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1967 NASA AUTHORIZATION

HEARINGS

BEFORE THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS U.S. HOUSE OF REPRESENTATIVES

EIGHTY-NINTH CONGRESS

SECOND SESSION

ON

H.R. 12718

(Superseded by H.R. 14324)

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APR 1966 19
MANHATTAN, KANSAS

MARCH 10, 11, AND 22, 1966

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*Mr. Casey and Mr. Adams resigned from committee effective Mar. 8, 1966, and Mr. Green and Mr. Cabell named to committee by H. Res. 755.

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THE 1967 NASA AUTHORIZATION

THURSDAY, MARCH 10, 1966

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The Committee on Science and Astronautics met, pursuant to call, at 10 a.m., room 2318, Rayburn House Office Building, Washington, D.C., Hon. George P. Miller, (chairman of the committee) presiding.

The CHAIRMAN. The committee will be in order.

First I want to welcome a new member of the committee to this first meeting. We have had some changes and Congressman Earl Cabell, of Texas, has been assigned to the committee. It is his first meeting and we welcome you here, sir.

Mr. CABELL. Thank you, Mr. Chairman.

The CHAIRMAN. I just want to tell you we will put you to work and you will learn the meaning of the word from now on out.

We are very happy to have Mr. James Webb here this morning, accompanied by Dr. Robert Seamans and Mr. Shapley.

I want to again welcome Mr. Webb. I know that he has a lot to tell us, so without further ado, we will turn the microphone over to you.

Mr. WEBB. Thank you, Mr. Chairman.

STATEMENT OF HON. JAMES E. WEBB, ADMINISTRATOR, NASA; ACCOMPANIED BY DR. ROBERT C. SEAMANS, JR., DEPUTY ADMINISTRATOR, NASA; AND WILLIS H. SHAPLEY, ASSOCIATE DEPUTY ADMINISTRATOR, NASA

Mr. WEBB. Mr. Chairman and members of the committee, I appreciate the opportunity to present today President Johnson's recommendations for the fiscal year 1967 authorization of funds for the programs of the National Aeronautics and Space Administration. Over the past several weeks, your subcommittee have been examining in detail almost all of the specific elements included in the authorization request. Today I will endeavor to set these discussions in the broad context of the total program, its accomplishments, its present status, and the implications for the future.

For the first time in the 8 years of authorization hearings since NASA was established, one of the prinicpal architects of this Nation's capability in aeronautics and space activities is not here. But all who have participated in the events of those years know that in his extraordinary career of public service, Dr. Hugh L. Dryden provided the standards by which we measure our understanding of how the unique values in science, technology, engineering, and management must be

brought together to reach successfully toward the fundamental objectives outlined in the Space Act. He gave us all new insights and a clearer perception. Today it seems appropriate to remark upon one of these; that is, his view that a major research and development project served more than its immediate ends, because it served also as a creative force in the total advancement of science, engineering, and technology, with the momentum generated by the advances in the disciplines toward which it was directed, creating values which transcended, in the long run, those of the project objective itself.

The CHAIRMAN. Mr. Webb, may I take this opportunity, if I may interrupt your prepared statement, to say that I am sure that every member of this committee, every man that ever knew or had the opportunity to work with Hugh Dryden, join you in what you have said about him. He was a gentleman; he was a scholar, and he was a great scientist, and it can truthfully be said that when he was cast, they broke the mold and threw it away.

Thank you.

Mr. WEBB. Thank you, Mr. Chairman.

You know 10 years before this program came forward in 1959, Dr. Dryden went to London, in April 1949, and he made a very important statement that has guided all that we have done in this program. He, in effect, said there in his Wilbur Wright lecture to, I believe the Royal Aeronautical Society, that you must have from time to time, in addition to the cutting edge of advancing science, a review of the state of the art, a summary of where you stand, something that designers can use as a basis for thinking of and designing new vehicles, new machines, and new concepts. Following that it is absolutely essential to have research in support of the development of new designs. This is the basic structure on which our aeronautical and space programs have been constructed now for over 15 years.

Mr. Chairman, in 1961, when the Nation stood at the crossroads in its space effort, the goal of a total capability in space, to be demonstrated by manned exploration of the Moon in this decade, was selected. That decision was advocated by Dr. Dryden because he saw not only the need for us to create a broad-based capability in space, and because he also knew that many other vlaues would come into being as a result of the effort required. In working toward that goal, the Nation has fulfilled that expectation. It has new assets, new strengths, and new capabilities. This committee can take pride in the very important part it has played in this effort, through critical examination, broad understanding, and continued support, of creating the Nation's space power. But satisfaction in yesterday's accomplishments is not enough to serve a future that is advancing upon us faster than the past is retreating. National power based on science and technology is dynamic and its ingredients, if not exercised, rapidly dwindle and disappear. In space we are today approaching another crossroads. Major new decisions for the future, and with implications more far-reaching than any this committee and NASA have faced together in the past, must soon be made.

The authorization request before you might be described as a bridge between the present and the time when these decisions can no longer be delayed. The President's recommended authorization for fiscal year 1967 provides no more than is essential if major projects are

to proceed. It provides for the future only enough to maintain, and not close off this year, opportunities to use for constructive purposes the assets in know-how and facilities we have been at such pains to acquire.

To begin, let us look back at the accomplishments of 1965. We have operated with severe resource limitations. However, this past year has been one of extraordinary results. We have demonstrated that we can overcome the difficulties inherent in long leadtimes, that we can carry very complex plans forward to fruition, and that we can do what we set out to do.

For example, our successful Gemini flights have demonstrated the feasibility of meeting all the basic requirements for complex and long-duration manned operations in space, including those for a manned lunar landing. We have proven that man can operate usefully for long periods of time—at least 14 days—in space and that he is able to function outside his spacecraft for limited times. We have demonstrated and tested the precise guidance and control required for space rendezvous and docking maneuvers. In recent missions, we have demonstrated the great value of our space flight operational system, which joins a versatile machine capacity with the capabilities of thousands of highly trained personnel all around the world and ties both together through a network directed by a central mission control system, where the critical real-time decisions on matters of the greatest complexity can be made efficiently on the basis of accurate information properly displayed.

In unmanned operations using deep-space probes, we have returned to Earth and delivered to the Nation's scientists and engineers the first high-resolution close-up photographs of the Moon and the first nearby pictures of Mars. The long-duration Ranger and Mariner flights have demonstrated that we can build, launch, and control highly reliable unmanned spacecraft with great accuracy over distances of hundreds of millions of miles, and bring back useful and important information.

You may be interested, Mr. Chairman, in the fact that January 4 of this year we made contact again with Mariner IV at a distance of 216 million miles, which is the maximum distance it will reach from the Earth in its present orbit. Our unmanned scientific satellites have returned to Earth and delivered to our scientists more scientific data in a single year than in the entire previous history of the space program. NASA launch vehicles and spacecraft enable scientists to send their instruments to the precise locations in space where they believe measurements should be made. A wide variety of new discoveries, from scientific data that can only be obtained in space, is providing an entirely new understanding of the properties of the environment through which the Earth moves and of many of the Earth-Sun relationships which have a profound influence on the Earth itself.

In our programs to apply what we have learned in space to help solve major problems facing mankind on Earth, we have completed the development of the world's first operational weather satellite. With ESSA I and ESSA II, both launched in 1 month, in the month of February, by NASA for the Weather Bureau of the Commerce Department's Environmental Science Services Administration, regular meteorological satellite operations are demonstrating a major prac-

tical use of space technology. In the communications field, we have seen the results of our pioneering with Telstar, Relay, and Syncom utilized in commercial operation by the Communications Satellite Corp.'s Early Bird launched about a year ago.

In less noticed, but equally significant work on the ground or in the air, we have demonstrated many things, including:

The use of ground simulators to investigate and solve flight problems associated with proposed designs of the supersonic transport.

The soundness of the design of the giant Saturn V launch vehicle which will carry our astronauts to the Moon. All three propulsion stages of Saturn V have been tested at full power.

The feasibility of advanced propulsion systems for future vehicles. We have had successful firings of the 260-inch large solid rocket motor. We have had successful ground test of the NERVA nuclear rocket engine.

The ability to simulate dynamically the conditions the lunar landing vehicle will encounter in landing on the Moon.

These accomplishments have been possible because we have used a system of management that focuses our strengths, and those of our associates in industry and universities, on the continued improvement of a coordinated, hard-driving, flexible organization for aeronautical and space research that relies on a true partnership of these three elements.

At NASA headquarters, Dr. Seamans and I are consolidating our management functions into a single strengthened unit—the Office of the Administrator—in which he will serve both as Deputy Administrator and as General Manager of the Agency. We have centralized and streamlined our functional staff groups that provide support both to the Office of the Administrator and to the four Associate Administrators. The major burden of planning, management, and execution of NASA programs devolves upon these four Associate Administrators, and I believe our recent accomplishments show that in George Mueller, Homer Newell, Mac Adams, and Edmund Buckley—and the men who work with them—the Nation has an effective and proven team to conduct our aeronautics and space activities.

The NASA record of success has been built by the imaginative application of limited resources, a decentralized structure with strong program and project leadership, and dedication to the purposes our program serves. Perhaps the greatest strength that our Nation has drawn from our space program to date has been the clear showing that we, as a Nation, can do the tasks we set for ourselves. That we have this capability is no longer a matter of opinion. We have put it on view for all the world to see. The world knows today that the United States can digest the space-related problems of extreme complexity and long lead times, can hold its position in a demanding competition, and can forge ahead simultaneously in both aeronautics and space and in those advanced technologies of which space is the leading symbol.

I do not wish to give the impression, however, that we are the unchallenged masters of this new environment or that we have come to a time when we can rest. Quite the contrary. Last year I answered your questions as to whether we would be able to close the gap between the U.S.S.R. and ourselves by saying that we could not at the budget

levels recommended. The gap is still there and this budget will not close it. We are as much as 2 years behind the Soviet Union in certain important aspects of space power. In the year just passed, 1965, they launched 52 Cosmos satellites; successfully orbited a 3-man spacecraft; demonstrated a communications satellite capability with 2 Molniya spacecraft; and orbited the heaviest payload by anyone in the world to date, indicating they have developed a new launch vehicle with some 2½ to 3 million pounds of thrust. Since the beginning of 1966 they have achieved a successful soft landing on the Moon and they have reached Venus with two probes.

The Soviet program shows every evidence of a continuing major commitment to long-term, large-scale operations in space. There is little room for doubt that they are rapidly moving toward an increased frequency of manned and unmanned flights and that their capabilities will soon reach a point where they could expect success in an attempt to land men on the Moon. The massive Soviet commitment to a rapid buildup and a long-term program underlines the importance they attach to advancing their space capabilities. It will require a strong and increasing effort initiated no later than fiscal year 1968 and vigorously pushed in the years after the United States has achieved a manned lunar landing to prevent them from forging ahead as the unchallenged leader in space.

The program we began presenting to you, Mr. Chairman, in 1961, and have been elaborating in each succeeding year, was intended to meet fierce competition and to end up ahead. It was also intended to give us a number of options in space from which we could chose those offering the greatest advantages at the least cost. The competition is still fierce, and we are not yet able to feel assurance that we will end up ahead in the option areas where the Russians are developing their strongest potential.

In my view, the main question which this committee must consider as it takes up the 1967 budget is whether we can or will meet this challenge. The authorization request for 1967 totals $5,012 million and represents a program carefully structured and balanced in terms of what we have done, what we are quite sure we can do, what others are doing, and this year's fiscal need to defer every item that can go over to fiscal year 1968. The outstanding characteristic of this NASA budget is its austerity, which is also the characteristic of the entire Federal budget.

Along with austerity, the NASA authorization request also reflects the President's determination to hold open for another year the major decisions on future programs—decisions on whether to make use of the space operational systems, space know-how, and facilities we have worked so hard to build up, or to begin their liquidation. The fiscal year 1967 budget is designed to maintain at a minimum level the studies and long leadtime procurement related to those decisions.

In adjusting to this budget, we have had to face difficult problems and make hard decisions. We have had to meet the four essential requirements which constitute the core of the NASA program for this decade, a program which you have approved in five annual budgets since 1961:

To develop through Apollo a total national manned space capability and to use it to carry out a manned exploration of the Moon.

To continue the important projects in space science and applications that are basic to a knowledge of and effective use of space.

To continue the work in advnced research and technology that underlies the Nation's ability to plan for and reach decisions on future projects in aeronautics and space.

To take those steps that are required to avoid an otherwise certain gap in our future space activities.

With the full authorization and appropriation of the $5,012 million requested by the President, we can provide for these priorities. There will be no margins and no backup hardware. Any failure on test or other setback will mean that one or the other of these priorities will suffer.

In terms of manned flight effort, we are this year beginning the first real flight activity in Apollo, starting with the successful suborbital test of Saturn IB last month. By next year, we can expect to be testing the Saturn V launch vehicle, which, as you know, is the operational booster for flights to the Moon and long duration flights in synchronous orbits or orbits nearer the Earth. The fiscal year 1967 funds requested for Apollo will, we believe, be sufficient, on an austerity basis, to maintain for another year the schedules needed to carry out a manned lunar landing and return before the end of the decade. We are utilizing the concept of all-up systems testing which, if successful, provides full crew training and more data from each flight mission and therefore reduces the time and costs required to qualify the entire system. However, the overall program risk is increasing and is greater than under previous budgets. We are 1 year nearer the end of the decade, with less time to turn around if we encounter trouble. A major failure could not be overcome and would require a complete reassessment of our target dates and of our ability to meet the goal for the manned lunar landing.

Mr. FULTON. Mr. Chairman, can I have an explanation of a term that has just been used? I would like an explanation of the target dates and your inability to meet the goal for the manned lunar landing.

Mr. WEBB. If you will remember, Mr. Fulton, when the $5,750 million request of President Kennedy was reduced by some $6 million, and when we came before you the next year with a request of $5,445 million, which included a supplemental of $141 million, we made it clear that we would have to go to a system where we did not test each stage of a booster and then bring the next stage into play and build up through a proven system of the lowest stages the capability for later flights. We said that the only way we could still maintain the capability to make the lunar landing within this decade was to put the whole system together and on every flight exercise the whole system, including the men on the ground, in the control centers, the tracking network, and so forth. Thus, what we are doing, as you saw in the Saturn IB, is flying a complete stack from top to bottom, with the first stage never flown before, the second stage never flown before, and so forth. However, if we have a failure, we have learned, we believe, more from that failure, but we also have more of a risk of failure when we do not sequentially do it, but do it as a total package test.

Let me repeat that this budget provides no margins of time or of resources to counter the effects of setbacks or failures. We will be

working on a "success" schedule. The hazards of booster and spacecraft development are still great. The fact that the Saturn I flew 10 flights without a failure; that we have successfully completed the Apollo abort tests; that we have fired all the stages of the operational Apollo vehicles; and that our management team has demonstrated its effectiveness gives us some measure of confidence. But there is no margin left, and we are entering a phase of heavy flight activity.

In the area of space science and applications, we have canceled the AOSO, but will be able to continue with the other important projects underway, such as the astronomical, geophysical, and solar observatories, the Explorer satellites, the biosatellite, and the Lunar Orbiter and Surveyor projects. In several important areas, the fiscal year 1967 budget cannot accommodate the recommendations of the Space Science Board of the National Academy of Sciences. Instead of working toward missions to Mars in the early 1970's, using the voyager spacecraft system for planetary orbiters, probes, and landers, we are stretching out the Voyager program and allocating funds in 1967 only for the continuation of the system design. If funds are provided to initiate a major effort on the Voyager program in fiscal year 1968, there is the possibility that we could undertake to launch a landing capsule at the 1973 Mars opportunity. However, the magnitude of the task encompassed by an automated biological laboratory suggests that we should defer that mission to the period after 1975. In general, our space science level of activity in fiscal year 1967 will be considerably below that currently underway in fiscal year 1966.

