35	4.35	15.67	2.50	13.17	----	----	20.02
Deep-space probes	16.00	10.84	10.84	5.16	3.55	1.61	.40	.40	15.60
Vanguard division	25.54	23.80	23.80	1.74	.07	1.67	1.04	1.04	24.50
Satellite applications investigations:									
Meteorology	3.40	----	----	3.40	1.15	2.25	----	----	3.40
Communications	4.70	2.16	2.16	2.54	1.00	1.54	----	----	4.70
Space operations technology:									
Manned space flight	37.66	17.38	17.38	20.28	11.24	9.04	----	----	37.66
Space rendezvous techniques	----	----	----	----	----	----	----	----	----
Space propulsion technology:									
Solid-fuel rockets	.70	----	----	.70	----	.70	----	----	.70
High-energy-fuel rockets	7.00	3.03	3.03	3.97	.23	3.74	.06	.06	6.94
1,000,000-pound-thrust single-chamber engine	12.00	12.00	12.00	----	----	----	----	----	12.00
Nuclear rocket engines	8.50	1.90	1.90	6.60	----	6.60	----	----	8.50
Space engines	.30	----	----	.30	----	.30	----	----	.30
Auxiliary power units	.50	----	----	.50	----	.50	----	----	.50
Space systems technology:									
Advanced vehicle systems	.50	----	----	.50	----	.50	----	----	.50
Booster recovery systems	.50	----	----	.50	----	.50	----	----	.50
Orbiting space laboratories	----	----	----	----	----	----	----	----	----
Supporting activities: Tracking and data acquisition	4.30	.87	.87	3.43	.47	2.96	.02	.02	4.28
Total, research and development	204.62	107.93	107.93	96.69	[1] 24.87	71.82	[2] 2.28	2.28	202.34

[1] Plus $9.460,000 since Jan. 31, 1959.
[2] Estimated total, fiscal year 1959, $52,000,000.

Appropriation summary, fiscal years 1959 and 1960

	Fiscal year 1959				Fiscal year 1960, regular estimates
	Appropriated			Supplemental estimates	
	NACA	NASA	Total		
Salaries and expenses	$78,100,000	$5,000,000	$83,100,000	$3,354,000	$94,430,000
Research and development	----	50,000,000	50,000,000	20,750,000	333,070,000
Construction and equipment	23,000,000	25,000,000	48,000,000	24,250,000	57,800,000
Total appropriations	101,100,000	80,000,000	181,100,000	48,354,000	485,300,000
Transfers from Department of Defense	----	----	154,619,532	----	----
Air Force $57,800,000					
ARPA 67,200,000					
Navy (Vanguard) 25,541,282					
Army (JPL) 4,078,250					
Total obligational authority	----	----	335,719,532	48,354,000	485,300,000

Research and development programs, fiscal years 1959 and 1960

Page No.	Program	Fiscal year 1959		Fiscal year 1960 regular etsimate
		Allotments	Supplemental estimates	
	Aircraft, missile, and spacecraft research:			
205	Support of NASA plant	$338, 800		$16, 670, 000
226	Support of JPL plant	8, 156, 500		8, 156, 500
230	Research contracts	5, 500, 000		8, 200, 000
	Scientific investigations in space:			
232	Sounding rockets	5, 000, 000		10, 000, 000
235	Earth satellites	44, 000, 000		61, 800, 000
238	Lunar probes	20, 021, 750		24, 043, 500
242	Deep-space probes	16, 000, 000		22, 500, 000
245	Vanguard program	25, 541, 282		
	Satellite applications investigations:			
250	Meteorology	3, 400, 000		15, 000, 000
253	Communications	4, 700, 000		13, 000, 000
	Space operations technology:			
256	Manned space flight	37, 661, 200	$20, 750, 000	70, 000, 000
260	Space rendezvous techniques			3, 000, 000
	Space propulsion technology:			
262	Solid-fuel rockets	700, 000		3, 000, 000
264	High-energy-fuel rockets	7, 000, 000		17, 000, 000
266	1,000,000-pound-thrust single-chamber engine	12, 000, 000		30. 200, 000
268	Nuclear rocket engines	8, 500, 000		8, 000, 000
271	Space engines	300, 000		3, 000, 000
274	Auxiliary power units	500, 000		3, 000, 000
	Space systems technology:			
277	Advanced vehicle systems	500, 000		1, 500, 000
279	Booster recovery systems	500, 000		1, 500, 000
281	Orbiting space laboratories			2, 000, 000
284	Supporting activities: Tracking and data acquisition	4, 300, 000		11, 500, 000
	Total, research and development	204, 619, 532	20, 750, 000	333, 070, 000

National Aeronautics and Space Administration programs and duration

Program	*Duration*
Sounding rockets	2 years for funded projects.
Earth satellites	Do.
Lunar probes	Do.
Space probes	Do.
Meteorological satellites	Do.
Communications satellites	Do.
Manned space flight	3 years for funded projects.
Solid fuel rockets	Continuing research and development studies.
High energy fuel rockets	Do.
1,000,000-pound rocket	4 years.
Nuclear rocket engine	Continuing long-term research and development.
Space engines	Do.
Auxiliary power units	Do.
Advanced vehicle systems	Do.
Booster recovery systems	Do.
Tracking and data acquisition	Yearly support of continuing program.

The Office of Space Flight Development has made commitment plans since January 31, 1959, for additional projects totaling $9.46 million. These are not reflected in the January 31, 1959, financial report.

The CHAIRMAN. May I say to the gentleman at this point that we have 4 pages of questions here that have been handed to me all relating to the Bureau of the Budget and to the budgetary figures. I want to put them into the record at this point. I do not think we can get answers to them at this time because it will just clog up the hearing at this point, but they should appear in the record and if there is no objection, I am going to ask that they be placed in the record at this point. They come from Mr. Fulton.

(The documents referred to are as follows:)

Mr. Chairman, yesterday, the representatives of the National Aeronautics and Space Administration appeared before this committee. There was not opportunity to pursue in detail some of their budget planning, detail which I believe is important to this committee if it is to discharge its responsibilities to the Congress. We were shown a chart which showed the overall level of budget requests, but it did not directly answer how much is going to be spent to speed our space program with the proper urgency.

I request that the chairman direct the Administrator of NASA to submit for inclusion in the record following yesterday's testimony sufficient detail of his program planning that this committee can have a clear picture of what NASA is up to. I want to know not only the amount which has been authorized and appropriated, and what is under request, but also what has been spent, what has been obligated, and what has been programed though not yet obligated. I want to know whether any funds have not yet been programed. I believe we should be told not only how much has been obligated, but in what years these obligated funds are to be spent. Obligation for long-term projects is necessary, but it can also be cover for stretching out programs to hold down expenditures.

Mr. Chairman, I think we should ask NASA to give us a listing of their major projects which they have programed, and what the current and expected future financial status of each of these projects is. I want to have them supply a list not only of the projects they are currently undertaking, but also a list of those projects which have been set aside for later consideration, or which have been abandoned for lack of funds. I want this list of projects underway and list of those set aside identified as to whether they are short run or long run in character. I want to see the justifications which have been developed for each of these programs.

It is my understanding, Mr. Chairman, that at a later date NASA will be coming back before this committee for authorization hearings. But meanwhile, I think the record should show this information I have requested so that the committee may have an adequate advance opportunity to familiarize itself with the plans and programs of NASA. I do not believe we are in any position to judge the adequacy of the NASA plans until they are presented in such form to make possible adequate analysis by the members of the committee.

Mr. Chairman, I request we specifically receive breakdowns of the research and development expenditures and plans.

FISCAL YEAR 1960

How much for research and development.
How much of this for astronautics?
Compare with fiscal year 1959.
How much for 1959 and 1960 is—
(*a*) programed?
(*b*) contracted for?
Breakdown for development of—
(*a*) propulsion.
(*b*) guidance.
(*c*) tracking stations, and so forth.
(*d*) man in space.
(*e*) medical—psychological.

The CHAIRMAN. I would like to ask you a question that I let go by in the interest of saving time.