The advanced research and technology effort of NASA, that includes our research in aeronautics, is a fundamental foundation for all future programs. The 1967 budget adjusts this downward in most of the important areas. The M–1 engine development has been terminated, but an energetic program in the investigation of high energy, liquid-fueled engines has been included. The work on the SNAP's nuclear-electric power system is continuing, but at a restrained pace. A low level of effort in the large solid motor area is included. There will be an increase in the total level of resources applied to aeronautics. Viewed overall, however, advanced research and technology is receiving minimal funding.

In the fiscal year 1967 budget, we have taken certain steps to avoid creating a gap in our space activities and to permit in the context of the fiscal year 1968 budget, decisions to be made for future programs that we will be in a position to implement effectively.

For example, in the program of planetary exploration, we have instituted a Mariner Venus mission in 1967 and a Mariner Mars mission in 1969. Without the initiation in next year's budget of a Voyager Mars mission, we will have no further planetary flights planned. We believe the country does not want to leave this important scientific area entirely to the Russians and will endeavor to make a successful case for it next year. In the meantime, these two intermediate missions have been included to provide continuity and important new scientific data. This program is in an area whose importance is most heavily stressed by the Space Science Board.

In the area of chemical propulsion, we now plan an additional firing of a half-length 260-inch solid rocket motor at increased thrust levels. This is a minimum to preserve the option of undertaking full length motor development.

Perhaps the most critical gap that we face is in the area of manned space flight. The Apollo Applications effort, recommended for funding at a minimum level in fiscal year 1967, represents another major deferred until fiscal year 1968 of an important decision vitally affecting the future of the program. Let me emphasize two points: First, while there is a possibility that some boosters and spacecraft from the presently approved Apollo program may not have to be used to complete its requirements and thus may be available for alternate missions—and it is therefore prudent to plan for their most effective use—at the same time, we must remember that we are today only at the beginning of the period that will see success or failure on each of a large number of extremely difficult ground and flight tests. To get through this period without a major setback will require the best use of all of our resources and the highest management and technological skills. It is a time when we need your help and support more than ever. No one can say that we will get through it without using the full complement of vehicles now programed. Second, although we are planning to keep every possible option open for a smooth transition from the development flights that will prove out the systems to the flights that will expand their usefulness in the post development period, we already know that the limitations upon our resources in fiscal year 1966 and in fiscal year 1967 will not permit us to exercise all of these options should we have full success.

Since we cannot make the necessary decisions in 1967, the future of the NASA program lies largely in the decisions for fiscal year 1968. Beyond that time, we cannot consider the full-scale initiation of Project Voyager for a 1973 flight. At that time, the 1968 budget season, we must decide on the initiation of development and procurement for missions to use the Apollo and Saturn capability—or see this capability erode. We must also consider increases in the levels of effort of selected program areas where important work has been deferred. Projects such as a permanent or resupplied manned space station or a lunar base, or projects for manned planetary exploration, can await further maturing of our operational, scientific, and technological experience. But it is becoming clear that in fiscal year 1968 the Nation must choose to proceed with some of the major options that the NASA program has provided or see them expire. I believe that in the year ahead, we must establish the major objectives that we will look to for a national focus in the years to come.

One example of how the position we have already achieved in space can contribute to objectives of great importance was President Johnson's proposal to Chancellor Erhard, of Germany, in January, for consideration of a major new program of cooperation in space technology between the United States and the nations of Western Europe. Our now proven system of bringing science, technology, engineering, and management into effective large-scale teamwork opens the possibility for the European nations to use the knowledge they have already gained by their own efforts in the European Space Research Organization (ESRO) and through cooperative efforts with NASA to now undertake large projects in spacecraft technology projects which generally appear to them as too big for any one nation. The idea under discussion is that, through the cooperative developmnet and production, at their expense, of a large spacecraft—perhaps a probe to

Jupiter or a vehicle for solar research—which we would launch for them, they could gain for scientists in their universities and engineers and workers in their industries an ability in the main fast-moving fields of science and technology that would serve many of their present and future needs. This ability would give both their specialists and their most thoughtful leaders a better basis for determining their true interests and needs in many areas of decision making where the opportunities and limits set by science and technology, if properly understood, can add or subject large elements of value.

President Johnson feels that all mankind will be able to live in a better world tomorrow if we can find a way to use an expansion of the scientific exploration of space and the cooperative international development of nonmilitary space technology to provide an expanding basis for cohesion among interested nations for a broader international concert of some areas of policy to better serve many areas of common international interests.

NASA already has, in our present programs with 69 nations and several international organizations, a strong and successful base for further international cooperation in space. It may be possible, in line with the President's new proposal, that certain of the nations of Western Europe may wish to join in undertaking and financing cooperative projects much larger and more advanced than any they have heretofore thought possible—projects which would require and generate within their national universities, their own industries and laboratories, a considerable expansion of science and technology of a very advanced sort. This would undoubtedly open up many opportunities for some of their brightest minds.

There is a growing understanding, both in Europe and in this country, that if the European community is to continue to be economically strong and competitive, it will have to find some way to make a major effort in the years immediately ahead to develop its own indigenous and self-renewing competence in the fields of advanced science and technology which are characteristic of the space program. President Johnson's proposal is one way to move out in this direction.

The past accomplishments of the space program have had a direct and positive effect on mankind as a whole and upon the position of the United States in the society of nations. Without question, our accomplishments in space, openly conducted for all to see, prove our capability to do and achieve even more in the future than we have in the past.

I believe that the details you have covered in your subcommittee hearings, and which the Associate Administrators will summarize for the full committee tomorrow, make it clear that the budget recommended for fiscal year 1967, while austere, will permit us to continue progress toward fiscal year 1968 decisions on how we will use our capabilities in the best interest of the Nation. To operate under this will, however, require your full support and our utmost care in husbanding our resources and maintaining flexibility. We in NASA are prepared to make a major effort to assure that realistic options and alternatives will not be foreclosed before you have an opportunity to take them up in 1968.

The CHAIRMAN. Thank you, very much, Mr. Webb. I want to congratulate you on a very fine statement and to say that the concept

of all-out systems testing which has been forced upon you apparently has paid off. I think this is greatly to NASA's credit, the fact that you were able to do what has been done and meet your schedule in this new manner is certainly a credit to you and your great team that you have assembled in NASA.

We realize, as you do, the difficulties under which you have to operate at the present time, and I am certain that as we have in the past, we can reconcile differences, if they do arise, but our responsibility requires us, of course, to examine carefully these programs and we will not be lax in that responsibility.

Mr. WEBB. Thank you, Mr. Chairman. May I say one word with respect to all-up systems testing? We really have had very limited experience with these very large systems. It has worked up to date, but it is not reasonable to expect that we will run through 27 vehicles of the Saturn class under this kind of a concept without some most serious difficulties which we and this committee will have to face together. The important point is that we are building a system here that can make and fly any rocket, not just one rocket or one family of rockets, and that is I think the major thing that Dr. Mueller and others have contributed from their experience in previous military systems.

The CHAIRMAN. That is why I want to recognize their ability and capability within NASA. It has been inspiring and I think we all recognize that you don't win on every pass at the dice table. The thing that worries me is that our successes, particularly in the manned space phase of this work, have been so great that the probabilities are playing against us, but I am certain that the drive and energy that you and your team have put into this thing, we are not going to fail.

Mr. Teague?

Mr. TEAGUE. Mr. Chairman, I agree with you completely concerning Mr. Webb's statement. I feel like that if he could have given this statement out at 1600 Pennsylvania Avenue it would have been of a lot more benefit. I daily become more disturbed at the attitude of the executive branch of the Government as to whether they really want an aggressive program like we should be carrying out, and why we should wait another year to make major decisions, I don't understand. To me it is like telling a child that we are going to make you crawl another year before you can walk and I think our capabilities are already eroding as far as the Apollo program is concerned and I would like to ask the Administrator why we should wait another year to make major decisions on future programs.

Mr. WEBB. Mr. Teague, I am sure you know I have had some experience in programing the total work and money programs of the Government and the Bureau of the Budget. No agency, no administrator, can insist that his program take priority over all others. The total Government program is in reality the consensus of this Nation. Nationally and internationally, the President has had extremely difficult problems to solve in connection with this budget, with the one last year, and I have no doubt that he has done his very best to reconcile the various demands and interests. He has not lost his interest in space. He has preserved in this budget options for decision and not closed them off, and that is the fullest extent to which he felt he could go in connection with this year's budget.

I can assure you that all of these matters were clearly before him.

Mr. TEAGUE. Do you have any assurance that next year we are not going to drop further behind?

Mr. WEBB. No, sir; each budget rests on its own and there is no assurance with respect to the future. There is, of course, a certain continuity in these programs and in the trends, and our trend has been downward now for 3 years.

Mr. TEAGUE. You know we have been told in committee hearings that there is indications that a considerable increase would come in Apollo applications for example, next year. There must be some assurance that we are going to pick up and move forward and not let this capability erode. As I said before I think it has already eroded.

Mr. WEBB. Mr. Teague, I know of no assurance that has been given or could be given that Apollo applications will be funded at the rate you indicate next year. We are certainly going to, as an agency, make the most vigorous presentation we can to the Director of the Budget, to the President and all others who will listen to us and we hope very much that we will from the studies this year be able to project enough knowledge, information as to the time and costs and usefulness of the system, so that it will be adopted. However, I must say I can give you no assurance that any program will be funded in any future budget. I would say this, that the leaders in the executive branch, including the President, do pay a good deal of attention to what Congress and committees like this think about these matters and this is one reason that I have made it very clear that each of us is going to have to stand up and be counted.

Mr. TEAGUE. I would predict your agency will be treated a lot better by Congress than it has been treated by the Bureau of the Budget and the White House.

The CHAIRMAN. Of course, I think that matters far beyond the control of the President and the Bureau of the Budget or the Congress will be the dominant factor in determining this in the future, but I hope that success rests with us and shortly we can return to more peaceful ways and then I am sure we can get on with this program in the manner in which it was planned. I am confident that the President is still a great champion of space.

Mr. WEBB. He did recommend $5,012 million, Mr. Chairman, and that is a substantial recommendation in this budget.

The CHAIRMAN. I am very happy to see Mr. Martin here today. He does not wish to come up and take his proper seat.

Mr. MARTIN. You need not call attention to it.

The CHAIRMAN. Have you any questions, Mr. Martin?

Mr. MARTIN. No; I have no questions. To Mr. Fulton I yield.

The CHAIRMAN. Mr. Fulton?

Mr. FULTON. I am glad to have you here. I want to compliment you on your successes to date. We are sorry we lost the two astronauts, but that was really not a space accident. That was a transportation accident within the atmosphere. We hope that our 100-percent safety record in space will continue.

The question I have is on the point you make that we are behind the Soviet Union in certain important aspects of space power and you put a time of 2 years before we can catch up. It would seem to me that you should be referring simply to boosters, their size and their thrust

capacity and you should not be referring to much else because we certainly are abreast of them on guidance, maneuverability, control, and successful launches, so actually isn't your statement limited simply to the thrust power of the large boosters which we believe the Soviet Union has the capability for at the present time?

Mr. WEBB. Mr. Fulton, in my view we are moving rapidly into a period when it will be to our interest, and I think the Russians are moving into that same period when it will be to their interest, to do many things with large spacecraft, with combinations of missions, multipurpose missions, and the booster is only one part of that. Now, it is true that we have developed a very sophisticated capability with these small unmanned craft like Ranger, Mariner, and with our orbiting laboratories——

Mr. FULTON. But I am trying to get you to put a limit on your statement that we are 2 years behind the Soviet Union, because it would appear to me from your statement that it is in the field of the large booster.

Mr. WEBB. I was coming to this. When you get into the problems of the control, guidance, and propulsion of large spacecraft, you are moving out of the field where we have had any experience and we will not have any experience until we get into it with the Apollo. With respect to Gemini, we have a limited amount of propulsion and we proved that our concepts of the new ratio of thrust to inertia as against the old aeronautical terms of lift to drag, would work correctly. But with large spacecraft you have to have larger engines and you have to be able to start them and stop them many times. Even in the lunar and planetary field, my view is that the Russian program is about three times that we have projected at this time.

So I would not want to limit myself to just the booster field because the spacecraft that are flown on the boosters are the things that are going to do the work.

(The information requested is as follows:)

(Excerpt from 1966 hearing of the House Committee on Science and Astronautics:)

Mr. FULTON. You had spoken of the position of the U.S.S.R. in astronautics. Would you just briefly compare the U.S. position at the present time with the U.S.S.R. and tell us whether this proposed budget will bring us even with them, keep us ahead, or leapfrog the U.S.S.R. program in space?

Mr. WEBB. Congressman Fulton, I think a fairly general statement that I would make would be that this program, compared with what they are doing, will not leapfrog them, will not in this immediate fiscal year of 1966 proceed to close the gap that has existed, except as it provides for vehicles that will fly in later years.

The program that we planned in 1961 was designed to develop every capability required in space, both manned and unmanned, to get heavy vehicles and specialized vehicles into earth orbit, to be able to launch those accurately from earth orbit outward for any purpose that we needed, and to orbit and land on other bodies in space.

We are building the manned space flight capability on the experience we have had with Ranger and Mariner, and the Voyager will be built on this experience also.

In the period that we are discussing, this entire program, which I have clearly described as operating at a lower level than we could efficiently operate and with a foundation on which we could expand, still must be considered, as meeting our own needs. The program must be considered against those needs and whether our needs will change as a result of what the U.S.S.R. is doing.

I would characterize their program as being a broadly based one. There is no indication of a slowdown. In fact, they have launched about twice as many important space missions during the calendar year 1964 as in any previous years.

I would doubt that there is evidence to show that they are in a program like Apollo on the same schedule that we are, but they may have some substitute or may have the desire to build a program on the broad base of their operations.

No one can know to what specific missions the Soviet program is directed, but the Russians certainly are developing all of the capabilities to do the kind of advanced missions that we have regarded as being in our best interest to pursue.

I think it is possible that they are planning to increase their image of capability in space and in very advanced technology on the base they have already built. They have had great success with their space program—perhaps more success than with any other program—and I think it offers them a capability for flexible determination of missions and for execution of missions that will probably not be exceeded—that is, their image will not be exceeded by the United States—within the next year or two.

The success we have achieved already has, we believe, denied the U.S.S.R. many of the benefits and many of the options which the Soviets expected their space program to provide as a part of their forward thrust toward world domination. It would be a mistake, however, to feel that the Russians are no longer pursuing an active and vigorous program or that they do not see many advantages of a vigorous space program. They give every evidence of a determination to achieve these advantages. While our program has been planned as a 10-year effort to accomplish what we believe we need as a nation, it cannot be conducted without regard to what the U.S.S.R. is doing. Their space activity is steadily increasing. Whatever that country may do, we do have built now a stronger base on which to take all actions which may be required in our national interest.

Mr. FULTON. May I compliment you on continuing the work on the SNAP-8 nuclear electric power system, because we do need an operational capability of that type in space. Likewise I am glad to see that on page 14 of your statement you say an energetic program and investigation of high energy liquid fuel engines has been included.

You will recall for the past 7 years I have urged the emphasis on this program, so I would like to compliment Dr. Newell on that, too.

Then my final point is this, and it somewhat runs along the same lines that Mr. Teague has pointed out, and that is the method of the choice of future programs. For example, the method of choice is in Apollo applications as well as in advance studies; so in 1966 we had 48 million for Apollo applications, and in 1967 we had $41.9 million programed. Now in the advance studies we put in 26 million in 1965; we put in 10 million in 1966, and this year we are going to put in 8 million. I understand the Apollo applications are really procurement items of boosters and spacecraft, dependent upon the configuration of Apollo IB. My question is this: I don't know and I wish you would tell me what we have received for our money previously on these two authorizations, and second, if the decision is being put off until fiscal 1968 by the President, maybe we are off on the wrong track on this procurement because this generation of vehicles and hardware will be obsolete in 2 years, so we would then be procuring obsolete vehicles.

One other point on the advanced studies: I think that in your consultations with the President you must act in setting the objectives of the programs beyond Apollo, and I believe we must have those decisions made and then the programs must be looked into to see if they are feasible. Therefore, my feeling is that in advance studies you are really getting the cart before the horse and that Apollo applications authorizations of 41.9 million is probably buying obsolete equipment, boosters and spacecraft, without the overall decision having been made. Therefore. I question these items.

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Will you please follow up on Mr. Teague's statement and reply to my feeling on this?

Mr. WEBB. Yes, sir. First of all, Mr. Fulton, when you run through the Saturn I flights and upgrade that booster and establish a production line which is necessary to prove out the Apollo system in Earth orbit, and have it available as one of our national launch vehicle family, and when you have made one flight with it, then you are not dealing with an obsolete booster. This is an eight-engine booster that has an engine out capability. If one engine fails, it can still carry out its mission. Nothing like it is available in our system.

Mr. FULTON. Can I comment on that? We don't want to use an elephant when the rabbit might be the best means of propulsion. We don't know what it is going to be suited for and when we go ahead with $41.9 million in the coming fiscal year and procure vehicles and spacecraft of this generation without knowing their end item uses or how it is going to effectuate or implement a program, maybe we are just saying we are going to buy some sort of a thing and hope it will be usable. On top of that we have to remember last year we put in $48 million and in the current fiscal year we are putting in $48 million into the same item, Apollo missions, which is simply current procurement.

There is one other item that should be looked into and that is if we have this same success on the later Saturn flights, the Saturn I–B and Saturn V, as we have on the 10 Saturn I's we are going to have equipment and boosters and spacecraft left over from the Saturn program. Why don't we make the decision quicker and then see how we are doing on these programs, because we may be having spacecraft and boosters lying around with hardware that is not modified for the particular purpose required?

Mr. WEBB. Mr. Fulton, the cycle for maintaining the production line of Saturn I–B's requires the procurement of certain long leadtime items like engines this year. Failure to do so would be insuring a gap in that production line. Now, only one Saturn I–B has flown to this time and this is the largest booster we have except for the Saturn V. It is certainly a very advanced vehicle with a liquid hydrogen in its upper states and with tremendous capability. It seems to me that neither do you want to do as you say, try to use an elephant for a job that you need something smaller for, nor do you want to carry 10-ton loads on a 1½-ton truck. This Nation has been somewhat in that position for a long time. Having spent the money to put a production line into effect and having passed the point on the learning curve where the costs per booster goes down, I, for one, would view with the greatest concern a decision now not to buy those long leadtime items that would maintain that booster in production.

Mr. FULTON. Being the Devil's advocate, you must look back at your own successes of 10 on Saturn I and 1 on Saturn I–B and if you project the same success into the Saturn I–B future operations as well as Saturn V you find a much different pattern on the use of vehicles and the use of boosters because that says to me that there is a good chance you will have both boosters and vehicles left over in the Apollo program.

My other point is this: We are making advances so quickly in both propulsion, boosters, guidance, controls, spacecraft, and modifications

that I don't want to get set and get tied down to another generation of vehicles and spacecraft that may become obsolete, and especially when it is a year before the decision is made as to what we are going to do, and that decision must be made by the Executive.

The CHAIRMAN. I would like to say that I hope the gentleman is right, and that we can see that these vehicles will be becoming obsolescent, and the point that I make, until we get a few more tests on them, maybe we better have a few in standby. I think you would agree with me we have done pretty well and I don't think we are going to get too far out.

Mr. FULTON. With $48 million in the current fiscal year and $41.9 million for Apollo Applications, that is about $50 million for standby and I think that is going a little high.

The CHAIRMAN. I don't know.

Mr. FULTON. That is all.

The CHAIRMAN. Mr. Karth.

Mr. KARTH. I have no questions.

The CHAIRMAN. Mr. Mosher?

Mr. MOSHER. Mr. Chairman, don't I remember some months ago the publication of a popular opinion poll—I think it was one of the reliable polls—that listed our space program high on the list of public programs that the general public seems to think is expendable. Is this a factor in the White House thinking that Mr.Teague brought up—in the White House's apparent hesitant attitude toward NASA's program? Are they following a public opinion that is hesitant toward space, too? Does public attitude concern you on our space program?

Mr. WEBB. Mr. Mosher, I know of no case where the President has followed the polls when he makes decisions with respect to the build-up of these kinds of tools and the considerations of their use in the national interest for our national power position. I think that as sputnik recedes into the past and as Gagarin recedes into the past and as we continue to bring down two Gemini within a few miles of the aircraft carriers, the easier it all looks. The plain fact is that we are moving into a much more difficult field, and public opinion here is less valid than the kind of analysis that we give you when you consider the total national interest.

My own view is that we must do the job and that the public will be glad it was done. I do not find, in my own personal appearances around the country, any diminution of public interest among the vigorous, forward-looking and particularly the younger people. There are, of course, also people who cannot understand why it takes so much money to operate in space.

I think it takes time to understand that we are dealing with a completely new thing when we use a rocket engine and move out from the Earth and get into situations of dynamic flight and when we build a vehicle that has the power of 6,000 Boeing 707's. The public hasn't had time to catch up with that yet. They do know there is something important here and I doubt very much that they would fail to have a reaction if they felt there was a gap in the production lines and if we, in effect, decided to abandon these fields in space to the Russians. My own view is there would be a strong public reaction against such a gap and such a decision.

Mr. MOSHER. I am inclined to agree with you. Your prepared statement seemed to be basically an apology for sort of a barebones program in fiscal year 1967. You are giving us your assurance, I judge, that you are not afraid of public opinion in this field but the reason for a barebones program is caused more by Vietnam than anything else? Is that an accurate statement?

Mr. WEBB. Well, I think, Mr. Mosher, the longer a program like this runs and the more people there are who need $200 or $300 million for some other project and make speeches saying if we only had a few hundred million dollars that the space program is consuming, think what we could do with it in this field or that, that all of this begins to build up into some question in the mind of some segments of the public.

I think the program is very, very soundly conceived. We all have gone through a period in the last 5 years within which we presented to you five different times a program that was to run for 10 years and which was to rise to a level between $5½ and $6 billion, run there for a couple years and then taper off. Now this program within those 5 years has been cut $1,100 million below the President's recommendations by the Congress. In the meantime the President himself has accepted, as I said here at this table last year, the bench mark established by Congress and in that year recommended approximately the same level. He added $10 million to your previous appropriations. This year with all of the problems he had with the budget, his recommendation dropped below the amount you recommended last year by about $250 million and below the appropriated amount by $163 million. So, in a sense he has followed the Congress downward. But there has been $1,100 million knocked off our plan for a 10-year program which has added 2 and maybe 3 years to the program and has about $3 billion to the cost of the same work in the manned flight field. This is the situation we face as a Nation.

Mr. MOSHER. One more question. In the Karth subcommittee we have been very much concerned about the postponement of the first Voyager flight from 1971 to 1973 and now I notice on page 13 you are suggesting 1975 as almost inevitable for the first Voyager.

Mr. WEBB. What I am saying there is unless we really give Voyager active funding and prosecute it vigorously in the years after 1968, we can't make it in 1973. Also, I am saying you now have probably eliminated the possibility of an automated biological laboratory to Mars in 1973. That has to go over. There isn't time to do that for the 1973 mission even now.

Mr. MOSHER. Would a little more money in the Voyager program this year be helpful as a greater guarantee of success in 1973?

Mr. WEBB. A commitment to go forward to the 1973 date with the funding necessary from this year right forward to that time would insure the project, but by a little more money for studies, if what you mean is a little more money for studies without a committal to the program, I would doubt it.

Mr. MOSHER. What I mean is a little more money for studies and you doubt it?

Mr. WEBB. I doubt it.

The CHAIRMAN. Thank you.

Mr. Hechler?

Mr. HECHLER. Mr. Webb, I am greatly heartened by the statement that you made on international cooperation in space and its potentialities for the future of mankind. Our subcommittee has been very excited, as other members of the committee have, by the success of the technology utilization program and we intend to put a little bit more money into this this coming year, more than you have asked. We think this also perhaps could be applied abroad in the area of international cooperation that you mentioned.

Now you have sounded the alarm bell of the night so far as Soviet progress is concerned. I note on page 9 you refer to "the massive Soviet commitment to a rapid buildup and a long-term program." It would seem to me if the Soviet Union is able to devise such a long-term program, we in the United States ought to be making just a little bit more progress toward setting our long-range goals.

Finally, I am deeply concerned about the declining amount of money and support given to research and development in advance research and technology. Just listen to these figures. Fiscal year 1965, $331 million; fiscal 1966, $289 million; fiscal 1967, $278 million; that is the way that support for advance research and technology is going down. My question is: Why we can't spend a little bit more on advanced research and technology, because this will really determine the Nation's strength, not only in space, but the total national strength in the 1970's and 1980's.

Likewise, we should be spending more for research in aeronautics. You are the Administrator of National Aeronautics and Space Administration. Yet I don't believe that NASA is putting enough emphasis on aeronautical research. If our subcommittee has its way, we are going to increase the money for aeronautics beyond your budget request. You mention, at the top of page 14 of your statement, that you are carrying on the SNAP–8 development at a "restrained pace" and "a low level of effort" in the large solid motor area. If this committee added several million dollars more for SNAP–8 and several million dollars more for the 260-inch solid rocket motor, would you actually use it?

Mr. WEBB. Mr. Hechler, I don't have the authority to make the final decision in that matter. The President has sent his budget to you. I am sure that he will consider your actions first when he signs the legislation and second when it comes time to make a working program under both the authorization and the appropriation. I am not able to give you that assurance. The President felt last year that these programs should be eliminated and he did not include funds for them in his budget. We acted with his concurrence and that of Congress to preserve the values in the program and carry them up to a certain point where we could, in a sense, put into the bank the technology that was gained. Your action last year has been taken into account by the President, by us, and by the Budget Director and we have come forward with the least amount of money that we believe will preserve a very important capability that has been built up and a large investment by the company that is doing this work.

Now if you choose to differ with that and to take another action, all I can say is that whatever you do, it will be very carefully considered by the President, by me, and by the Budget Director. However, I am not able to act alone in the matter.

Mr. HECHLER. It seems a useless exercise if this committee and Congress indicates the clear-cut judgment that the programs deserve and the Nation needs the support of the programs, and then the actions of Congress are "carefully considered."

Mr. WEBB. Well, you could say the same thing on behalf of the President's recommendation to you. The Budget and Accounting Act of 1921 looked for a responsible place in the executive branch that Congress could get a full and complete and politically responsible recommendation as to the budget. They found it in the President and no place short of the President. He makes his recommendations to you and you take your action. We have a Government of divided powers and I know of no way that—well, I know of only the way of cooperation to get on with the job in the space program. It seems to me that we all ought to never lose sight of the fact that we must consider these actions on the basis as to whether they help the space program rather than as to whether or not it is a useless exercise to make a recommendation to the President.

Mr. HECHLER. Well, I only hope, when you refer, on page 7, to planning, management, and execution of NASA's program, that the word "execution" doesn't indicate you will execute and kill the 260 and the SNAP's.

Mr. WEBB. No, sir. I want to say that this Nation should not, in my opinion, close off the opportunity to use nuclear power, big solids, and these various other high-energy fuels. The technology of the oceans dominated the world for about 400 years. We entered the space age only 8 years ago, but it is going to last a long, long time and the only way you can get out through the air and into space and operate there is with propulsion.

Mr. HECHLER. One final question. At the top of page 14, you say "the advanced research and technology effort of NASA is a fundamental foundation for all future programs. The 1967 budget adjusts this downward in most important areas." There seems to be a basic conflict there. You emphasize the importance of advanced research and technology and then you say therefore the budget was adjusted downward. In line with my previous comments, I would like for you to project into the future what you feel the importance of advanced research and technology is for the space effort?

Mr. WEBB. Mr. Hechler, first as to the language, it is my responsibility to point out to you what I think is important and the actions taken in this budget. I think it is important and it is adjusted downward. That is all I am saying. With respect to its importance, I think that there has been no more frustrating experience that this Nation has had than to find it has been unable to close the gap in areas of space technology and to find that it took one of the most major efforts that we ever undertook to achieve our present position with respect to ballistic missiles and a deterrent force. Now in the process of learning, since World War II, how to take science, to build on its technology and to have science then improve the technology, to go to engineering design and then to have enough management ability to bring into being the power the Nation needs, the working capability the Nation needs, we have found that we could not on the basis of existing knowledge give either good time or cost estimates or even good estimates of the manpower required. This has produced false starts, and

the cancellation of projects. It is this foundation on which you put your finger that permits us to tell you how long it takes, what it costs, what technology is required, and what the chances of success are. If you are going to have good decisionmaking, you need that and you need it very much and it is one of the best investments that you can make.

Mr. HECHLER. Thank you, Mr. Webb. I agree that advanced research and technology is an excellent investment.

The CHAIRMAN. Thank you very much.

Mr. Roudebush?

Mr. ROUDEBUSH. Mr. Chairman, I want to congratulate Mr. Webb on a very fine and candid statement. It is one that concerns me somewhat, that is the information contained therein, the implied inadequacies of this budget to close what you term the gap in our space program in competition with the Russians.

On page 9 of your statement you bring certain Soviet achievements to our attention, and especially the point of the Soviet landing by Lunar 9 on the Moon this year. I have heard the conversation concerning the inadequacies of our booster capability. However, we have programs that haven't been particularly spectacular in their success that have no regard to booster capability. I think of the Surveyor program.

As you know, I have been on this committee since 1961 and I recall that we were going to soft-land our Surveyor on the Moon in 1963, which is 3 years ago. Now, I believe the recent releases say that NASA now anticipates a soft landing on the Moon in May of this year. I believe I am correct in that. I recall that we were told that this program, and here I certainly am not attempting to embarrass you because I know this was early in preliminary planning, would cost I think $50 million. I think we have expended in excess of $300 million on it—I think around $350 million and now there is an anticipated price tag of something like $700 million. I wonder, and just to be specific, let's take the case of the Surveyor, what has caused this program to lag so badly?

Why are we 3 years behind our target date? Why did we allow the Russians to scoop us on a soft landing on the Moon?

Mr. WEBB. I think, Mr. Roudebush, these are all good questions.

I am not embarrassed by them. We both have to face the problem of how to develop equipment to make a soft landing on the Moon. When the Surveyor was started, it was conceived as an unmanned instrumented vehicle of limited capacity. The Mercury program had not gone forward. We had not committeed ourselves to a program. Estimates like $50 million were in my view completely unrealistic. I think this was a product of not enough advance research and technology so that you could count on the estimates given you. I would like to take one second to contrast that with the lunar landing program where we have told you consistently since 1961 that it would be between $20 and $40 billion, and it is still within the ball park of the lower figure if we have some follow-on programs so as to absorb part of the overhead between now and 1970. Now, specifically with respect to Surveyor, the best that could be done with our people in the Government, with good companies working on the program, was to make an engineering design that appeared to have the possibility of working. When it was tried out in the drop test it was inadequate

and failed. We had to go back and start over again. So you have this learning process which I described to the chairman, and you have an organization that includes Government, industry, universities, and scientists that can make any vehicle, not just Surveyor. So the Surveyor program must be considered in the light of the total space program. Surveyor is going to work and do a good job, but I do not believe that the weight limitations imposed by our boost capability helped it any. I think the requirement for increased weight in the Surveyor to do the kind of things we wanted to do with it, which are very complex——

Mr. ROUDEBUSH. Execuse me, you mean the redesigned Surveyor?