First I would like to ask you this, Doctor—by the way, a colleague of mine mentioned this, but I had a question on it.

What about this McDonnell Aircraft contract? I have read a lot about it. Don't you think you ought to tell us something about it? Why is this company the recipient of that contract? What makes it qualified to handle it?

You covered it. You mentioned it this morning. But you didn't answer it in detail like we would like to have you do.

Dr. GLENNAN. I think if you want a full detail on it, we would be very happy to provide this for the record.

There were some 35 companies, I believe, that were invited to bid on the specifications. I think, as I recall, there were 11 that finally sent in proposals. These proposals were then divided as between the business end of it and the technical end of it, and we set up teams in each of these areas to evaluate the proposals of each of the 11 companies.

Those two teams, when they came up with their evaluation and rank-ordered the bidders, made their report to a third team which, again, put together the results of the first two teams. They then brought their findings to Dr. Dryden and myself and gave us their best evaluation of the proposals. And Dr. Dryden and myself, after about 2½ hours of question and answers on the work of these men, which had taken perhaps 15 man-weeks of effort, made this decision.

The CHAIRMAN. Now, was McDonnell rated the top one on your list?

Dr. GLENNAN. Yes, sir.

The CHAIRMAN. Wasn't it rated otherwise with the Air Force?

Dr. GLENNAN. Not that I know of.

The CHAIRMAN. Wasn't it rated some eighth or ninth in the Air Force?

Dr. GLENNAN. No. I am not sure why they would have rated them in any event. This was our competition.

The CHAIRMAN. You have thoroughly investigated the financial background and management of the company?

Dr. GLENNAN. This was one of the criteria looked into by our business team.

The CHAIRMAN. And McDonnell was the lowest acceptable bidder?

Dr. GLENNAN. No, they were not the lowest bidder.

The CHAIRMAN. Who was the lowest bidder?

Dr. GLENNAN. I don't know.

Mr. McDONOUGH. Is this negotiated or a contract by competition?

Dr. GLENNAN. This is a negotiated.

The CHAIRMAN. Negotiated contract.

Mr. McDONOUGH. Mr. Chairman, I am sorry. Do you yield to me?

The CHAIRMAN. Yes.

Mr. McDONOUGH. This is the vehicle here, a plastic model of it. I think for the information of the committee you might bring it over in front of you and give us a little description of the purpose of its design and its function. This contains no power?

Dr. DRYDEN. No power. This is a substitute for the nose cose of a ballistic missile. It goes on the front end.

This frame on the top is a part of the rescue system in case of accident. If, for example, the engine would catch on fire on the launching pad, the pilot can fire this rocket, which would take the whole capsule up into the air to a sufficient altitude so that he could descend safely. When the vehicle goes in orbit, this part of the device is discarded. So that the vehicle is a pressure chamber containing a man.

The man is—I am sure we will have to pass this around for you to see it—the man is supported on a couch which is molded to fit to his form. Men supported in this manner have been exposed to accelerations as high as more than 20 G's in a centrifuge in Johnsville and have withstood this safely.

In the actual operation accelerations would not reach that value. The closest to it would be in an escape maneuver in low altitude in the dense atmosphere, where it might touch 18 or 19 G's for a few seconds.

The man is then protected against the launching acceleration. He takes it in the most favorable position; transfers through his body.

When the capsule goes into orbit, attitude controls are used to change the position in a manner suitable for reentry, so that this blunt end is first. The blunt end contains the heat shield, and here are the retrorockets which he uses to start his maneuver to come back to earth. The firing of the retrorockets, say, over Hawaii, will bring him down in the Atlantic missile range, something of this sort. It will reduce the speed enough to cause the capsule to spiral in toward the earth.

Mr. McDonough. You say he fires the rocket for retrograde over Hawaii?

Dr. Dryden. He would come in very closely, land somewhere in the Atlantic missile range for recovery.

Mr. McDonough. Clear across the United States?

Dr. Dryden. The reentry must be a very gradual one to keep within the bounds of acceleration and heat.

Mr. McDonough. What speed is he traveling when he fires that?

Dr. Dryden. He starts at around 18,000 miles an hour, something of this order of magnitude.

The Chairman. If he discharges the retrorocket in California, he will land in Florida?

Dr. Dryden. In that order.

The Chairman. Something similar to that?

Dr. Dryden. Something of this order.

Mr. McDonough. Does he stay in the reclining position at all times or can he move around?

Dr. Dryden. He will practically stay in that position. He can move his hands. He can exercise some control. There will be both primary and secondary controls on firing retrorockets, escape maneuver and all of this.

The medical people are engaged in deciding which shall be the primary control, and which will be the secondary control. Probably that will not be decided until the experience with flights to shorter ranges. The beginning of this project will fire full-sized capsules over perhaps a hundred miles at the start and then to successively greater ranges, first with instrumented capsules, some would contain animals, and ultimately, as a part of the pilot-training process, a man might take the shorter-range flight before going into an orbital flight.

The top part of this contains two parachutes—three parachutes, a small one to slow him down in the high upper atmosphere, a main parachute for the later part of the descent to the surface, and a spare to use if there is any failure of the first one.

The safety of the man has been considered in all aspects of this design. He of course is provided with communication devices. He will be instrumented for physiological measurements of various sorts. He will be able to do some simple functions so that we get some idea of the capabilities of man in space.

Mr. McDonough. This is Project Mercury, and this is the object that the McDonnell Aircraft is building for you?

Dr. Dryden. They are building some dozen or more of these capsules which will be used first in these qualifying experiments and finally for orbital flight.

Mr. McDonough. How much thrust do you need to put that into orbit?

Dr. Dryden. An Atlas missile will do it.

Mr. McDonough. We have enough thrust now?

Dr. Dryden. Yes.

Mr. McDonough. And you say that—you have about a dozen under order?

Dr. Dryden. It calls for roughly a dozen, with some spare parts of various kinds, some extra heat shields. We hope to recover these, you see, and use them over and over. If we can't recover an instrumented capsule, then obviously we can't recover a man. So we plan to use them over and over.

Mr. McDonough. What is the cost of this obligation?

Dr. Dryden. The contract is about $18 million, as I recall it.

The Chairman. What is that made of?

Mr. McDonough. Inconel?

Dr. Dryden. Does anyone know the materials here?

The heat shield we will use in our experiments, both a berylium heat sink-type shield and an ablation-type shield. The material is titanium, someone tells me.

The Chairman. Is that the cost? Is it in the design or the material, the $18 million?

Dr. Dryden. It is the whole thing. They are working out the detailed design. We have given them general specifications. This is our rough idea. They don't have to use this. They come up with the detailed design and the manufacture of 12 complete with the communications equipment, the life-support equipment to furnish the oxygen, deal with the CO_2 and all the rest of it.

Mr. McDonough. How large is the base of that compared to the base of that table?

Dr. Dryden. It is about 8 feet across.

Mr. McDonough. Eight feet in diameter? And how high?

Dr. Dryden. It looks like overall about 10 or 12 feet.

The Chairman. Any more questions?

Mr. Sisk. Mr. Chairman.

The Chairman. Mr. Sisk, all right.

Mr. Sisk. I just simply, in view of the discussion on this particular instrument, I wanted to ask a question in view of some things I have read and heard and discussed.

Who evaluated the drag-brake system, Dr. Dryden, and determined your reasons for not using it in preference to this method?

Dr. Dryden. We are using a drag brake in the form of a small chute on this; this is being evaluated by actual drops from airplanes, simulating the final end of this trajectory. Those experiments are very well along.

Mr. SISK. Well now, there is what they term to be a drag-brake system, which I understand, I believe—there is something I read on this—which is somewhat different from this particular system.

Dr. DRYDEN. You may be referring to a proposal which is for a system not yet tried out or developed.

We are considering the matter of a research contract on this. But this project is not based on new technology or the completion of new research. We are using the presesent knowledge insofar as possible so as to drive this forward at the fastest possible rate.

Mr. SISK. Just to conclude, then, because I know our time is getting away:

You are having this other method evaluated, is that correct? If so, who is making that evaluation?