Mr. WEBB. I mean we were trying to get as much as possible out of those flights and the Surveyor is a very much more complex instrument than the Luna 9. It is designed to do many different jobs and this makes its development a very difficult thing. We have never undertaken to go out with just some spectacular thing like a landing. I think the Russians got their money's worth and they got information about the Moon with Luna 9. But we have not wanted to invest time, effort, and boosters in a limited vehicle like Luna 9, so we have gone to a very much more complex vehicle.

Mr. ROUDEBUSH. I would like to make one other comment, Mr. Chairman. In view of the colloquy you entered into with another member of the committee concerning the cuts imposed by Congress, I would like to say some of those cuts were imposed by the Appropriations Committee, not this authorizing committee, which is No. 1 and, secondly, you referred to the limited success and the progress you are making on SNAP–8. Here is a program that this committee insisted be kept in the program and wasn't even recommended by the President last year, as you are aware. Also, our large solid fuel boosters, if it hadn't been for the individual effort or I should say the joint effort of the members of this committee, we would have no solid fuel program within the capabilities of NASA. So, I certainly think my colleagues should be commended.

The CHAIRMAN. Thank you very much.

Mr. Daddario?

Mr. DADDARIO. Mr. Webb, during the last several days the Manned Space Subcommittee has been holding hearings as you know and I want to compliment you on the caliber of testimony and the manner of the men you sent up here, Dr. Mueller, Mr. Lilly, George Low and all the others. I feel they did an outstanding job with a very difficult authorization bill.

I do have just one question. It boils down to your hope that we would give this request of yours our full support. I wonder how you envision congressional responsibility in this regard and to whom in fact we are giving support—to you or the Bureau of the Budget? You take Apollo applications and there is no question you wanted some $200 million more than you received. In supporting that request, we support not you, but the Bureau of the Budget. Where does this matter of choice come in? How do you envision the congressional responsibility in this regard?

Mr. WEBB. Mr. Daddario, I have heard many times from Members of Congress the expression, "Any budget can be cut 5 percent or 10 percent." I would hope that this committee would authorize the

complete amount recommended by the President and that you would do what you can with us, as you have done in previous years, to persuade the Appropriations Committees to do the same. This is what I mean. Anything less than this full appropriation is going to be more serious this year than it has been in any year in the past.

Mr. DADDARIO. The unfortunate part of that is that over the past years there have been cuts by this committee and I think we should take that responsibility and I think we can point to cuts made which have been in the best interests of both the space program and the country. I don't know that we ought to be asked to give full support to a full authorization, considering that we do have experience on which we can make cuts not just on a percentage basis but because we believe, as a committee of responsibility and some knowledge of the subject, that those cuts represent a clear choice insofar as the Congress is concerned. Now, we run into that particular situation. I understand the problems you will run into if we do cut, but since we have already in our subcommittee, frankly, come to some determinations, based not on a desire simply to cut, but because it seemed to us to be a good choice, we find ourselves running in opposition to you in that regard.

Mr. WEBB. Mr. Daddario, I do my best to present the needs of this program to the Director of the Budget and to the President and to the four committees in Congress with over 100 members, that consider that program. Many people have different views. Certainly that is the democratic process of decisionmaking. I would like to point out we are at a critical time and conducting a very large program and having to turn rapidly around in things like the Gemini VI and VII effort where we weuld have lost a good deal of time had we not succeeded and where we had to come to the last countdown twice with Gemini VI before we got it launched.

We are in a very difficult period and I would hope this committee and its subcommittees would try to be very, very sure they were improving the program and improving the capability of NASA to turn in a success in the program when they make their judgments. That is what I am urging. I am urging everybody to think twice and to count to 10 because it isn't a question of whether I want the money. I have made it very clear to this committee that we have constructed a machine that can go faster or slower, and the policy must be fixed elsewhere, but I now am making it very clear that the decisions here are going to affect the program and they may do the program harm.

Mr. DADDARIO. Mr. Webb, you have done an outstanding job with the funds the Congress has given you and I am sure I am not the only one in this committee who feels so, but I just wondered did you make the same arguments to the Bureau of the Budget?

Mr. WEBB. Yes, sir, I have made them right straight through to the highest levels.

The CHAIRMAN. Maybe you were a little softer in your committee.

Mr. DADDARIO. Mr. Teague made a prophecy a bit ago and I am sure when this is all counted and put together you will find the percentage restrictions placed on you by the Congress will be much less than those placed on you by the Bureau of the Budget.

Mr. WEBB. May I say this, that while I have made the strongest argument I could for the preservation of the assets that we have pur-

chased with $21 billion and where men like you and Seamans and others of us have put in 5 years of our life, I have made the best argument I could, but I have also said to the President, and say to you, when you decide, we will try to get you a dollar's worth of value out of every dollar you appropriate, and we are not going to whine about your decision.

The CHAIRMAN. Mr. Rumsfeld, I believe, is next.

Mr. RUMSFELD. I have two questions. You made the statement, "I have constructed a machine that can go faster or slower."

Mr. WEBB. We have constructed one.

Mr. RUMSFELD. Well "we." It has been constructed. As I recall there were some discussions between representatives of NASA and this committee in previous years about the possibility of a stretchout. We received voluminous documentation to the effect that any stretchout would cost the taxpayers of the country considerably more money over the long run. You recall this information being supplied to the committee. This year there is a cut being made by the Bureau of the Budget and I have not seen reams of material indicating exactly how this stretchout will dramatically increase total costs. I think that the record before our Manned Space Flight Subcommittee indicates that in some areas it is going to cost in the neighborhood of 20 percent more because of these cuts. Is that your understanding?

Mr. WEBB. I think, Mr. Rumsfeld, I would like to put it in a slightly different way.

Mr. RUMSFELD. I am not surprised.

Mr. WEBB. In the calendar year 1964 when we were making the plans after a ratification of the program by the Congress, we could have designed a program that would have run over a longer period of time. Now, what I testified in connection with the 1965 and 1966 budget is that if you slowed up in that period of time you would have a major increase in the risk involved, you would stretch the time out and it would cost about another billion dollars a year.

Now, the actual reductions in the $5,750 million recommendation by President Kennedy and the $5,445 million recommendation by President Johnson brought us down about a half billion dollars below the projection we made for the operations at the time we were planning the program. Up to now we have been able to absorb those cuts through all-up systems tests and still maintain target dates, but we tell you every year if we have a major failure those target dates will have to slide. Dr. Seamans and I and our associates have faced very thoughtfully up to the question of whether we should make some arbitrary reductions of major programs in order to create a little more reserve and to incorporate a little less risk. We have chosen to not do that but to proceed on the basis we can succeed in every one of them.

Mr. RUMSFELD. My question was whether or not it is your understanding that there are going to be increased costs in the program as a result of the cuts which have been taking place between NASA and the Bureau of the Budget. That is the testimony before the Manned Space Flight Subcommittee.

Mr. WEBB. I have said to the Bureau of the Budget and I have testified that it costs about a billion dollars a year to stretch the program out to do the same work. They have the same information you do.

However, I must point out to you that the President came down to your benchmark at a time when we were saying to you to speed it up because to slow it up would cost more money.

Mr. RUMSFELD. My second question involves something that distresses me. On page 11 you make the statement there will be no margins and no backup hardware. Any failure on tests or other setback will mean one or the other of these priorities will suffer.

On page 12 you say, "Let me repeat that this budget provides no margin of time or of resources to counter the effects of setbacks or failures." It is my understanding, that as a result of hours of testimony before the Manned Space Flight Subcommittee that that is just not accurate. Now, if I am mistaken, I would really like to know because the number of vehicles that have been programed clearly provides a margin.

It would be unconscionable for this committee, I think, or NASA to recommend a budget that provides no margin and I can cite page after page that shows there is a margin. Are we not on the same wavelength here?

Mr. WEBB. Mr. Rumsfeld, of course, you have to make up your own mind about how you judge the testimony that is given to you in subcommittee. I am simply saying that when you look at a broad program to spend $5 billion a year and you are responsible at the top administratively for bringing about success and also have in mind what you do in the case of failure, you look at the margins, you look at the schedules, and you tighten up schedules in order to force the pace at a rapid march by the organization. Dr. Mueller clearly indicated to you what the Gemini program has been through and how the time interval between launches has been brought down to 2 months——

Mr. RUMSFELD. Isn't it misleading to say there is no margin because we all know there is?

Mr. WEBB. That is precisely what I was going to say. My candid and carefully stated judgment as Administrator of this organization is that while we have target dates for these schedules, in terms of actuality, considering all of the risks, there are no margins. We are as tight as we can be. As I have said to the Senate, and say to you, we are like a skater moving across thin ice. As long as we can keep in motion, we are not going to drop through. We are doing that, but if we slow up you are going to see a major requirement for revaluation, and I have stated that here.

Mr. RUMSFELD. I can appreciate there can be changes, but with 15 Saturn V's, I can't believe we can't say there is some margin.

I just don't think it is an accurate presentation.

Mr. WEBB. When we will meet here next year, or maybe 2 years from now, we will see who is right. But, if you expect us to fly 27 Saturn vehicles and do all of the work that is required to develop a full capability to get out to the Moon and land on the Moon and come back with less than 15 vehicles and fly men on the third or fourth flights of these big systems, and consider that 15 has much margin in it, I should say I am surprised.

Mr. RUMSFELD. I have so much confidence in NASA, I will predict when you come back here next year we will find your statement has overdramatized the thin aspect of it.

Mr. WEBB. I invite you to join our executive group and help us do the job.

The CHAIRMAN. Mr. Roush.

Mr. ROUSH. No questions.

The CHAIRMAN. Mr. Conable.

Mr. CONABLE. Thank you, Mr. Chairman.

Mr. Webb, I realize you get asked this every year, but in the light of the developments of the past year, would you tell me what you think the Russian goals in space are and to what extent it is necessary for us to respond competitively, to what aspects of these Russian goals must we respond competitively?

Mr. WEBB. First, Mr. Conable, let me take the latter part of your question. I do not believe that we have to meet what I have called fierce competition, item by item, and on the precise time scale to maintain the power of this Nation to control its own destiny. I do think that in this kind of business, as systems get developed, you find that it takes them a long leadtime to bring them into operation. We already know a great deal about the space environment and this program will give us in the next 3 years a vast amount of experience with the operational capability of our own vehicles and a chance to observe what they are doing. So I think we are developing knowledge which permits us to meet any risk that their program provides for us.

I think that they started out to do two things.

First, to reinforce the success of their space program, which is the major success they have had, to try to do, in a sense, what President Johnson is now suggesting to Western Europe, they started out to develop a total range of technologies to give them the ability to decide what is in their own interest and what is not in their own interest and not have to rely on someone else. I think this they needed, and to use that not only with respect to space and aeronautics but with respect to their total economy.

Second, I think the power they have deveolped and the demonstration they have made in the past year, both around the Earth and outward to the Moon and planets, brings them nearer to the time that they will be selecting the options for full exploitation. My own belief is that they will be able to put up as big or bigger payloads as we can with the Saturn V at any time they choose to do so. The obvious use of such payloads are the same for us and for them—a lunar base, a large Manned Orbital Laboratory, a manned multiuse system in synchronous orbit and with some added high-energy stages, and manned exploration of the planets. So, I think you can look for some fairly spectacular operations, with very large spacecraft, at the same time we are conducting what I would call a very spectacular operation with the Saturn V. That is not going to be any small item. That is going to have the power of 6,000 Boeing 707's in 1 machine. It is going to be dramatic, and it is going to be even more dramatic if one of them doesn't go when the engines are lit, as we have seen happen in the Titan. So I would say that they have now the capability to adopt any option that they wish, including a manned lunar landing, and roughly within the same time scale that we planned our own program.

I cannot forecast exactly what they will do with this capability, but they can do anything we can do and we have not closed the gap.

You know, Mr. Fulton asked me very carefully about this last year and I stated we would not leapfrog them this year. I would say now, as between last year and this year, my judgment is that they have progressed very much more rapidly in the year in terms of clear indications of what they can do, will do, have the capability to do, than we have.

Mr. CHAIRMAN. Thank you. Mr. Davis?

Mr. DAVIS. Mr. Chairman, I just have a comment or two.

Mr. Webb, a great Republican by the name of Abraham Lincoln once made the statement that public opinion was everything, that with it nothing could fail and without it nothing could succeed. I think he gained that insight after having served in the House of Representatives.

I just wanted to say this: That, of course, we have a free country and Russia has a country that is not free. It has a monolithic government, but nevertheless I would bet that Abraham Lincoln's dictum holds true in Russia and I would bet that the average Russian citizen is enormously proud of his space program and that that is the reason that the Russian leaders can get by with investing the percent of their gross national product into the space effort that they get by with investing.

Mr. WEBB. Mr. Davis, this is not only important for them, but for us—that stimulation. I think you put your finger on one of the most important aspects here. They are prouder and more vigorous and ready to be dynamic than they could possibly be without this program.

Mr. DAVIS. I think that is exactly right and I think you are also right when you observe that it is necesesary for our adrenalin to be stimulated by the Russian effort, but I think if Mr. Teague is right and we are delaying these decisions that have to be made in the next fiscal year too long, if the American people will realize we are letting our abilities erode, I don't think they would forgive the leadership of this country. I think if you could take a poll on the question of whether or not we ought to let Russia get ahead of us, every right-thinking American citizen—the average American citizen—would say by no means let Russia do that. Of course, nobody wants to see any waste in the space program and lots of people will say, "Why does anybody want to send a man to the Moon?" I think Dr. Teller had the best answer, by the way, to that question when somebody asked Dr. Teller before our committee—I think it was a subcommittee meeting—"Dr. Teller, what is it you expect to find when you finally get a man on the Moon?" And Dr. Teller's answer was "Russians." I think that is the best answer to that question.

Mr. WEBB. In terms of what has happened in the past year, I am more of his mind than I was a year ago.

Mr. DAVIS. That is all.

The CHAIRMAN. Mr. Ryan?

Mr. RYAN. Would you say you do expect to find Russians on the Moon when we arrive?

Mr. WEBB. I believe this program is going to be supported by the people and this committee and I think by 1969 we will be there with less than the 15 Saturns, but at the same time, I think that it would be very foolish not to have those 15 Saturns devoted to doing it in the early part of 1970, if we can't get there in 1969. I would say

there is more chance than I thought a year ago that they will be there before 1969, but I still think that we can beat them if these resources are provided.

Mr. RYAN. You stated previously we had not closed the gap with the Russians during the past year. Would you say the gap has widened?

Mr. WEBB. Yes; I would. Speaking of the total space investment and effort and capability and options and so forth, it has widened, in my view.

Mr. RYAN. In the fall of 1963, I believe, President Kennedy suggested a joint venture between the United States and Russia on a Moon program. Has there been any thinking in the past 2 years in NASA on this subject and has NASA explored this in any way?

Mr. WEBB. Mr. Ryan, we always think about any suggestion made by a President. We have, of course, looked for any evidence that they were interested and found none. In fact, I would say the evidence has all been the other way. I think you must bear in mind that any very senior national leader like the President always knows with respect to a big program like this that you wear two faces—one is cooperation and one is competition, and while you are vigorously competing and don't mean to lose to competition, you still hold out the opportunity for cooperation with the benefits that are implied there.

I think that President Kennedy wanted to make it clear he was prepared to cooperate or to compete, and that is why he recommended $5,700 million to you gentlemen. I think we are not investing any great amount of effort in trying to design spacecraft that would fly on their boosters or vice versa. They show no evidence of any kind in giving us a key, or even a partial key, that might unlock the door of cooperation.

Mr. RYAN. Do you think their failure to show any evidence of interest and cooperation is due to their belief that they will succeed in arriving on the Moon ahead of us?

Mr. WEBB. This certainly is one element in it. Another, of course, is the total relationship between the nations. I think that they know that they must advance in other areas than space before they can get the truest form of cooperation that would be to their benefit. So they are going to exploit the one area that is useful to them as an image and to develop capability over a period of time to build up in other fields in the same way to improve their position. Unequal partners or an unequal partnership is a very hard thing to make work. They know that, as we do.

Mr. RYAN. I think all of us share your sentiments expressed earlier in your statement regarding Dr. Dryden. I know the members of this committee, and I think the Nation suffered a great loss. I wondered who in your agency now is handling negotiations on the international front, the cooperative effort.

Mr. WEBB. I am taking the lead in the policy issues, Mr. Ryan. Dr. Newell, Mr. Arnold Frutkin who is in charge of international programs, and Dr. Townsend, who was with Dr. Dryden during his negotiations, take care of the technical side. But on the policy side, I am doing that myself.

Mr. RYAN. Page 17 you state that it is becoming clear in fiscal 1968 the Nation must choose to proceed with some of the major options. What options do we have to choose among in 1968?

Mr. WEBB. Well, first of all we see now a decline in the engineering groups that designed and did the total systems engineering on the Saturn I–B. While the production workers are still there, the employment even on the production line will begin to decrease rapidly. By buying the engines this year, 1967, we can still decide next year to capitalize on our big investment in an Apollo application program but only if you appropriate the money to keep that production line going. This is one kind of an item.

With respect to long missions like the Voyager, we also are spending enough study money and trying to develop systems that could be used so that we will be able, if you appropriate the money next year and approve the project, to move ahead. I could go ahead with others but these are two large ones.

Mr. RYAN. May I ask one final question?

The CHAIRMAN. Very quickly. You are over your time, now.

Mr. RYAN. This has concerned me and the other members of the subcommittee and it is this. Did NASA really need all of the money it asked for in past years for electronic research centers?

Mr. WEBB. Yes, because we are buying $2 billion a year of electronics and we have many failures in the electronics area. This whole area needs basic research.

The CHAIRMAN. That is your last question.

Mr. Vivian?

Mr. VIVIAN. Mr. Chairman, I would like to make one observation and ask two questions. The first observation is I would like to encourage the increased stress on international cooperation, particularly the suggestions for a European-Oriental group for the study of the planets, which I think is highly desirable, and I think you will remember my indications to you in the past year on that subject.

My questions are in two categories. The first question is about fiscal 1967 and the second about fiscal 1968. I am concerned we are planning a 1967 space budget on the premises that in 1969 they will be generous and allow us to recover many things we are putting over. I am frankly very apprehensive that is not a correct assumption and we better start in planning over a longer period for the simple reason that our commitment to Vietnam has cost us approximately the total cost of the space program to take it over nearly a decade. We are shipping something like 30,000 tons a week, I think, to Vietnam, whereas the north is shipping in 30,000 tons—in other words, our logistic ratio is very unfavorable.

We have other similar problems ahead. Lin Piao, the Defense Minister of China, said we face many more wars of national liberation, the Havana Conference has met and has pushed more wars of national liberation. The International Education Act of the President is a very important one and I regard it high on my list, and therefore I am quite worried. Are we looking ahead and going ahead far enough? Is the 1968 budget going to recover all of the problems we are putting off? I think not.

Mr. WEBB. Mr. Vivian, this budget recommended by the President has a $300 million less expenditure figure than the 1966 budget. This means about 30,000 or more people less will be working on this program at the end of another 18 months. So you are going to approach the time in 1968 when the decisions must be made or you are

going to drop very, very rapidly. You will drop, I would guess, 100,000 people the next year, over and above the 30,000, unless you go forward to use these capabilities.

Mr. VIVIAN. My present expectation is we will be faced with a more severe budget cutback next year instead of this year; therefore, I hope we are planning this year's budget correctly relative to this possible alternative, as well as hoped for increase.

Second is the motivation on the part of Russia. She has half the gross national product I believe we have. Therefore she is importing goods and exporting military supplies and yet they are pushing ahead, as you say, very aggressively, and apparently are doubling and tripling their efforts in some areas and some successes they have made was a matter of pride, and I concur with that, and other successes were made on other motivations. Could you summarize in about five sentences your principle of motivations for them?

Mr. WEBB. I think they have a successful space program while they have not succeeded in other areas. They want to take this success and apply it broadly. They realize that they are dealing with energy, with new materials, with total systems engineering and with human beings matched with machines. This is what they need to apply broadly and this is the thing they are learning.

Second, I think it makes a vast difference in the way they can act in the world when they land Luna–9 on the Moon and when they have two probe successes out at Venus, just as I think our Gemini rendezvous makes a vast difference as to how we can act in the world as against a failure in that regard. I do not believe that the strong forward thrust of Russians for world dominance is over, and I think they are looking for a means of both image and power, both prestige and the reality of power, and hope to get either out of this program in some way.

Mr. CHAIRMAN. Mr. Schisler.

Mr. SCHISLER. No questions.

The CHAIRMAN. Mr. Cabell.

Mr. CABELL. No questions.

The CHAIRMAN. Thank you very much. I want to thank you and thank your staff for coming here and being so patient with us and to warn Dr. Seamans we will be prepared for him.

Mr. FULTON. I would like to ask if Mr. Webb would bring my questions to you of last year and integrate them with my questions to you of this year.

Mr. WEBB. I have them here and I will do that. You mean for the record?

Mr. FULTON. For the record.

The CHAIRMAN. Without objection, the committee stands adjourned until tomorrow at 10 o'clock.

(Whereupon the hearing was adjourned at 1:50 p.m. to reconvene Friday morning, March 11, 1966, at 10 a.m.)

THE 1967 NASA AUTHORIZATION

FRIDAY, MARCH 11, 1966

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The Committee on Science and Astronautics met, pursuant to adjournment, at 10 a.m., room 2318, Rayburn House Office Building, Washington, D.C., Hon. George P. Miller (chairman of the committee) presiding.

The CHAIRMAN. The committee will be in order.

I am going to ask the witnesses to present their statements which will all be read or put into the record before we have any questioning by the committee. I am doing this in the interest of time and so that we can get these statements into the record and I am trying to give some consideration to the witnesses who are before us whose time can be much better spent, perhaps, in the interest of the program in their offices than they can in talking to us up here.

Without further ado then, Dr. Mueller, will you proceed.

STATEMENT OF DR. GEORGE E. MUELLER, ASSOCIATE ADMINISTRATOR FOR MANNED SPACE FLIGHT, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. MUELLER. Thank you, Mr. Chairman. I would like to summarize the statement with your permission.

The CHAIRMAN. This I presume is the summary.

Dr. MUELLER. Yes, sir.

Mr. Chairman, the achievements of the past year reflect substantial progress toward the accomplishment of this Nation's objectives in space. Yet even with this progress the competition for leadership in space is keen. The Soviets reminded the world of their intentions in space by landing a spacecraft softly on the Moon on February 3, 1966, and by the hard landing of a spacecraft on Venus on March 1. The Japanese have indicated that they will be launching their first satellite in the near future.

Elsewhere in Europe there in increasing concern about the technical leadership accruing in the United States from our space program. I recently spent several days in Germany and I can assure they are concerned about the technological gap that is developing. The launch of the second French satellite on February 17 illustrates the European determination to narrow this gap.

The desire for technological leadership—and through it, ideological leadership—is causing the Soviet Union to invest resources equivalent

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to ours. The pace of the Soviet space program has almost doubled in the last year. The launching of a new booster enabled them to orbit the Proton spacecraft, which is about a ton heavier than anything orbited by the United States.

In the light of this keen international desire for technological leadership, I would like now to report on the results of the Manned Space Flight program directed toward our national objective of U.S. leadership in space.

Our major milestones (fig. 1) remain unchanged with the exception that the first Gemini rendezvous flight was accomplished in 1965 rather than in 1966 as originally scheduled.

The major milestone for 1966 was accomplished on February 26, 1966, with the successful launch of the first Apollo Saturn IB unmanned flight.

During 1965, the Gemini spacecraft was flown six times—five with men. A most significant result was that the crew returned in excellent health, both physical and mental as the flights increased in duration up to 14 days.

From our medical analysis, flights of a month or more appear feasible. Last year, 1,299 hours in space were logged by Gemini crews, equivalent to about two-thirds of a man-year on the job.

A significant event of 1965 was Ed White's 22-minute trip outside the spacecraft. White proved that man can do useful work in space moving about with a hand-held maneuvering unit. White was alert and effective throughout the time he was outside, and there was no disorientation.

Another major event was rendezvous. Within the hour after Lovell and Borman took off on their 2-week flight in Gemini 7, we were setting up another vehicle and spacecraft on the same launch pad.

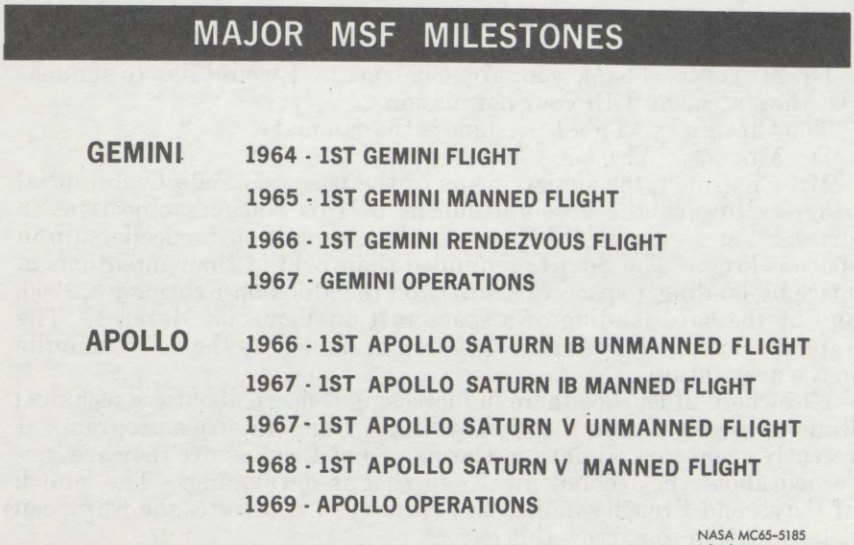

FIGURE 1

Gemini 6 lifted off 11 days later with Wally Schirra and Tom Stafford to carry out the first rendezvous.

Many people deserve credit for these outstanding accomplishments. A broad-based Government industry team carried out the work. The astronauts were magnificent.

Another aspect of Gemini is worth noting. A year ago, the program was behind schedule and we were concerned about the possibility of cost overruns. Through management actions and a new contract in which the profit of the Gemini contractors is tied to their total performance, schedules have been accelerated and costs are under control. I do think the operation of these cost-plus-incentive-fee contracts has constituted one of the finest examples of the proper working of the free enterprise system.

We have also made progress in the Apollo program.

In Apollo, the first phase of the Saturn vehicle program was completed in 1965. In 10 flights of the Saturn I, 10 were successful. This is an unprecedented record of success in rocket development. Much of the technology required for the later Saturn launch vehicles was proved out in the Saturn I project. This technology includes the guidance, the concept of clustered rocket engines, and experience in using liquid hydrogen as rocket fuel.

On February 26, 1966, we successfully flight tested the uprated Saturn I launch vehicle in an unmanned flight. With this launch vehicle later this year, we will place some 35,000 pounds in Earth orbit.

With this first flight, we introduced a new concept in our flight-testing procedures—the "all up" concept. Both stages of the launch vehicle, the instrument unit, the spacecraft Command Module and the Propulsion Module—which supplies propulsion in space—were flown together for the first time. With this launch we also accomplished the first flight test of the J–2 and the Propulsion Module engines. This procedure enables us to get more test results on every flight. It also represents some increase in risk.

During 1965, excellent progress was made in the development of the Saturn V launch vehicle and the Apollo spacecraft to be used on the lunar flights. All three stages of the Saturn V launch vehicle were fired in ground tests. The third stage and the instrument unit of this vehicle were proven in flight on the February 26 uprated Saturn I flight. Testing, assembly and deliveries of engines and stages continue on schedule as does the activation of facilities for test and operational needs.

The spacecraft Command and Propulsion Modules also were successfully flight tested on the February Apollo Saturn flight.

The Lunar Module development is progressing on schedule toward an unmanned flight test in 1967.

I would like to emphasize three points on the status of the manned lunar landing program. First, the Government-industry team required to carry out the program is organized and working.

Second, the program is on schedule, a schedule set when the program began.

Third, if our progress continues, we will carry out the first manned lunar landing before the end of this decade.

Next, I would like to discuss what the Nation has invested in this program. For the Manned Space Flight program we have invested

two and a half billion dollars of funds appropriated to NASA for the acquisition of facilities and their equipment. We have been able to make use of ground facilities and plant worth $760 million, which had been established by the Department of Defense for missile and other programs. Beyond this, American industry has invested $650 million of its own stockholders' funds in new facilities and equipment required to do the job. The NASA Manned Space Flight facilities have a total value of about $4 billion.

Altogether, the Manned Space Flight program is carried out by a team that consists of our Washington office, 3 field centers, 12 prime contractors and some 17,000 subcontractors in every part of the country.

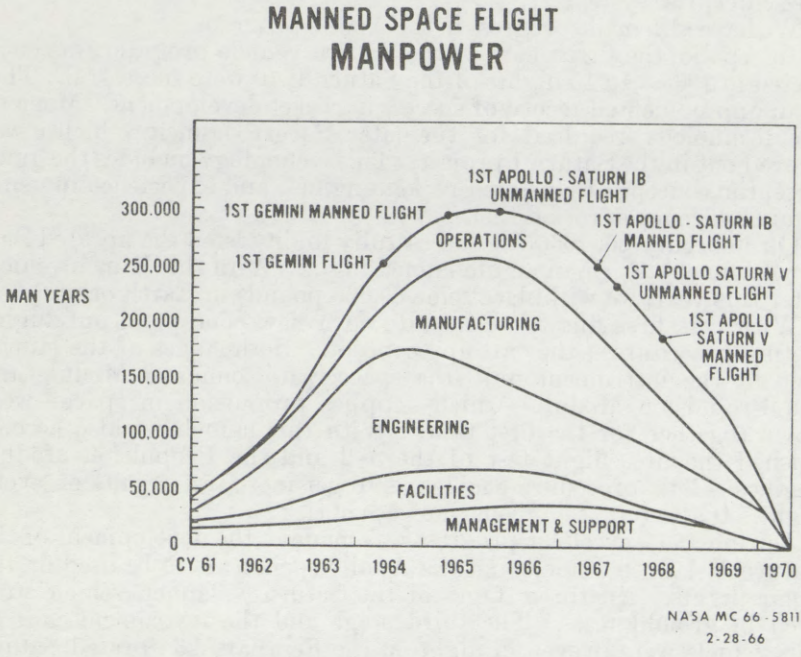

FIGURE 2

We have arrived at our manpower peak of 300,000 people, in the Manned Space Flight effort (fig. 2). The civil service component is about 5 percent of this total. Supporting these people is a group of contractors who assist in the operation of our field centers. With the rapid completion of facilities, construction manpower is phasing out. The bulk of the manpower is engaged in research and development carried out by industrial contractors.

We have passed our peak in engineering, we are reaching our peak in manufacturing, and we are at our peak in total Manned Space Flight manpower resources. The proposed budget for the coming fiscal year, beginning July 1 calls for a leveling off of effort.