Dr. DRYDEN. Our staff has evaluated it in the sense that we would not make the success of this dependent upon the development of this device which has never been used, never been flown.

We have suggested to the proposer that we will entertain a research contract to develop that device for use in later application.

Mr. SISK. It is under evaluation, though?

Dr. DRYDEN. Yes.

The CHAIRMAN. I promised to recognize Mr. Anfuso.

Mr. ANFUSO. I withdraw.

Mr. OSMERS. How long do you propose the man to remain in this?

Dr. DRYDEN. Anywhere from 10 to a dozen orbits, probably about an hour and a half, probably only a few at first, because the launching will be from Canaveral, and you would like to make the recovery there where you have the ship facilities, tracking facilities.

Mr. OSMERS. He will be gone an hour and a half, then?

Dr. DRYDEN. He must be gone at least an hour and a half to go around once. You can go in multiples of this until the path of the satellite is changed so that it doesn't come over Canaveral. Then you have to wait 24 hours.

Mr. OSMERS. What do you contemplate on this first trip?

Dr. DRYDEN. Probably an hour and a half.

Mr. OSMERS. For one trip?

Dr. DRYDEN. Yes.

Mr. McDONOUGH. This is a controlled entry?

Dr. DRYDEN. It is a controlled entry.

Mr. McDONOUGH. He could stay up there longer?

Dr. DRYDEN. He could stay there longer.

The CHAIRMAN. Any further questions?

If not, Doctor, we thank you very much.

All three of you gentlemen here, we had you down here rated for 15 minutes on the program, but I think you can see by the interest shown from the members of the committee that we couldn't confine it to 15 minutes.

We certainly thank all of you.

Let's see, who is the next witness on the agenda?

Mr. DUCANDER. Mr. Chairman, Dr. Glennan?

Dr. GLENNAN. I just wanted to express my appreciation, Mr. Chairman, for the fact that so many of your committee have stayed through this session and have given us a chance to express ourselves.

We will be glad to come back at any time, and Dr. Stewart will carry on the balance of the program.

The CHAIRMAN. I think we had just about 100 percent attendance, and they have stayed all the way through, and all of that evinces their interest in your program there.

The best of luck to you, sir.

All right, Doctor, do you have a prepared statement?

Dr. STEWART. I do not, sir.

The CHAIRMAN. We will be happy, then, for you to proceed with whatever statement you wish to make.

Dr. STEWART. Thank you.

We have prepared a series of discussions here to provide you and your committee with a general view of the plans and activities that we are involved with.

I think in each case, as one of the men comes up to present his portion, I will ask him to introduce himself and to give a wee bit of personal history for your own background. We expect we will be seeing you in the future.

The CHAIRMAN. Sir, before you begin that, let me ask you: Would you give us a preview on what you have in mind? My thought there is this: If it is going to be impossible to see these last witnesses this afternoon, we should release them. If there is a possibility we can get to them, of course we want to go ahead with our program.

Dr. STEWART. What we have in mind is the following:

First, we would like to have Mr. Siepert, who heads up the Office of Business Administration in NASA headquarters, to spend a few minutes with you to show the picture regarding overall facilities, such as manpower, budget.

Then we would like to have Dr. Homer Newell, who is one of the oldtimers in the high-altitude research business, say a few words, telling you what is going on, how this started, and the kind of thing we are doing there.

Then we would like to go to Mr. Wyatt and Mr. Cortright, who are in the Office of Space Flight Development, who will describe the portions of the program in this, which is the newer area in NASA.

Finally we have Mr. Addison Rothrock who will speak of the research activities of the organization.

The CHAIRMAN. Fine.

Well now, that gives the committee an idea of what we have in front of us. We certainly want to hear everybody we can.

If you will call your first man, make your statement, sir, and then call your first witness, I think the witness will bear with you and we can speed this up some in order to hear most of the program that we have on the agenda.

Dr. STEWART. Very good.

Mr. Siepert, will you introduce yourself, please?

STATEMENT OF ALBERT F. SIEPERT, DIRECTOR OF BUSINESS ADMINISTRATION, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. SIEPERT. Since I will be talking from charts, would you prefer I use the mike this way rather than try to come over?

The CHAIRMAN. Fine.

Mr. SIEPERT. My name is Albert F. Siepert, Director of Business Administration. I am one of the new staff-on-board, coming October 13. I am trained in public administration, I have had about 20 years of career civil service in five different agencies. Just prior to this job I served as executive officer of an organization I think some of you are familiar with, the National Institute of Health, which is the Government's largest program in medical research.

My particular job—do all of you have this organization chart in front of you? My particular job is in this area over on the left, the responsibility for seeing that the management requirements behind the technical research program are met. Specifically that means to see to it that men, money, the materials that the scientists need to do their job, is on hand as they need it.

Now, I would like to give you very quickly here what are the kinds of resources that are available to our organization to do this new job that is inherent in the new Space Act.

As Dr. Glennan pointed out, we are building on a foundation of the National Advisory Committee for Aeronautics, which has been the world leader in aeronautical research for many, many years. This is a large organization. It had some 8,000 people who came with us. They are scattered geographically in various places throughout the United States. Let me cover them briefly.

Here is a picture of Langley Research Center, Langley, Va., just north of Norfolk; about 3,300 people, the oldest and the biggest center. It specializes in aerodynamics research, structures, in aircraft operating problems and in pilotless aircraft. It happens that this is the center where temporarily we are housing the man-in-space project, in order that it can get the very best facilities that we have currently available.

Second, at Cleveland is the laboratory called the Lewis Research Center; 2,600 people. This is an organization that primarily specializes in engines, other propulsion systems, and materials research.

Third, out at Ames Research Center, at Moffett Field, just south of Palo Alto, Calif., we have the Ames Research Center in which we have concentrated aerodnyamic research. Particularly they have some very large wind tunnels, as you see here, for a much larger model of work.

Now, moving on down to here, these hangars, the high-speed flight station at Edwards, Calif. This is the terminus of the X–15 flights, this is where we carry out actual research with high-speed aircraft. Work with the X–1, the first plane to fly faster than the speed of sound, built under similar technical direction such as the X–15, by the NACA. This is where the X–15 will land.

Now, those are the areas we had before the program started, plus one other, called the Wallops Island Station, a pilotless aircraft station on the Virginia coast here, where we have been conducting experiments with small rockets, multiple stage rockets in exploring pilotless aircraft; only about 100 people in that organization.

Now, coming to the new space program, what we find is that we are building at Beltsville, Md., just outside Washington, on land given us by the Agricultural Experiment Station, a Beltsville Space Center. Here we will concentrate work in space sciences, technical people who will concentrate on the development of our part of the program on payloads, a central data and collection center, so that we can make scientific use of the data we collect from these various probes.

Finally, from Beltsville we will concentrate our monitoring and our leadership of the research and development contracts that we place with American industry for the production of space hardware.

In addition we have taken over—here is a picture of the Jet Propulsion Laboratory operated by California Institute of Technology. This is located at Pasadena, about 2,300 people. They are retained by us on contract. This is a very well-known, outstanding research organization. Some of you doubtless have heard of its work on JATO, the jet-assisted take-off work during the war and subsequently on the Corporal missiles and the initial——

Mr. MILLER. About how big is the plant at Ames?

Mr. SIEPERT. Excuse me, sir. About 1,800. The other spots on here I will quickly point to. When we have a big booster to shoot, an Atlas or a Thor-Able or a Jupiter, it has been shot from Cape Canaveral where we have a field station there. As the Pacific test range opens up out here, we will put some facilities there and people when we wish to shoot on the Polar orbits.

Mr. MILLER. Is that the proposed one at Point Arguello?

Mr. SIEPERT. Yes.

Mr. McDONOUGH. Near Vandenberg AFB?

Mr. MILLER. No. It will be at Point Arguello.

Dr. STEWART. It is directly adjacent to Vandenberg Reservation.

Mr. MILLER. Yes. But you see they can shoot north and south.

Mr. SIEPERT. The advantage is you can shoot south.

The CHAIRMAN. Are these facilities under NASA?

Mr. SIEPERT. The facility here is not, nor is the facility at Cape Canaveral.

The CHAIRMAN. Other than that, all of the facilities are under NASA?

Mr. SIEPERT. All of the ones that I have described.

The CHAIRMAN. What arrangement do you have at the cape and the other one out there on the Pacific Coast, at Vandenberg?

Mr. SIEPERT. Yes. We asked for the use of facilities when we have a scheduled firing. This is programed by the military services.

The CHAIRMAN. It is temporary use of the facilities during your operation?

Mr. SIEPERT. Yes, sir.

The CHAIRMAN. And they, in effect, loan you their housekeeping force at that time so that you can use the facilities for that?

Mr. SIEPERT. That is right, and we retain technical direction and management of the particular project.

Mr. MILLER. On the one at Point Arguello, when that is built, that will be your facility, will it not?

Mr. SIEPERT. You mean in terms of actual ownership. We do have in our budget construction funds to build a launching pad for us, yes.

Mr. MILLER. That will be under you?

Mr. SIEPERT. Yes.

Mr. MILLER. It may be on land—I do not know who is going to own the land, but it will be your facility just as at the present at Ames you are on Moffett Field, and at Langley you are on a Navy installation and at Wright-Patterson you are a tenant of the Air Force. Is that not right?

Mr. SIEPERT. This kind of tenancy, I can assure you has been most productive and quite satisfactory to us.

Mr. MILLER. Quite satisfactory.

Mr. SIEPERT. Yes.

Mr. McDONOUGH. Your individual launching site, however, is Wallops Island.

Mr. SIEPERT. Yes.

Mr. McDONOUGH. That is not used for military launching at all?

Mr. SIEPERT. No, but we believe in reciprocity.

Mr. McDONOUGH. Yes.

Mr. SIEPERT. If they wish to use it, we would be happy to work out arrangements, yes.

Mr. McDONOUGH. What about the new acquisition down at Chincoteague?

Mr. SIEPERT. The Chincoteague Naval Air Station is about 7 miles to the north of Wallops Island. It has been essential to our operations in terms of the air strips to permit us to get personnel and material, rockets and the like, in there, in a way that would be very difficult to do overland. We are discussing now with the Navy, because they are closing it, arrangements which we hope we would be in a position to make effective use of a part of those permanent facilities.

The CHAIRMAN. What about the missile range, the Atlantic missile range? What arrangements do you have with these other countries to use the facilities?

Mr. SIEPERT. We operate on the same agreements as does the Air Force in working with other——

The CHAIRMAN. You use the Air Force agreement with foreign countries.

Mr. SIEPERT. Yes.

The CHAIRMAN. You use their basic agreement when you use their range?

Mr. SIEPERT. Yes.

The CHAIRMAN. You get cooperation from all the armed services, do you?

Mr. SIEPERT. We are getting excellent cooperation.

Mr. CHENOWETH. Where is this Moffett Field?

Mr. SIEPERT. Four miles south of Palo Alto.

Mr. CHENOWETH. This chart indicates C.O.L. I thought that was Colorado, at first.

Mr. SIEPERT. I think that is an example of our too fast reproduction facilities.

Mr. MILLER. I would like to say something off the record.

Mr. CHENOWETH. Is there any particular reason why California should have all of these installations and we do not get anything in Colorado?

Mr. SIEPERT. I can only answer——

Mr. CHENOWETH. Is there some particular atmospheric condition out there that leads you to California?

Mr. SIEPERT. I can only comment on that that I am a newcomer to this space age, myself, and I cannot assume any responsibility for where the centers have been located.

Practically speaking I should say this, that some of the development on the west coast is directly attributable to the fact that the aircraft industry has concentrated on the west coast and much of the NACA program has been based on close cooperation with industry.

Mr. CHENOWETH. But do you not think that ought to be moved into the interior a little bit?

Mr. SIEPERT. I have no——

The CHAIRMAN. While we are talking about that, the most secure place in the country is down in Louisiana. Let us proceed.

Mr. SIEPERT. Now——

Mr. FULTON. We can give the gentleman from Colorado a stationary satellite 1,500 miles above it.

Mr. SIEPERT. These facilities that I have described and shown here in these pictures are very complex, very expensive, subject to a high rate of obsolescence, because the state of the art in the field of aeronautics and space travel is moving at an astounding rate. Take for example this little part of the Ames photo as broken up and shown here. This is a unitary wind tunnel, one of five facilities that were built starting in 1949. Unitary really means a national program of wind tunnels for joint use by Government and industry. This one at Ames has three sets of tunnels, one here and one here and one here, to cover model testing in the transonic and supersonic ranges, starting at about 70 percent of the speed of sound, up to several times the speed of sound, mach 3.5. Three of these for the NACA cost $75 million. Let us go quickly to a budget figure now.

Now, in order to get going on this program we had to organize a headquarters organization that was slightly different from that which had operated under NACA. The administrator has this immediate staff which you see on the chart. The NACA had the organization of Aeronautical and Space Research. This coordinated the work of the field centers I have described, and a small business organization over here. We have added a third one, the Office of Space Flight Development under Dr. Silverstein. This is the group in headquarters that is specifically responsible for the charting of our new course in space development.

Now, a closing word on the budget. This obviously is not intended to be a budget justification session, since we operate under authorization procedure. I think we will be back before you to discuss our budget in more detail. There are certain characteristics that you should know. The old NACA organization which we took over had a 1959 appropriation base of just over $100 million. This is for research and development within its own research laboratories. In addition there was $154 million of defense money representing space projects in various stages of work or planning which were turned over by Executive order to us. And the Congress appropriated $80 million to get the new program started, in addition to these two items. This gives us for 1959 a total of $335 million. You will notice it is made up of three kinds of things and I would like to explain these parts because you will encounter them when you examine our budget. The blue area, which we call R. & D., is research and development contracting. I want to emphasize that. This is the amount that will be used to buy research services and actual hardware from nongovernmental, from non-NASA facilities.

This area, salaries and expenses, represents research, again, to pay for the scientists, the technical people and the supporting staff, to carry on aeronautical and space research in our own NASA laboratories. Bear in mind that at least half of that present research effort is related to space activities. The other half is primarily aeronautical activities. The green area, C. & E., represents construction and equipment. By that we mean the building of additional facilities for research work of one sort or another.

The 1959 supplemental estimate which has been transmitted by the President to the Congress ask for an additional $48 million, and the 1960 estimate is $485 million, of which one-third of a billion is research and development contracting, $94 million for salaries and expenses of the shop, and construction and equipment, $57.8 million. Basically this is the organization, the resources that we have. As I see it, and I think all my colleagues see it, we have a rough job to do. Our job is to organize this thing so it can roll, keep under constant study the changing requirements in this program, which are changing very fast, make decisions to mobilize our resources and then come in wisely and quickly.

Thank you.

The CHAIRMAN. Thank you very much, sir. Now if there are no urgent questions——

Mr. McDONOUGH. Just one point, Mr. Chairman. Does this comprehend all of the functions of NACA as well as NASA?

Mr. SIEPERT. Yes, sir, this is the total budgeted program for the old activities carried right on in terms of our keeping in the forefront of aeronautical research as well as space flight development, yes, sir.

Mr. MILLER. Mr. Chairman.

The CHAIRMAN. Mr. Miller?

Mr. MILLER. Then as I take it, your 1960 budget, over two-thirds of it will be spent with nongovernmental agencies, with private research agencies and with, I assume, people in the air industry in research and development, is that correct?

Mr. SIEPERT. Not quite. Let me answer the question: Yes, with this exception, that if we are engaging with ABMA which has come up for discussion here, to buy Jupiters——

Mr. MILLER. That would come out——

Mr. SIEPERT. This comes out of this, that is right. So that included in here are interagency governmental transfers. But we are distinguishing here that which is spent within our own house for our own research staff.

Mr. MILLER. You mean less than one-third of it will be in your own house?

Mr. SIEPERT. Yes, sir.

Mr. MILLER. Thirty-two percent?

Mr. SIEPERT. Yes, sir.

Mr. FULTON. Mr. Chairman.