A striking anomaly of the space program is that we begin to "go out of business" before we fly our first operational vehicle (fig. 3). The program to develop the uprated Saturn I launch vehicle illustrates this

MANNED SPACE FLIGHT
SATURN IB MANPOWER

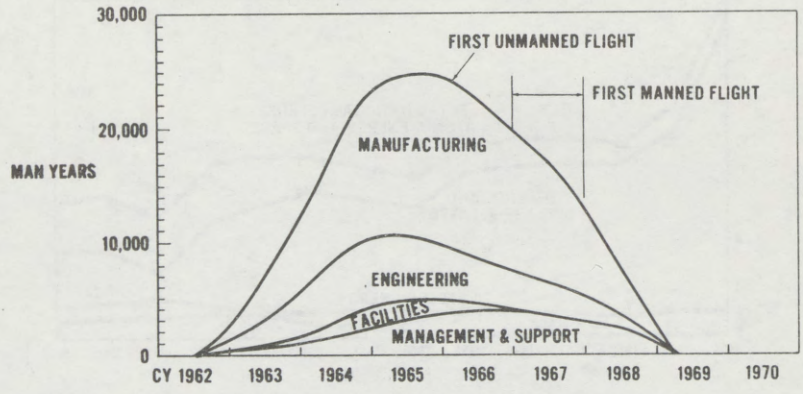

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FIGURE 3

situation. The decline in manpower on this program has been underway for several months, but the first flight took place only 2 weeks ago—and the first manned flight is almost a year away. By then, the employment level will be almost half the peak level of 1965.

The same anomaly characterizes the overall program (see fig. 2, p. 32). The flights of the Apollo Saturn V will begin next year after the program has begun its decline; and the manned flights will begin in 1968 after this decline has been underway for sometime.

Three points should be made regarding the investment in manned space flight.

First—and perhaps most important—an organization consisting of a government contractor structure exists with a total of 300,000 people trained and established in special facilities for Manned Space Flight work.

Second, the program is under control, working toward clearly established program goals, within total cost estimates established at the program inception.

Third, the time has arrived for a decision as to whether and how this capability might be employed for programs to follow present programs.

Now what about the resources committed to the space program?

We are most fortunate to live in an economy that is growing, despite increasing total of Federal expenditures. The share of gross national product represented by these expenditures has been relatively stable—close to 15 percent in the last several years.

One way to view the national commitment to space activities is to look at the related Federal expenditures for the Department of Defense, the Atomic Energy Commission and NASA (fig. 4). (Please note the break in the chart, where it jumps from 1 to 8 percent.)

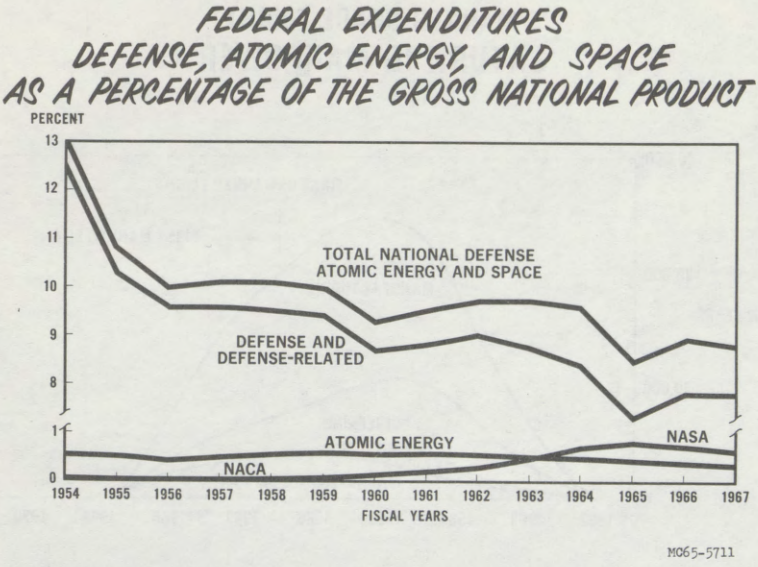

FIGURE 4

Twelve years ago, when the gross national product was $362 billion, the expenditures for national defense, atomic energy, and NASA's predecessor, the National Advisory Committee for Aeronautics, totaled $47.1 billion. This was 13 percent of the gross national product.

In the current fiscal year, the projected total is $62.26 billion, down to 8.9 percent of the gross national product of $700 billion. In fiscal year 1967, if the gross national product grows as anticipated the total expenditures of $66.12 billion for defense, atomic energy, and NASA will represent only 8.8 percent. Thus it is clear that the share of our national wealth represented by the costs of these related activities has been declining over the last decade and will continue to decline in the coming fiscal year despite substantial expenditures for Vietnam. In this perspective, it seems clear that the Nation can afford to carry on the space program.

What comes next?

With the accomplishment of the Apollo program in this decade, we expect to begin the exploration of the Moon.

But, the Apollo system is not limited to manned lunar landings. We can carry out a wide variety of flights in Earth orbit, in lunar orbit and on the lunar surface.

Typical flights include placing an Apollo spacecraft over a point on the Equator at an altitude such that it maintains its position above a fixed point on the ground; or learning to transfer crew and materials between two spacecraft; or placing the spacecraft in orbit about the Moon for 2 weeks to survey the Moon's surface; or launching spacecraft to the same place on the Moon's surface where a landing has already been made, thus using equipment left behind on the previous flight.

Now why is it desirable to fly such missions? What are the potential applications of benefit to man on Earth? With the weight-lifting capabilities available, it would be possible to place both large antennas and powerful transmitters in stationary orbits. Manned with technicians, these stations can bring live television to all countries of the world to be viewed on ordinary home receivers.

An exciting related application is in the early establishment of control towers in space, for communications and navigation of aircraft and ocean-going ships.

An entire group of potential applications is based on the use of observations in space to make fuller use of the resources of the Earth, considered on a planetwide basis.

Observation of land areas can provide current information on minerals, crops, forest stands, and the status of rivers and lakes. The oceans can be observed for oceanographic features, marine life, and other resources.

Another application is to the weather. A group established by the National Academy of Sciences issued a report indicating that the time may well have come to do something about the weather. The Apollo Saturn flight hardware is capable of assisting in this effort.

Finally, there are the applications to science. Scientists associated with the National Academy of Sciences and other leaders recommended the exploration of the Moon, and the placing of large telescopes and other astronomical instruments in space. The reports from these studies expressed the belief that the presence of man in space, close to these instruments, can greatly improve the ability of science to increase knowledge about the origin of life and the history of the Earth, of the Sun, of the planets and of the universe around us.

But it is important to realize and to emphasize that the first task to be performed, before benefits can be provided to potential users, is to learn to operate in space. Before we can deliver people and equipment to the place where this work is to be done, we must investigate the conditions and the problems associated with operations in the weightless, vacuum environment. And we can learn to operate effectively in space only by doing—by spending time in space.

The Apollo-Saturn flight equipment will enable us to multiply our present man-days of flight experience to man-years of flight experience. In the period immediately following the accomplishment of the Apollo program, a most important task will be to gain this experience and to develop the advanced operational techniques so necessary for use in future programs.

Beyond Apollo Applications several major options for future programs exist. Emphasis can be placed on further lunar exploration, advanced Earth-orbital operations and planetary exploration. Still, the necessary precursor of any of these future missions is the knowledge and experience gained from exploiting the investment and capability we have developed under the Apollo program.

There is a problem which is characteristic of Government programs. The budget for the coming fiscal year permits NASA to hold open the option for a program to procure additional flight vehicles beyond those now programed for Apollo so as to employ the Apollo hardware and capabilities at least through 1971. If we do not exercise this option in the decisions for the fiscal year 1968 budget, we will have to

begin a phase down of the Manned Space Flight activities and the "mothballing" of some of our facilities. The time for decision to exercise this option will be made on the budget to be submitted to Congress for fiscal year 1968.

In this regard, I would like to call attention to a few facts. The Wright Brothers' first flight at Kitty Hawk dramatized the possibility of flight, but it was not until airplanes were numerous and barnstorming had given way to commercial flight that profit began to come from aeronautics. The history of the airplane is interesting for another reason. Although the United States was first in its invention, it remained for the Europeans to adopt it for practical use, so that this Nation was forced to borrow British and French designs for use in World War I and, in fact, no American-designed plane flew in that combat.

The submarine was invented by an American named Holland but was first exploited by Germany. Robert Goddard of this country proved that a rocket would work in a vacuum, but the Germans used the principle to build ballistic missiles, and the Soviets first achieved space flight.

In view of these facts, I would personally hope that we as a nation are perceptive enough to profit from history and that we do fully use and exploit these machines we have developed at such a heavy investment of resources, and that we do allow ourselves the time and freedom to realize their—and our—full capabilities in space.

To maintain the Manned Space Flight activity we are requesting for fiscal year 1967 a total of $3,405.4 million for research and development, administrative operations, and construction of facilities (fig. 5).

NASA
MANNED SPACE FLIGHT
FY 1967 BUDGET ESTIMATE
(MILLIONS OF DOLLARS)

	FY 1965	FY 1966	FY 1967
RESEARCH AND DEVELOPMENT	$2,949.0	$3,204.0	$3,022.8
GEMINI	308.4	226.6	40.6
APOLLO	2,614.6	2,967.4	2,974.2
ADVANCED MISSIONS	26.0	10.0	8.0
CONSTRUCTION OF FACILITIES	199.8	21.4	54.4
ADMINISTRATIVE OPERATIONS	281.2	295.5	328.2
TOTAL	$3,430.0	$3,520.9	$3,405.4

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FIGURE 5

(The complete prepared statement of Dr. George E. Mueller follows:)

PREPARED STATEMENT OF DR. GEORGE E. MUELLER, ASSOCIATE ADMINISTRATOR FOR MANNED SPACE FLIGHT, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ABSTRACT

INTRODUCTION

The purpose of the statement is to present an annual report of accomplishments in the past year and plans for the fiscal year beginning in July 1966. The statement will review manned space flight management, report on the status and planned activities of the Gemini and Apollo programs and advanced manned mission studies, and will outline the schedule for accomplishing specific objectives.

MANAGEMENT

Manned space flight organizational and personnel changes are reviewed, including the activities of mission operations and Saturn/Apollo applications. Procurement management and emphasis upon incentive contracting are discussed. Relationships with industry, science, and other Government entities are noted.

GEMINI

Gemini's contribution to all objectives of manned space flight with the program's one unmanned and five manned flights of 1965 is summarized. Accomplishments reviewed include the completion of flight qualification, extravehicular activity, three long duration flights of 4, 8, and 14 days, and history's first successful space rendezvous, involving close formation flight of two Gemini spacecraft and four astronauts.

Production and delivery of flight hardware to support increased operational activity during 1965 is noted, and the production status of all remaining flight hardware reported.

Four Gemini missions are planned for 1966. Major objectives will be further development of various phases of rendezvous and docking, extravehicular activity, and extensive experiments continuing the successful experiments program of 1965.

APOLLO

The substantial progress of Apollo during the past year is cited. The first phase of the Saturn I program was eminently successful in providing the base on which the large launch vehicle technology is built.

The foundation for Apollo flights has been laid and the first Apollo-Saturn flight is approaching. Movement of flight hardware for manufacturing, test, and flight operations is being accomplished. An operational capability has been built for basic mission control and recovery.

Conversion of Saturn I launch facilities nears completion, while construction of the Saturn launch complex progresses toward the start of checkout operations on that facility.

The timetable for upcoming unmanned and manned Apollo-Saturn flights is reviewed.

The resources capability that exists or is being developed in support of the present lunar landing program is summarized in terms of management, personnel, and facilities. The capability of NASA and contractor facilities for development, manufacturing, test, and the capability of NASA launch and space flight operations facilities are described.

Apollo Applications is given as an example of a follow-on effort that capitalizes on the resources available through the Apollo program. The background, operational capabilities, objectives, and specific applications operations are reviewed.

MISSION OPERATIONS

Mission operations for Gemini and Apollo are summarized. The Manned Space Flight Network for unmanned and manned missions is described. Launch crew, flight controller, and flight crew training is discussed.

ADVANCED MANNED MISSIONS STUDIES

The background of Advanced Manned Mission studies is reviewed. The evolution of future program planning is discussed, and program evolution alternatives are listed. The status of Earth-orbital, lunar, planetary, and vehicle program studies is noted.

FUNDING REQUIREMENTS

Funding requirements to continue the Manned Space Flight program for the next fiscal year are given. In fiscal year 1967 Manned Space Flight will require a total of $3,405.4 million for Research and Development, Administrative Operations, and Construction of Facilities.

Research and Development requirements are identified in the three Manned Space Flight Programs—Gemini, Apollo and Advanced Manned Missions—for a total of $3,022.8 million. Gemini program requests for the next fiscal year are $40.6 million. Total Apollo program requirements for fiscal year 1967 are $2,974.2 million. The fiscal year 1967 request for Advanced Manned Missions, to examine advanced manned space flight mission concepts, is $8.0 million.

The total Manned Space Flight administrative operations requirements for fiscal year 1967 is $328.2 million. These funds will provide for the operation of the three Manned Space Flight Centers. The John F. Kennedy Space Center at Kennedy Space Center, Florida requires $98.1 million; the Manned Spacecraft Center at Houston, Tex., requires $98.2 million; the Marshall Space Flight Center at Huntsville, Ala., requires $131.9 million.

"Construction of facilities" funding requested for fiscal year 1967 totals $54.4 million. This amount covers continuation of the outfitting of Launch Complex 39 at Cape Kennedy; a Lunar Sample Receiving Laboratory and astronaut training simulator facilities at Manned Spacecraft Center; a Hazardous Operations Laboratory at Marshall Space Flight Center; utilities at Michoud Assembly Facility; modifications and additions to test facilities at Mississippi Test Facility and Sacramento Test Facility.

SUMMARY

This presentation reports on the excellent progress and the major problems during the past year in meeting Manned Space Flight program objectives. Plans for the coming fiscal year are discussed.

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INTRODUCTION

General considerations

Mr. Chairman and members of the committee, today I would like to present to this committee our annual report of accomplishments in the past year and plans for the fiscal year beginning in July. Our progress has been excellent in these 12 months. Gemini has slipped forward enough to recover all the schedule loss we reported last year. It is now on schedule. We are progressing on schedule in Apollo and are about to reach the first of five major program milestones. As this committee well knows, in any unprecedented program of this size, development, testing, and manufacturing problems are expected and are being encountered. Thus far we have been able to solve the problems without appreciable schedule impact. We have progressed in the definition of the next major Manned Space Flight activity, Apollo Applications, and we have continued the studies of alternative future manned flight programs.

The experience of working together during the past year has highlighted the need for a close relationship between the Manned Space Flight organization and other elements of the NASA team. Thus, we are working in close coordination in the development of future manned and unmanned missions. It is important, then, to consider the NASA program as a balanced and interrelated whole.

We have been cognizant of the concern of this committee with respect to NASA's plans for the period after the decline of the effort applied to the Apollo program. The committee's publication of the summary report of the Future Programs Task Group, followed by the staff study conducted last fall by the Subcommittee on NASA Oversight, underscored this concern. In accordance with National and NASA policies, and with the resources available, we are working to formulate our future programs.

We have also been cognizant of the fact that the attention of the Nation is focused on the Vietnam conflict. We have provided some measures of the contributions to national and international security made by the development of capabilities in Manned Space Flight.

These contributions are generally in three areas—(1) technology and skills directly applicable to the current requirements of the Department of Defense; (2) technology and skills potentially applicable to the future requirements of the Department of Defense and; (3) technology and skills that provide a visible focus of power, evident to all the world, of a broad capability to do whatever is necessary to insure security and peace on this planet.

In the first category is the Gemini spacecraft, which has been selected as the manned vehicle for launch and reentry of the Manned Orbiting Laboratory program of the Department of Defense.

In the second and third categories is the ability to perform rendezvous in space, demonstrated by the Gemini 6 and 7 spacecraft on December 15, 1965. This contribution was emphasized 2 weeks later by Mr. Webb at Houston, Tex., when he said:

"Now, with respect to Vietnam, my own view is that what these men on this team * * * what our team has done, is to show the world that we can operate men and machines together very, very efficiently. We cannot only remain up 14 days, but make the rendezvous within a very short time interval from what we anticipated on the ground. This means that the world sees a nation of great capability." In addition to the demonstrations in Gemini, there are those skills and techniques being provided in the Apollo program. The accomplishment of lunar landing and return within this decade will provide visible evidence relating to the balance of technological power in the world.