The CHAIRMAN. Yes, sir.

Mr. FULTON. When I had spoken previously I had spoken of $480 million. Actually it is $384 million for the current year. I transposed the 4 and the 3.

Mr. SIEPERT. Yes, sir.

Mr. FULTON. Now, how much of that for the current year is at present, first, unprogramed, and secondly, not yet committed, unobligated?

Mr. SIEPERT. I think the answer—you may wish to explore this in a little more detail.

Mr. FULTON. Will you submit it for the record later?

Mr. SIEPERT. Yes, sir. The answer is I would say it is programed. The answer whether it is obligated or not, you are dealing with about $40 million as yet unobligated.

The CHAIRMAN. Thank you very much. We have next Dr. Newell.

I am happy to state that Dr. Newell here is one of the consultants of this committee, too. We are happy to have him back in a different capacity at this time.

STATEMENT OF DR. HOMER L. NEWELL, JR., ASSISTANT DIRECTOR FOR SPACE SCIENCES, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. NEWELL. Thank you, Mr. Chairman. I am Homer Newell, Assistant Director for Space Sciences, at this point in the organization chart in the space flight development area.

For the past 12 years, I have been associated with rocket exploration of the upper atmosphere and had the great pleasure, as the chairman has mentioned, of working with this committee last year.

In my subject, I would like to review for you very briefly the background of space sciences. When research on the upper atmosphere began in this country with rockets 12 years ago, we had available to us sounding rockets that went to only 200 miles.

At that time the V–2 was the workhorse of the effort. From the V–2 we went on to Vikings, Aerobees, Rockoons, which are balloon-launched rockets and other vehicles, which for the most part did not get to above 200 miles altitude.

Nevertheless, with these vehicles a rather extensive program was carried out. Prior to the International Geophysical Year, which began on July 1, 1957, this country fired over 400 sounding rockets to investigate the upper atmosphere.

So you see that there was a rather extensive beginning program in space research when the IGY began. During IGY, we fired an additional 200 sounding rockets, and of course we launched our first space satellites and space probes.

Mr. McDONNELL. You are speaking about the United States or the world?

Dr. NEWELL. I am speaking about the United States. This is the U.S. program.

Now, at the present time we find ourselves in this situation: We have greatly advanced vehicles and a rapidly advancing technology that the scientists can now use.

You recall that I mentioned earlier that the sounding rockets used previously went to about 200 miles altitude, maximum. Now our space probes have gone out to over 70,000 miles and our satellites, of course, have been coursing above the upper atmosphere for some time.

We find ourselves with 12 years of experience in upper atmosphere research, and beginning of space research carried on with these sounding rockets and the satellites that we have launched. We find ourselves in the problem of a twofold task.

First, to collect the pieces of an extremely intricate puzzle.

And, secondly, fit those pieces together to get the picture.

Now, to give you some idea of the complexity of this puzzle, let me reveal to you one small corner of our area of interest, namely the earth's upper atmosphere. I think the chart will give you some impression of the complexity of this subject, and I should like in the next few minutes to try to go through it in order to remove some of that complexity on the basis of information gained during the last 12 years.

To begin with, here, pressure in the upper atmosphere, we know that it falls off with altitude. In fact, if you wanted an easy mnemonic, for every 10 miles you go up in altitude you divide the pressure by 10. This is easy to remember.

The same is true with the density of the atmosphere divided by 10 for every 10 miles you go up in atmosphere.

When you go up to 100 kilometers or 60 miles, you find that the atmosphere has become one one-millionth what it is on the surface of the earth.

When you get up to 500 kilometers, or above 300 miles, you find that the atmosphere has become one one-trillionth of what it was at the surface of the earth. There is therefore not much air with which to deal.

The CHAIRMAN. Do you mean in weight—do you mean one one-trillionth in weight or particles or what?

Dr. NEWELL. Pressure means weight, weight above that level.

Mr. McDONOUGH. In other words, component parts of the atmosphere are lacking, is that correct?

Dr. NEWELL. That is correct.

Mr. McDONOUGH. There is nothing there.

Dr. NEWELL. The number of particles per cubic centimeter is one one-trillionth of what it is at the surface of the earth.

Mr. McDONOUGH. In other words, it is a vacuum?

Dr. NEWELL. It is not a vacuum, but it certainly—it wouldn't sustain life, it couldn't contain the body fluids in your body if you were exposed to it. It would not give you the lift that is necessary for ordinary aerodynamic vehicles.

Mr. McDONOUGH. If a human being were exposed to that with no protection, he would fly apart?

Dr. NEWELL. That is right. Estimates have been given that he could last no longer than 5 seconds.

Mr. MILLER. As a matter of fact, you couldn't reduce a vacuum that low, or you couldn't evacuate a tube that low, could you, in vacuum, on the surface of the earth?

Dr. NEWELL. Not in our laboratories; no.

Mr. MILLER. In none of our laboratories could we reproduce the rarity of atmosphere that you would get at 300 miles, is that correct?

Dr. NEWELL. That is correct.

The CHAIRMAN. A human would blow up like a balloon at that altitude?

Dr. NEWELL. Yes.

Mr. McDONOUGH. Is there any knowledge of what that emptiness contains?

Dr. NEWELL. Yes.

Mr. McDONOUGH. That is the important thing. What does it contain?

Dr. NEWELL. I would like to emphasize that although this is emptiness, nevertheless it is extremely important, because as we will come to in a moment, the F region of the ionosphere lies up here, and it is this which makes it possible for us to send communications around the world.

Without the ionosphere to reflect back radio waves, we would be confined to line-of-sight communications. In other words, we have to set up repeater stations around the world in order to carry on our communications.

Another dramatic way of presenting the same information we have just been discussing is to consider the atmosphere as reduced to sea level conditions. Suppose we took our total atmosphere, which actually extends out for hundreds of miles and by some process or other could reduce it to the conditions of temperature, pressure, and density that we have at sea level, then we ask how thick would the atmosphere be? Under those conditions it would be 5 miles thick.

We have, then, 5 miles worth of sea level atmosphere.

What about the atmosphere in which the ionosphere lies, let's say above 135 miles? That portion of the atmosphere, reduced to the same conditions, is only one one-thousandth of an inch out of that 5 miles of atmosphere. Yet it is important to us from a communications point of view.

Another way to look at this is to ask what is the spacing between the molecules. At the ground, right where we are, the average distance between molecules is one one-hundred-thousandth of a centimeter, but when we get up to 60 miles the distance is 10 centimeters, and if we get up to 140 miles the distance is 1 kilometer, or three-fifths of a mile. And when we get up here to 300-some miles, the distance between particles is 20 kilometers.

Yet, in spite of this atmospheric rarity, it is extremely important in terms of the space research that we are entering upon.

Now, the primary driving force of our atmosphere is energy from the sun. This energy from the sun entering partly gets through the atmosphere, but in the ultraviolet and gamma ray regions, it is absorbed in the upper atmosphere, causes heating, gives rise to radiations that we call the airglow, night glow, causes ionization, and gives us the ionosphere, and this curve represents the intensity of ionization.

This is due to ultraviolet light and the X-rays being absorbed in the upper atmosphere. It causes a change in the molecules, so that what was oxygen molecules on the ground become oxygen atoms up here and become ionized.

A small amount of energy is brought in by meteors, some by starlight, some by cosmic rays, but the amount of energy brought in by those sources does not match nearly the amount brought in by the sun.

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Now, in our studies of the upper atmosphere we have used the Rockoon, the Moonwatch rockets, the Nike-Cajun developed by the NACA, the Viking developed by the Navy, and of course the satellites launched during the IGY.

With the satellites and higher sounding rockets and deep space probes, we are now able to move from this, I say, small corner, fairly complicated, but nevertheless small corner of our subject of interest, to study the entire universe.

And here we have illustrated schematically our areas of interest. The earth's atmosphere we have just discussed. Out beyond the earth's atmosphere we can now observe the distant galaxies, the stars, the medium between the stars and between the galaxies, the medium in interplanetary space, the sun itself, Venus, Mars, and the other planets and the earth—I beg your pardon, the moon, in wavelengths that we could not see at the ground.

You will recall in the previous chart I mentioned a large segment of wavelengths, the frequencies coming from the sun, were absorbed in the atmosphere. That was another way of saying that we didn't get to see them on the ground.

Yet it is probably true that there is more information contained about the universe than contained in those wave lengths that we do not see, than in the wavelengths in the visual or radio region.

This, then, gives you a very brief overview of some of the complexity of the space research that this country wants to do in the years to come.

The question now arises as to how we propose to conduct the program.

Mr. McDONOUGH. Before you do that: In your description of these various gaseous bodies, that is interstellar gas and the galactic radiations up there, does the spectroscope analysis of those gases indicate that there are elements that we do not know in any of those, or do they contain the same elements that we do know?

Dr. NEWELL. They contain the same elements that we do know. We have seen no new elements out there. In fact, the gases are largely hydrogen and helium, with small amounts of other molecules.

Mr. McDONOUGH. Is that interstellar gas body an isolated body, apart from itself, and the universe, or is it in a band around any part of the universe?

Dr. NEWELL. The interstellar gas, in our own galaxy, is distributed throughout the galaxy. It clusters in dense clouds at times, called nebulas, and is distributed between the galaxies in a much more attenuated form.

To give you some idea of how much gas is in our own galaxy, the total mass of such gas is about equal to the total mass existing in the stars, individual stars.

Mr. FULTON. Would you yield?

Mr. McDONOUGH. Yes.

Mr. FULTON. We really can't say that there are not some subatomic particles out there because we have no instrumentation to determine whether there are or not; isn't that right?

Dr. NEWELL. That is quite correct; that is why I said we have detected no different particles.

Mr. FULTON. But we have been able to get high energy radiation of a different kind, both primary and cosmic, and also we have gotten the new plasma, as it developed, from our IGY experts, have we not?

Dr. NEWELL. The great radiation belt; yes.

Mr. FULTON. So that really as far as that is concerned, we are much ahead of Russia on that particular angle, aren't we?

Dr. NEWELL. I think in the upper atmosphere and space research, we are ahead of the Russians. This is one area in which we are giving them a good run for their money. In fact, in Moscow last August the general feeling seemed to be, not only among the U.S. scientists, but other nations as well, that the material presented by the U.S. researchers was ahead of that which was entered by the Russians, both in quantity and quality.

Mr. FULTON. Likewise, we are ahead of them in communications in this area of what you would call the satellite methods; isn't that right?

Dr. NEWELL. You mean the use of the satellites for research?

Mr. FULTON. Yes. We are the first one that has communicated with a satellite.

Dr. NEWELL. Yes. I would say we have made better use of limited weight that we have put in orbit than the Russians have.

Mr. FULTON. For example, we aren't the only ones ahead of Russia. At the University of Manchester on a Jodrell Bank radio telescope, Dr. Lovell has picked up radiations from 2,000 light years, which is the equivalent of 52 billion miles—52 trillion miles—which is 26 million miles to a light year; isn't that right?

Dr. NEWELL. Yes; and in fact he has picked up radiations from even farther that that.

Mr. FULTON. The chairman says I am in error by a trillion miles. [Laughter.]

Mr. McDONOUGH. You don't show anything on this description of this band of cosmic rays that Dr. Van Allen——

Dr. NEWELL. This is down in the atmosphere, about 100 kilometers, or 60 miles out.

Mr. McDONOUGH. Where is this cosmic ray band that Dr. Van Allen referred to?

Dr. NEWELL. Dr. Van Allen's band is out between 2,000 and 30,000 miles from the surface of the earth.

The CHAIRMAN. Any further questions?

Mr. FULTON. Can we just finish on that?

Dr. NEWELL. Yes.

Mr. FULTON. It is 2 billion light years, isn't it, that Dr. Lovell has gone?

Dr. NEWELL. Two billion light years.

Mr. FULTON. And each light year is 6 trillion miles?

Dr. NEWELL. Six trillion miles, that is right.

Mr. McDONOUGH. That is a "fur piece."

Mr. FULTON. Two billion times six trillion in distance, we have gone further than Russia has gone in picking up radio emanations?

Dr. NEWELL. Yes.

Mr. MILLER. How do you distinguish between a billion and a trillion? I have a hard time distinguishing between 10,000 and 100,000.

The CHAIRMAN. Well, let's get along with the program, gentlemen. We want to thank you. If you have completed your statement, we want to thank you, sir.

Dr. NEWELL. I have one more remark, if I may, on how we propose to conduct our program. I think the committee would be interested in hearing this.

We have now the momentum of the International Geophysical Year in which the rocket and satellite teams that we have gathered together are the most powerful such research teams in this area ever assembled. It is NASA's plan to build up and develop these teams so that the space research program is carried forward on a broad base.

As an estimate, we would say between 10 and 20 percent in housework and 80 percent of research done by agencies throughout the rest of the country.

The CHAIRMAN. Thank you very much, Doctor. Who is next?

Dr. STEWART. Mr. Chairman, Mr. D. Wyatt will follow on with some discussions of the space program, with the emphasis placed on the direction of the requirements for vehicles, propulsion for various kinds of advanced missions.

STATEMENT OF DEMARQUIS D. WYATT, ASSISTANT TO THE DIRECTOR OF SPACE FLIGHT DEVELOPMENT, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. WYATT. Gentlemen, my name is De Marquis Wyatt. I am technical assistant to the Director for Space Flight Development. I have been with the NACA for 15 years, multilaterally as Associate Chief of the proposed Aerodynamics Division at the Lewis Research Laboratory Division, in charge of two of the largest wind supersonic tunnels in the world.

I propose to talk with you in a brief talk on some of the objectives of the space flight development, the new part of NASA.

Now, we take a total program that we think is essential and we can look at it several ways. For one, we can talk about the scientific objectives, one main category. Second, the applied technical objectives, that is the use of space for such purposes as communications, meteorological, and so forth.

And thirdly, the advanced technology backup which is an integral part of the program and which is required to further the first two parts of the program. In other words, we have to devote a lot of effort to the improvement of the technology so that we can get further along in both the scientific and applied areas. This will be one way of presenting the program.

Now, there is yet another as indicated on my first chart. This, as you look at it more by mission areas, I have outlined the mission areas of earth satellites, lunar exploration, planetary exploration, and solar probes. Now in the earth satellites we have the scientific objectives of the sort discussed by Dr. Newell. We have applied objectives in the field of communications, gentlemen, which will be touched upon by Mr. Cortright in succeeding talks.

As sort of a hybrid here we have the orbiting laboratories which Mr. Cortright will also discuss. Lunar exploration, there are a number of steps that are going to be essential. First are those involving the sending of probes to the vicinity of the moon and orbiting missions around the moon. I shall discuss in a moment some of the propulsion requirements to accomplish these missions.

We, of course, have attempted several probes; the Russians have made one successful probe in the vicinity of the moon. The next step is going to be making instrument landings on the moon, what we call soft landings. I will discuss these in just a moment.

Finally, we will get to the point where we will be able to make manned landings. From here on we don't know what the future holds.

Planetary exploring will follow the same general trend, except in this case I have not indicated the manned landings within a technical feasibility within the period that we can see ahead. Solar probes, this is a matter of taking an instrumented probe and dropping it into the sun, let us say.

Actually this is a job of very great magnitude. To give you an indication, we have to put a total velocity impulse on a rocket to go to the moon or say, a rocket to go into orbit of around 30,000 to 33,000 feet per second, in order to put an object into orbit around the earth.

In order to drop, if you will, a probe into the sun, we will have to put around 100,000 feet a second total velocity. You can guess that this would require a very high order of propulsion magnitude.

Now, the objectives in all of these—let's take the scientific objectives—can be summarized in this kind of chart. Dr. Newell has talked about findings with sounding rockets. We rather arbitrarily define sounding rockets as vertical shots that go no further than one radii from the earth, about 4,000 miles.

Actually most of our shots today have been in the 200- to 400-mile range. We are working on advanced designs of these rockets which will be fairly cheap rockets. In this manner we can explore the portions of the atmosphere near the surface of the earth.