Objectives

With these considerations in mind, let me now review our progress against the objectives of Manned Space Flight. Here (fig. 6) are the general objectives, which are unchanged. Next (fig. 7) are the specific objectives of the three Manned Space Flight programs—Mercury, Gemini, and Apollo—also unchanged from last year.

The achievements of the past year reflect substantial progress toward the accomplishment of all of these objectives, both general and specific. In five manned Gemini missions it has been demonstrated that well-trained and well-qualified astronauts are capable of performing effectively in weightless flight for missions lasting up to 14 days, almost twice the length of a nominal Apollo lunar mission. We have demonstrated that two spacecraft piloted by men can achieve rendezvous in orbit about the Earth, flying in formation at distances as close as 1 foot. We have begun research in the conditions of extravehicular manned activity in space.

However, this progress in Gemini was not accomplished without difficulties. The loss of the first Agena on October 25 was a serious threat to the timely accomplishment of rendezvous and has delayed the first attempt at docking. However, as a result of careful contingency planning, it was possible to revise the flight schedule and to conduct the Gemini VII and VI flights simultaneously.

In the Apollo program, major ground facilities are nearing completion. The first phase of the Saturn I launch vehicle program has completed a perfect series of 10 test flights and the first unmanned flight of the Apollo Saturn I (Saturn IB) space vehicle, a major milestone in the Apollo program, is near at hand. All three stages of the Saturn V launch vehicle have been test fired successfully on the ground. The Apollo spacecraft for Earth-orbital flights is in production and the design on the Block II model for the lunar flights has been completed.

This progress has increased our confidence that we will accomplish the Apollo objectives within this decade. However, the Subcommittee on NASA Oversight focused attention on program problems last fall when it issued the report, Pacing Items in the Apollo Program. The report included that:

"Given the objective of a lunar landing in this decade, NASA currently is progressing on schedule with the Apollo program. NASA Apollo management is

MANNED SPACE FLIGHT
GENERAL OBJECTIVES

- ESTABLISHMENT OF MAN'S CAPABILITIES
- NATIONAL COMPETENCE FOR MANNED SPACE FLIGHT
  - INDUSTRIAL BASE
  - TRAINED PERSONNEL
  - GROUND FACILITIES
  - LAUNCH VEHICLES
  - SPACECRAFT
  - OPERATIONAL EXPERIENCE
- EXPLORATION OF SPACE
- UNITED STATES LEADERSHIP

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FIGURE 6

MANNED SPACE FLIGHT
SPECIFIC OBJECTIVES

MERCURY
- ORBITAL FLIGHT AND SAFE RETURN OF AN ASTRONAUT

GEMINI
- TWO-MAN EARTH ORBITAL FLIGHTS
- LONGER DURATION FLIGHTS
- NEW TECHNIQUES, INCLUDING RENDEZVOUS & DOCKING
- EXTRAVEHICULAR CAPABILITY

APOLLO
- THREE-MAN EARTH ORBITAL FLIGHT
  - LONG DURATION MISSIONS
  - RENDEZVOUS AND DOCKING
- MANNED FLIGHT IN THE EARTH-MOON REGION
- LUNAR LANDING AND EXPLORATION

NASA M64-61
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FIGURE 7

demonstrating maturity of skill and knowledge which is surmounting the complex technological program problems. NASA has identified the controlling or pacing systems in this program at this time. These systems, the Lunar Excursion Module and the Command and Service Module and their critical subsystems, are analyzed in this report. This study indicates that several subsystems are critical in meeting the Apollo goal but have been identified by NASA-industry management and corrective action is underway. It is the finding of this study that NASA management is employing its resources effectively in the solution of these pacing system problems giving confidence to attainment of the Apollo goal. A corollary finding of this study indicates that limited additional funds of the order of $200 million over the amount NASA requested in fiscal year 1966 would have provided to NASA increased program alternatives providing additional assurance that a lunar landing will be accomplished in this decade."

I agree with the conclusion of this report, but remain fundamentally confident that, with effective and timely utilization of present resources and those requested for the coming fiscal year, we will, barring major problems, be able to complete the lunar landing on schedule.

Because of the urgency of other national needs related to Vietnam, the work on Apollo Applications is beginning at a slow pace. However, we do propose to begin procurement of long-lead-time hardware and to employ available resources to maintain the Apollo team as nearly intact as possible to provide required sustaining engineering for Apollo during the launch period, and to maintain the option of beginning in an orderly manner, major efforts in Apollo Applications in fiscal year 1968, when a decline in Apollo requirements is anticipated.

Schedule

Next, let us review the schedule for accomplishing these specific objectives. This chart is one shown for the last 2 years in our annual presentation. As was done last year, this chart has been updated to include 1965 accomplishments (fig. 8).

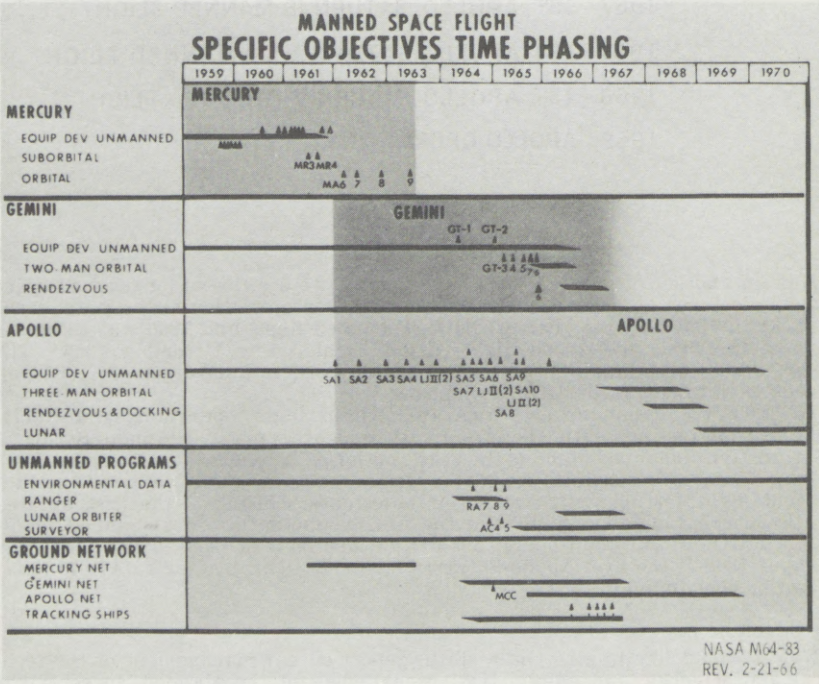

FIGURE 8

As can be seen here, in Gemini we completed five manned flights during 1965, rather than three as stated in my testimony last year, and the first rendezvous mission was carried out a year ahead of schedule. Apollo unmanned equipment development flights have continued. In the unmanned lunar programs, Ranger has been completed successfully and both Surveyor and Lunar Orbiter are nearing the time when we will be receiving lunar surface data. As to the ground network, we have now conducted four flights controlled by the Mission Control Center at Houston.

Maintenance of the Apollo schedule during the past year provides increased assurance of completing the Apollo program at a total cost of about $20 billion, at the lower range of the estimates mentioned by Mr. Webb in his testimony before this committee on April 13, 1961.

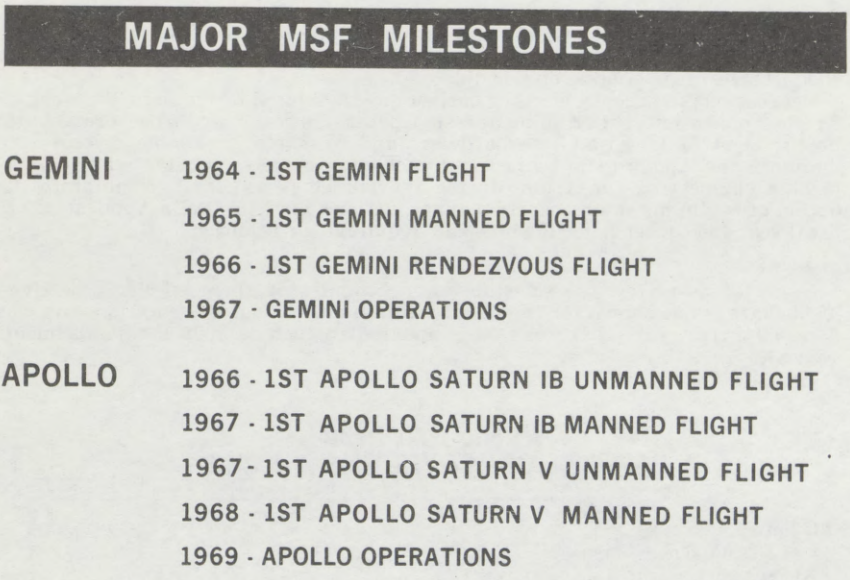

FIGURE 9

Now in another chart from last year (fig. 9), we see the major manned space flight milestones on a year-by-year basis. In Gemini, 1964 was the year of the first flight, 1965 was the year of the first manned flight and 1966 was to be the year of the first rendezvous flight—a goal achieved in December 1965. The major Apollo activities of filling the pipeline with test hardware in 1964 and development testing in 1965 are behind us.

In 1966, the dominant activities are Gemini flight operations and Apollo qualification testing, with the rapidly approaching uprated Apollo Saturn I (Saturn IB) unmanned flight as the year's major milestone.

In 1967, we will conclude the NASA Gemini program and Apollo will be in a year of flight testing with two major milestones scheduled—the first uprated Apollo-Saturn I manned flight and the first Apollo-Saturn V unmanned flight. Apollo Earth-orbital flight operations will be dominant in 1968. The major milestone of 1968 is the first Apollo-Saturn V manned flight, leading to Apollo lunar operations beginning in 1969.

MANAGEMENT

Introduction

Now I would like to give you a status report on our management of the technical and scientific and administrative challenges of the Manned Space Flight program.

Last year's review of our organization, manpower, and program management emphasized our efforts to acquire a proper balance between administrative and technical considerations in achieving overall objectives. Since then we have taken further steps to refine and improve our management organization for optimum use of our capabilities in people, physical plants, and flight hardware.

Loss of Dr. Lovelace

NASA's Director of Space Medicine, Dr. W. Randolph Lovelace II, was killed in a plane crash on December 12, 1965. This was the time when Gemini VII, primarily a medical experiments flight, was in orbit. Without his dedicated effort to his country and to his fellow man, this Nation could not with such early assurance have undertaken this flight. For it was man—his well-being and his safety—who was always Dr. Lovelace's central concern. Never for a moment did he forget that only through painstaking research and experimentation in the laboratory could man's destiny in space be realized.

His 30-year medical career included both clinical practice in surgery and pioneer research efforts in aviation and space medicine. It was as a world citizen and as a leader of men and ideas in the broad spectrum of the life sciences, however, that his loss will be most keenly felt. Yet it was the solid basis of his own scientific accomplishments and his personal standards of bravery and examples of heroism that won him the respect of the world. Dr. Lovelace was one of the pioneers who made it possible to integrate man and the machine so as to advance science and technology.

Dr. Lovelace was persuaded to assume the directorship of NASA's Space Medicine program in the spring of 1964. He was sworn into office by the President, and began a leave of absence from the Lovelace Foundation.

In the short tenure of his office he made significant contributions both in the field of international understanding and in the scientific experiments program for Gemine and Apollo. His stature as an internationally respected scientist was reflected, for example, during his trip to Russia in 1964 when he was awarded the Professor N. I. Pirogon Memorial Medallion in honor of the 150th Anniversary of the Academy of Medical Sciences, Moscow, U.S.S.R.

Under his leadership, the largest and most significant group of medical experiments yet flown in the U.S. Manned Space Flight program—prelude to lunar landings and beyond—was to be accomplished in the Gemini VII flight of December 1965. This is a significant and lasting tribute to him and to his 30-year career in molding aviation and space research and development. It proved that man could indeed adapt to space flight and control his destiny through the application of scientific research and development.

President Johnson summed up the Nation's reaction to Dr. Lovelace's death in these words: "A day of great achievement in space was marred by the news of the death of Dr. William Randolph Lovelace II. His life was too short, although his legacy to space medicine will endure and will be a resource of assurance to future astronauts whose names and deeds are yet unknown."

Office of Manned Space Flight

Organization and personnel changes covered in my statement before this committee last year included the establishment of a Mission Operations Office and the restructuring of my immediate office (fig. 10). Mr. William B. Rieke and Maj. Gen. David M. Jones, USAF, had been appointed to fill newly established positions as Manned Space Flight Deputy Associate Administrators for management and programs, respectively.

Mr. Rieke has since moved from the Office of Manned Space Flight to become Assistant Administrator of Industry Affairs.

The Manned Space Flight organization has been further strengthened since last year by the appointment of Mr. James C. Elms as Deputy Associate Administrator for Manned Space Flight. Mr. Elms previously served as vice president of Raytheon Co., and general manager of that company's space and information division following an assignment with NASA as Deputy Director of the Manned Spacecraft Center. In addition to serving as my general deputy, Mr. Elms is concerned with the relationships between the Centers and the Office of Manned Space Flight (OMSF).

General Jones has continued to serve as my program deputy covering the area of our program relations to insure effective implementation of the Manned Space Flight programs. General Jones is also Acting Director of the Saturn/Apollo Applications Office.

Lt. Gen. Frank A. Bogart, USAF (ret.), who was Director of Manned Space Flight Management Operations, moved into the vacancy created by Mr. Rieke's reassignment. General Bogart oversees the functional area of staff relations to assure the maximum effectiveness of our internal work.

Other key personnel changes have taken place during the last few months. Mr. Paul E. Cotton, assistant to the Associate Administrator for Manned Space

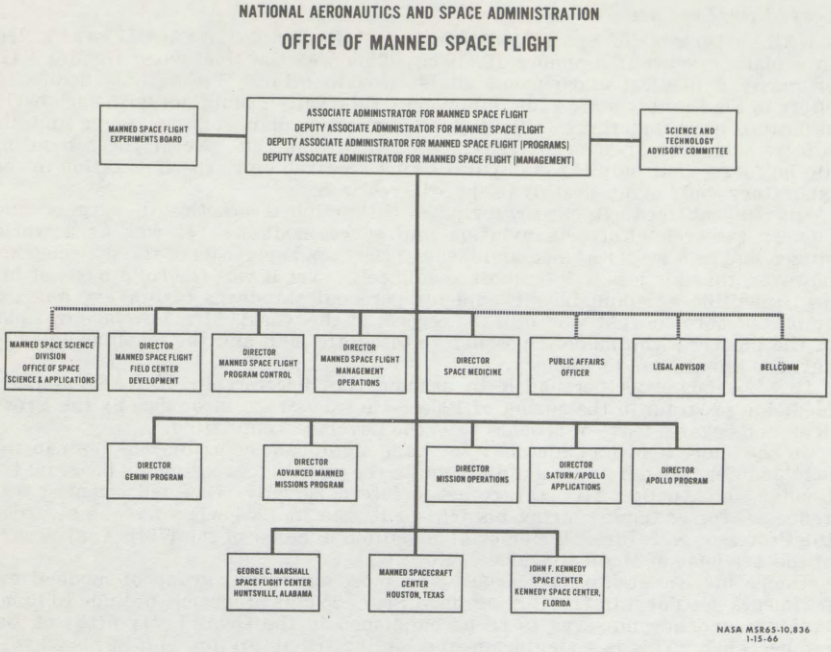

FIGURE 10

Flight, has been appointed Director of Manned Space Flight Management Operations, succeeding General Bogart. Brig. Gen. Julian H. Bowman, USAF (ret.), was named to replace Mr. Cotton. Brig. Gen. Carroll H. Bolender, USAF, and Capt. Roderick O. Middleton, USN, have been appointed Deputy Directors of Mission Operations. Mr. William C. Schneider, Deputy Director of the Gemini program, has been appointed Deputy Director of Mission Operations for Gemini missions. Mr. John H. Disher, Apollo Program Test Director, has been appointed Deputy Director of the Saturn/Apollo Applications office. Col. Jack Bollerud, USAF (MC) was detailed by the Air Force to NASA to serve as Deputy Director of Space Medicine, succeeding Dr. George M. Knauf, now engaged in biomedical research and development in private industry.