Then we have the satellites, with which we are all familiar. This is shown on what we call an elliptical path, rather than a circular path around the earth. Then finally we have the space probes which go out farther than this distance at 4,000 miles. The space probes can be divided into near space, lunar, interplanetary and so forth.

Now, the satellites that we will be launching are not few and simple. That is, you do not accomplish a scientific program, a total program by launching one or two satellites. On this chart I have indicated some of the complexities that are necessary in our satellite flights.

The general purpose of making a number of paths is to provide variations in time and position for the measurement of the scientific quantities of the sort Dr. Newell just described.

These satellites we have been launching today have what we call inclined orbits. That is, they are launched at an angle to the equator and go around in this direction. It will be very desirable to launch polar orbits which will pass from the north to the south poles. To do this we will have to use the Pacific missile range, because there we can get the down-south firing over unpopulated areas. We can fire inclined orbits from the Atlantic missile range, at Cape Canaveral. It will also be desirable in the future to have firings which have equatorial orbits, run around in the direction of the equator. To do this, it is going to be necessary either to set up launching bases close to the equator or develop more powerful rockets that will allow us to dog-leg onto the equatorial path.

The other circumstance that we must provide for in our programing is that some of the orbits should be almost circular, this to get us a uniform altitude above the Earth for the collection of scientific data, whereas from time to time it will be desirable to go into what we call highly elliptical orbits, for example, for the examination of the great radiation belt discovered by Dr. Van Allen, because in this manner we get a vertical section into the atmosphere over the Earth.

The space probes give us a means of proceeding far away from the Earth. On this chart we indicate that the purposes of the space probe, scientifically speaking, are to give us cross sections into space, to the Moon, to the other planets or to the Sun and to give us observations in the vicinities of these bodies, because we expect to learn a great deal, oddly enough, about the Earth, itself, and the factors influencing the Earth from studying the atmosphere and the characteristics of the planets.

Now, these flights are much more audacious than any that have been attempted to date. The flights to the Moon require a very sizable effort, but the distances involved and the energies involved are much smaller than those involved, for example, to go from the Earth to Venus as indicated by this inward path or from the Earth to Mars as indicated by the outward path.

We can pass from the Earth to Venus by what we call a minimum energy trajectory, which is the least amount of thrust that we can put into our rocket, which requires long times, or as indicated here we can go either inward or outward on what we call excess energy trajectories, providing we have the thrust capabilities that can greatly reduce the transit time to the body.

Now, not only must we have highly developed propulsion systems to accomplish these planetary probes, we must also develop power supplies so that we can transmit back the data from these very large distances and over a considerable length of time, perhaps in periods measured up into months and even years in some of these scientific explorations.

We must also develop the ground tracking equipment to receive this communication. The dishes that Dr. Newell or Dr. Stewart spoke of, the Goldstone dish, for example, to receive the signal from the probe. These must be developed technologically in order to permit the probe to operate with a minimum of transmission.

Mr. Cortright will discuss some of these aspects in his discussion.

Taking particularly the lunar exploration phases, proceeding from the probes of the sort that we have attempted and the Russians have attempted which simply pass by the Moon in one shot and then assume a position of trajectory about the Sun, the next step would be the unmanned orbit or a body that we send up and actually orbit around the Moon without attempting to bring it back.

Later on the greatly increased energy requirement, we may find it desirable to bring even the other vehicles back to the Earth. The next stage will be one of landing on the Moon, however. We have two categories of landing. The hard landing, which is simply that, where we come in at a very high velocity and hope to design the unit so that we can still obtain data and transmit it after impact. This is not impossible. It has been used in certain of the areonautical research in this country.

It depends upon a good many factors, however, including a choice of suitable terrain, which we are not likely to have in our initial flights to the Moon.

Hence we look to the soft landing, as the more desirable feature. By soft here we mean to let the package down slow enough so that we are fairly certain that it will continue to receive and transmit data.

And the difficulty arising here is that we have to destroy the energy that the vehicle has as it approaches the Moon or as it orbits the Moon in order to let it down at essentially zero speed on the surface of the Moon. This requires a large propulsive effort and this, in turn, requires to carry out to the Moon a rather large rocket, which has to be extended. This cuts down the payload we can put on the Moon.

Later on I will show you the magnitude of the payload that we expect to put on the Moon. The next step will be a manned orbiter around the Moon. I am taking these in the order of technological difficulty. Here we expect to put out a man or men and have them circumnavigate the Moon at a fairly close distance and then, of course, return to Earth.

Finally we come to the most difficult mission, that of landing a man on the Moon and then bringing him back. I shall point out in just a moment the difficulties that are encountered there, but to do all these jobs we have to have thrust. My portion, the main portion of my talk, I want to talk about these thrust problems.

Mr. Cortright is going to talk about some of the other problems that we have to solve.

Here are shown schematically the existing vehicles available to us in our space research. You can get an idea of the size from the figure of the man. We have the Vanguard, Jupiter-C, basically a Redstone missile with upper stage added. Juno-II which is the same as the Jupiter-C using a Jupiter first stage, and the Thor-Able, made by combining the Thor rocket with the upper stages from the Vanguard. These are the vehicles that we have available to us at the present time. The payload capabilities of all these vehicles at the present time are rather limited in terms of pounds, as you know. In the very near future we hope to have several vehicles available based upon the Atlas which will give us greatly increased poteníalities. Then one step further down the line—these are the Atlas Hustler engines—the next step down the line is to go to a stage which again uses the Atlas modified for the first stage and then uses new upper stage rockets.

The Atlas at present is what they call a stage and a half rocket. To get large increases in payload, it is necessary to add more staging, more rockets on top of that. These I will state, two of them, we consider essential to prosecute a space flight program. One that would actually come first in timing would use a modified first stage Vanguard engine, as a second stage using conventional fuel, and use a third stage of storable propellants under development.

The other system which would have an increase in payload capability would use a high energy second stage, otherwise it would be similar to this rocket here which we refer to as the Vega rocket.

Now these still do not have the capability to perform the missions I have been talking about. The next stage in rocket development underway now are the really advanced boosters. Now you will have noted here the figure of the man may have gotten so small that some of you at a distance cannot see it. Over here, what we refer to as the million-pound cluster actually will be somewhat over a million pounds in its final development. It is a cluster of rockets and the first stage, second, third, and fourth stages. The first stage is now being developed by ABMA. Over here we show by comparison the rocket which we call Nova that will be based upon a cluster of the 1½-million-pound single-barrel engines, discussed with you earlier today.

Here again we would have a cluster of these engines for the first stage, one of the engines for the second stage and succeeding stages up here. It is only when we get to the 6-million-pound cluster that we can accomplish some of the missions I have discussed.

Some of them cannot even be accomplished with the 6-million-pound thrust. For example, here is a payload potential for putting a satellite 300 miles above the earth. With the existing capability we can put about 300 pounds into orbit. This is sufficient for a good amount of instruments. This is not enough capacity to engage in some of the communications, meteorological work we wish to engage in, nor for advanced scientific experiments. It is not possible to put a man, of course, with a 100-pound payload into a 300-mile orbit. I might say in passing that you can put much larger loads into lower orbits. With the Atlas Hustler system which should be available in a few months, our capacity in this 300-mile orbit will go up to about 2,000 pounds. When we get this Atlas with the upper stages that I have referred to, we will be up to over 7,000 pounds capacity. Our million-pound cluster will enable us to put 19,000 pounds into orbit and when we get this 6-million-pound cluster we will have the potential for 150,000 pounds.

Mr. Cortwright, in his discussions, will discuss a mission in which we feel we can definitely use 150,000 pounds in a 300-mile orbit.

Now, the next mission that we can look at is that of a 22,000-mile orbit.

Mr. McDonough. Before you get away from that, these varying instances you are talking about there are dependent upon the design or the propellant?

Mr. Wyatt. Both. Some of them involve higher energies, propellants, some of them are bigger engines than we now have available.

Mr. McDonough. What I am getting at is: The propellants we know now and the design we know now, can be, with some research and development in the next year changed considerably? We haven't the ultimate in propulsion yet, have we, in either solid or liquid?

Mr. Wyatt. No, sir, not in a practical form. However, some of these engines carry in their upper stages some of the highest energy fuels that we know of.

Mr. McDonough. In which category are we advanced the furthest, the design or the propellant? At the present time, can you give us an idea?

Mr. Wyatt. I would say the propellant is a little ahead. In other words, we will be able to get some of the upper stages using high-energy propellants sooner than we can get—much sooner than we can get some of these very big engines using conventional fuels.

The CHAIRMAN. May I say to the gentleman that the committee is planning a special investigation of propellants at a later date, however, most of it will be executive, because of the nature of the inquiry.

Mr. WYATT. Yes.

The CHAIRMAN. Proceed, sir.

Mr. WYATT. Well, this 22,000-mile orbit is of interest, because if we put a satellite 22,000 miles or very approximately that, above the surface of the earth on an equatorial orbit, it would appear to be stationary relative to a point on earth, because it would spin around once in 24 hours. Here we have what we call a stationary satellite. This has certain advantages in space, because we can have a family of three to six of these continually observing fixed spots on the earth for meterorological purposes, or repeating messages, as the case may be.

However, with the rockets that we now have or those that we will have available, we have no capacity for putting a payload into a 22,000-mile orbit. We get that capacity when we get to the upper stages, with the Atlas missile, and we build that up until again out here the 6-million-pound rocket, we get a very large capacity for this. Actually, in here we have the capacity for performing a good many of the meteorological missions.

Now, the next mission I want to discuss is that of putting a payload softly on the moon, or a lunar landing coming in, orbiting, and then landing with a soft landing, essentially zero velocity.

Here again we have no capacity for doing that at the present time.

Well, with the Atlas Hustler we will have a capacity to put a small instrumented payload on the surface of the moon. This capacity will build up rather slowly through our million-pound cluster. Not until we get to our 6-million-pound engine will we be able to put about 20,000 pounds on the moon.

Mr. McDONOUGH. What is your time schedule on that?

Mr. WYATT. This one will be out—

Mr. FULTON. Don't say more than 7 years.

Mr. WYATT. I was going to say 6 to 8 years. This is the first one which, of course, you can begin to talk about putting a man on the moon. This does not yet bring him back. Actually, we take the case of landing on the moon and returning to earth. This rocket will give us the capability of bringing back 1 ton to the surface of the earth. This is about the weight of Project Mercury, about the minimum weight that we consider for putting a man out to the moon, landing him, and bringing him back to the surface of the earth.

Mr. McDONOUGH. You mean you need that weight to put him up there and give him propulsion to get back?

Mr. WYATT. Right. We would have to have a payload leaving the earth of over 4½ million pounds in order to bring 2,000 pounds back to the surface of the earth.

The CHAIRMAN. So that missile, the 6-million-pound cluster, will be the basic missile for that purpose?

Mr. WYATT. Right; yes, sir.

The CHAIRMAN. Nothing less than that would do?

Mr. WYATT. Nothing less. The million-pound engine will not do that.

The CHAIRMAN. Nothing larger than that is planned at this time?

Mr. WYATT. Not at this time. However, this picture will change as we advance in this technology. We do not say that 6 million pounds is the biggest rocket, biggest booster, that we are going to need. It is very obvious here that we can only do a minimum job as far as lunar exploration is concerned with a man, using even the 6-million-pound rocket. So it is going to be necessary in the future to go to even larger booster sections.

Gentlemen, this gives the picture of the way the mission capabilities that we desire to perform are linked in with the propulsion systems available to us, and an indication of the kind of propulsion systems that we are supporting in the future program.

The CHAIRMAN. Thank you very much.

Mr. FULTON. May I compliment the witness, because he has just now subtracted 1 year over Dr. York's 7 years.

The CHAIRMAN. Therein he fell into serious trouble.

Mr. WYATT. Thank you.

The CHAIRMAN. Now, gentlemen, we have one more witness tonight. We have been here since 10 o'clock this morning. The reporter is rather fatigued.

Mr. HALL. May we ask a question before this witness leaves?

The CHAIRMAN. Just come back, sir. They want to ask you a question or two.

Mr. HALL. Where does Russia stand on that scale now, so far as we know?

Mr. WYATT. Well, we don't know. I don't know definitely. It was indicated to accomplish their lunar mission that they had anything from a quarter-million-pound thrust up, depending on what we call the sophistication of their design.

Mr. HALL. Do we have any way of telling when they fire one of these missiles other than for them to tell us or to release the news? Do we have any detection systems?

Mr. WYATT. Do you have an answer to this?

Dr. STEWART. This is really a military problem which I think would be best to explore with the military.

Mr. HALL. That is all.

Mr. QUIGLEY. May I ask a related question?

The CHAIRMAN. Yes.

Mr. QUIGLEY. On the chart that you showed as to the 22,000-mile orbit, are the Russians currently capable of doing something in that area?

Dr. STEWART. I think the only proper answer is "Yes."

The difficulty with the 22,000-mile mission is a little bit greater than that of a passage by the moon, but not very much greater. So I would say that the general equipment that they have already demonstrated a certain capacity for this kind of thing. It would not be very many hundreds of pounds, but it would be more than zero.

Mr. QUIGLEY. So that we run the risk of the first worldwide television network carrying Russian broadcasts rather than English?

Dr. STEWART. This is conceivable, sir.

Mr. FULTON. You do not mean that there is going to be a 22,000-mile orbit that is a stationary vehicle, because they do not have any power of making a circular orbit or an eliptical orbit whose two focuses are within the diameter of the earth?

Dr. STEWART. That is quite right, sir. The problem is not a simple one. It is a very complex guidance problem. They also require special propulsion systems for use after you get out into the 22,000-mile station, so that the statement I made should have been more accurately stated, that they have the propulsion capability to launch a vehicle which might be used in that capacity.

Mr. FULTON. In an eliptical, but no capability in a circular orbit, which I believe the gentleman was discussing.

Dr. STEWART. I believe even a circular orbit they have a capacity for a little there, not as much as they put on the moon, because a good portion of that requirement had to be used up with the extra propulsion and guidance to establish a circular orbit.

The CHAIRMAN. Why is it a 22,000-mile orbit rather than 24,000?

Mr. WYATT. This is the way the mechanics of it work out: It is around 22,300, I believe. We just rounded it off.

The CHAIRMAN. 22,300. That will make a stationary——

Mr. WYATT. It makes it go 24 hours to make one turn around the earth, yes, sir.

Mr. Quigley, I would like to correct what may have been a misapprehension, when you said if the Russians are the first to put anything into the 22,000-mile orbit, they would be the first to have worldwide television.

There are other ways of getting the worldwide television service without having the stationary satellite.

Mr. FULTON. You could have a number of satellites, could you not?

Mr. WYATT. Yes.

The CHAIRMAN. Gentlemen, it is after 5 o'clock, and the reporter has been going all day long. I think in fairness to him—he must be pretty tired. The committee members having been here also since 10 o'clock—we can get Mr. Cortright, he would be available, wouldn't he, later on? And also we have two other witnesses this afternoon that we released earlier with the thought that we wouldn't be able to reach them.

If there is no objection on the part of the committee, I have this in mind:

Tomorrow morning we have the Army here to tell us what the story is from the Army viewpoint, give us the national defense angle. If we excuse these three witnesses now, we can call them later on in the course of this hearing, giving them ample notice. I think there would be a better reception, too, if we are a little less fatigued than we are this late in the day.

If there is no objection, my thought is: We would go on tomorrow with the Army and hear these three witnesses later on, hear their testimony and place it in the proper place in our record.

Is that all right, sir?

Dr. STEWART. Yes, sir, we are at your convenience.

The CHAIRMAN. We certainly thank you for a very painstaking presentation that you have made this afternoon and this morning. The committee appreciates everything that you have done. If there is no further business, and I assume there is none, we will adjourn until tomorrow morning at 10 o'clock.

(Whereupon, at 5:15 p.m., the committee recessed.)