Manpower

Concurrent with our organizational refinements and the changing workload of the Center, we have intensified our efforts to improve the utilization of our available manpower (fig. 11). One of these efforts was to conduct a human resources study to examine our headquarters organization, staffing, average grade and salary levels, and future trends. Some adjustments in overhead functions, deputy and staff advisory positions, lines of authority and responsibility and staffing were made as a result of this study. Through this and other actions we have been able to staff the Saturn/Apollo Applications Office in headquarters by the reassignment of personnel from the Gemini, Apollo, and Advanced Manned Missions program offices. Other adjustments of this nature are planned as additional changes in Gemini and other programs permit.

Another action which we have taken to satisfy these immediate staffing needs was a study at the three MFS Centers to determine whether all available personnel would be fully utilized for the next several years on current or future programs. Although we have been able to execute approved programs within current manpower authorizations, the increased complexity, frequency and duration of flight missions has put increased pressure on an already burdened work force at the Kennedy Space Center and the Manned Spacecraft Center. A study concerning operations-oriented functions has indicated that an increase in the work force is necessary to provide adequate support.

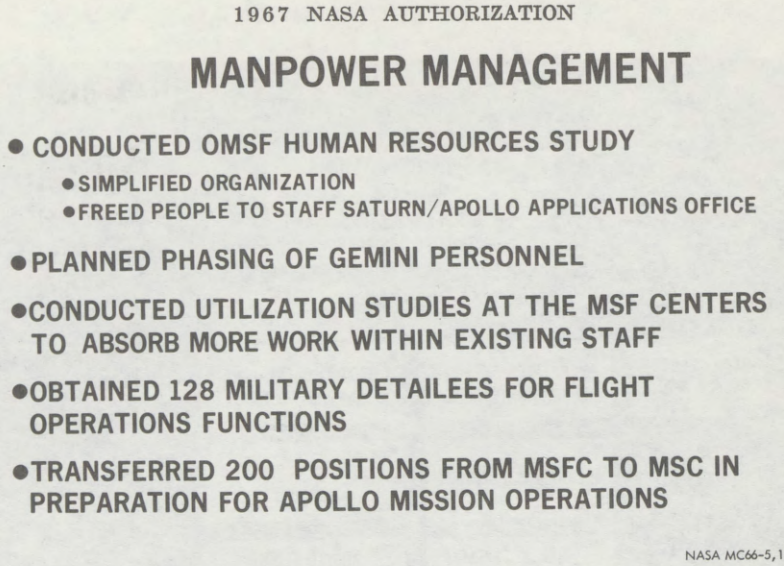

FIGURE 11

To fulfill part of this requirement the Air Force and NASA have entered into a cooperative arrangement whereby we have obtained 128 military officers trained in the ballistic missile program to perform flight operations functions at the Manned Spacecraft Center.

To satisfy the remaining requirement, we have transferred 200 positions from the Marshall Space Flight Center to the Manned Spacecraft Center for Apollo Operations. By June 1966, we will allocate an additional 310 positions to the Manned Spacecraft Center and by June 1967, the Kennedy Space Center complement will be increased by 195 positions.

A manpower management program is being developed by the MSF Centers. The program will employ management survey techniques and statistical reporting to evaluate our manpower needs and achieve better manpower utilization.

Mission operations

You will recall that the Mission Operations organization in the Office of Manned Space Flight was established January 1, 1965, to carry out missions operations for the Manned Space Flight programs.

The Mission Operations Office is headed by a Director who is supported by three Deputy Directors (fig. 12). The primary task of each Deputy Director is to serve as Mission Director for those space flights to which he is assigned. In addition, there are staff groups responsible for coordination of Operations Support Requirements, Ground Operations Support System, Flight Crew Support, and Operations Planning. The Mission Operations Director is also supported by the Directors of Flight Operations in each of the OMSF program offices. Two of the three Mission Directors currently assigned to Mission Operations—Brig. Gen. C. H. Bolender, USAF, and Capt. R. O. Middleton, USN—are military detailees from the DOD who are assigned to Apollo/Saturn flights. The third Deputy Director is Mr. William C. Schneider, formerly Deputy Director of the Gemini program. Mr. Schneider was assigned as the Mission Director in charge of Gemini flights beginning with the Gemini V mission.

Launch operations

During the past year Goddard Launch Operations and Pacific Launch Operations (fig. 13), previously assigned to the Associate Administrator for Space Science and Applications, were transferred to the Kennedy Space Center. These offices, physically located at KSC and the Western Test Range, respectively, are responsible for all major NASA satellite and probe launches from those sites. Both the Goddard and Pacific Launch Operations were combined at Kennedy Space Center under the Director of Launch Operations who reports to Dr. Debus, the Center Director.

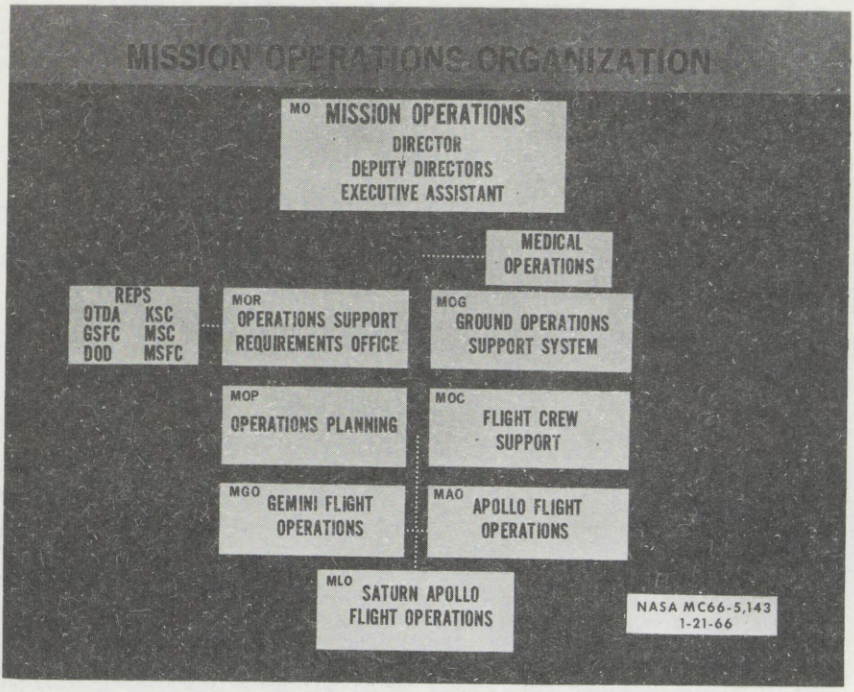

FIGURE 12

LAUNCH OPERATIONS CHANGES

- TRANSFER OF MANAGEMENT CONTROL OF GODDARD LAUNCH OPERATIONS AND PACIFIC LAUNCH OPERATIONS TO KENNEDY SPACE CENTER
  - CONSOLIDATES UNDER ONE CENTER DIRECTOR THE RESPONSIBILITY FOR MANNED AND MAJOR UNMANNED LAUNCH OPERATIONS
  - RESULTS IN CLEARER LINE OF AUTHORITY AND COMMUNICATION AND MORE EFFECTIVE INTEGRATION OF LAUNCH SCHEDULES AND SUPPORT

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FIGURE 13

With the transfer to KSC, clearer lines of authority and communication and more effective integration of manned and unmanned launch schedules and support are thus attained without diminishing the responsiveness to the complex requirements of all launch operations.

Saturn/Apollo applications

We have devoted increased time and attention to planning for future Manned Space Flight program activities. Toward this end a new organization, the Saturn/Apollo Applications Office, was established in August 1965. Here (fig. 14) we see the organization of this new office. As I have mentioned, Major General Jones is Acting Director and Mr. Disher is Deputy Director. This office is responsible for the direction of activities that make use, for purposes other than the Apollo program, of the capabilities of the Saturn launch vehicles and the Apollo spacecraft.

There are two segments in the Saturn/Apollo Applications Office. Saturn Applications is primarily concerned with the utilization of the uprated Saturn (Saturn IB) and Saturn V launch vehicles for potential future missions. Apollo Applications provides an organization for planning and directing activities which can utilize the spacecraft being developed under the Gemini and Apollo programs. The Saturn/Apollo Applications Office is organized in the same manner as the Apollo and Gemini Offices and is supported by functional organizations such as Program Control, Systems Engineering (Bellcomm), Test, Reliability and Quality Assurance, and Flight Operations.

The Saturn/Apollo Applications Office is currently engaged in the definition of Apollo Applications based on the maximum utilization of Apollo and Gemini system capabilities. The program definition tasks will be completed late in 1966 and a program develpoment plan for Apollo Applications will be available early in 1967.

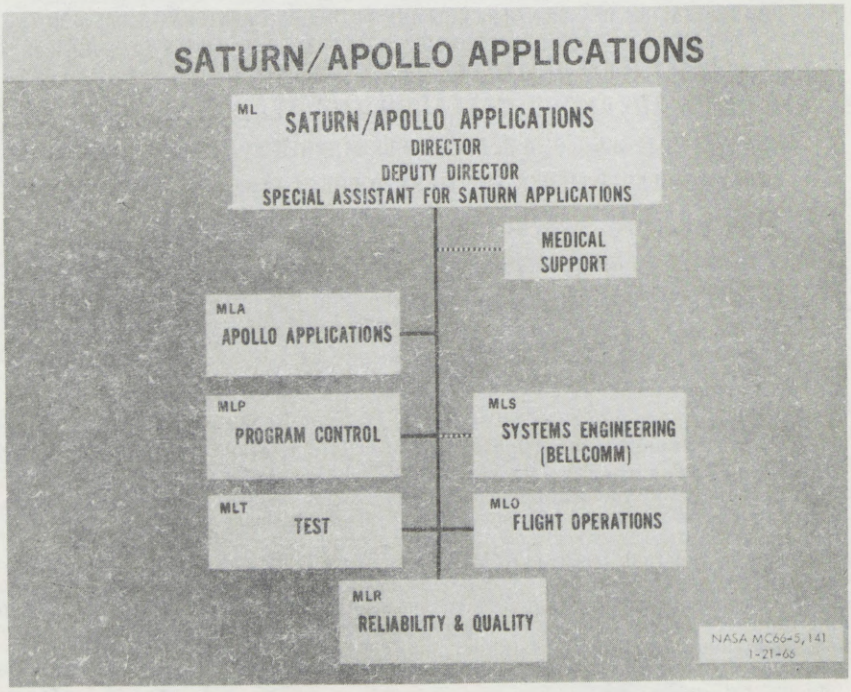

FIGURE 14

Saturn/Apollo Applications Role

The Saturn/Apollo Applications Office provides a service to the Office of Space Science and Applications, the Office of Advanced Research and Technology, the Office of Tracking and Data Acquisition, NASA Space Medicine, and the Advanced Manned Missions program office by carrying out for them the experiment programs assigned to Apollo Applications by the Manned Space Flight Experiments Board (fig. 15). This office first determines the feasibility of carrying out these experiments in the available spacecraft. Then it provides for the development of flight hardware; the integration of the hardware into the space vehicle; the planning and conduct of the missions; and the return of the data obtained to the sponsoring offices. The Saturn/Apollo Applications Office is also responsible for the design and development of the modifications to the basic Apollo/Saturn space vehicle required by the applications program.



FIGURE 15

Role of Manned Space Flight Centers for Saturn/Apollo Applications

As I mentioned earlier, Apollo Applications was formally established in August 1965 as a part of the Saturn/Apollo Applications Office. Parallel program organizations are being established at the Manned Space Flight field centers with responsibilities in carrying out this activity (fig. 16).

The major new task required of Manned Space Flight field centers in the Apollo Applications program is that of experiment payload integration. Experiments must be assigned and grouped into compatible mission payloads; specifications and interface definitions must be provided and compatibility with spacecraft and operational capabilities established. The Apollo Applications Office is responsible for overall mission and experiment assignment to the centers for implementation.

A number of arrangements have been examined for center management of the payload integration function for the Command Module; the Service Module, which is the Spacecraft Propulsion Module; and the Lunar Excursion Module (LEM), hereinafter referred to as the Lunar Module. It was determined that

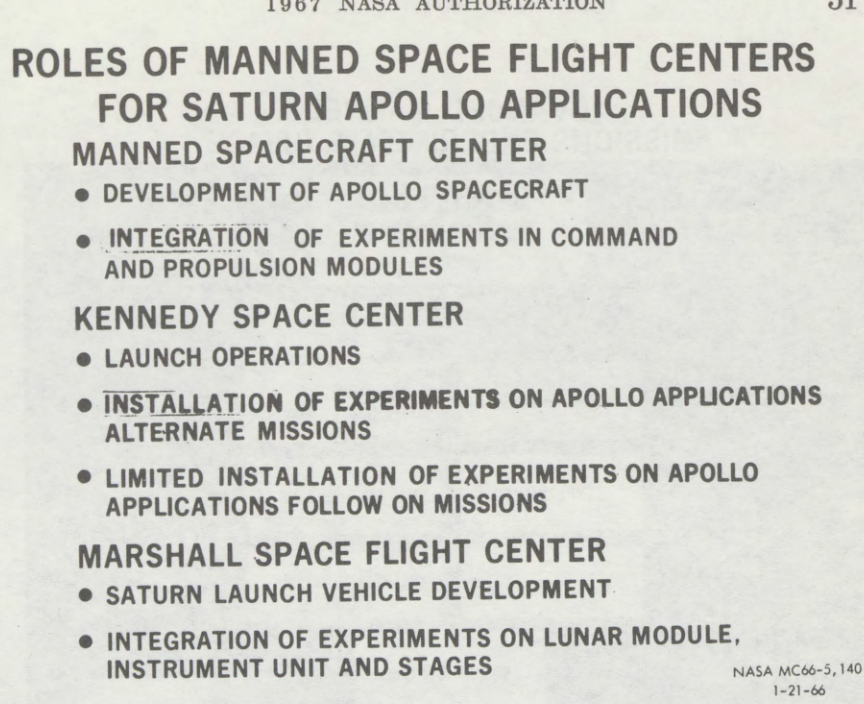

FIGURE 16

by asssigning Command and Propulsion Module payload integration to the Manned Spacecraft Center and Lunar Module payload integration to the Marshall Space Flight Center, the overall Apollo Applications payload integration task could be accomplished within the personnel ceilings established for the basic Apollo program.

It is important to recognize that with this assignment of payload integration responsibility the scope of activity for both Manned Spacecraft Center and Marshall Space Flight Center will increase. The role of the Manned Spacecraft Center with respect to spacecraft development, crew operations, and mission operations will expand in scope to encompass the new tasks associated with the Apollo Applications missions.

Experiments management

It has been recognized that the need exists for a strong central element at the Office of Manned Space Flight level to maintain cognizance over all Manned Space Flight experiment plans and programs. To fulfill this need (fig. 17) the Advanced Manned Missions Program Office was given the responsibility for Manned Space Flight experiment development coordination.

Here we see the organizational elements concerned with the Manned Space Flight Experiments program (fig. 18). Each NASA program office has established a Manned Space Flight experiments group which acts in close coordination in the development, selection and approval of experiments. When the experiment has been accepted by the program office responsible, it is presented to the Manned Space Flight Experiments Board for allocation and acceptance for flight. The DOD now participates on the Board, chaired by NASA, on a par with the NASA program offices.

The experiment is then reviewed for impact on the candidate flight programs and assigned to a specific project. The project then assumes the responsibility of developing and integrating it into the program.

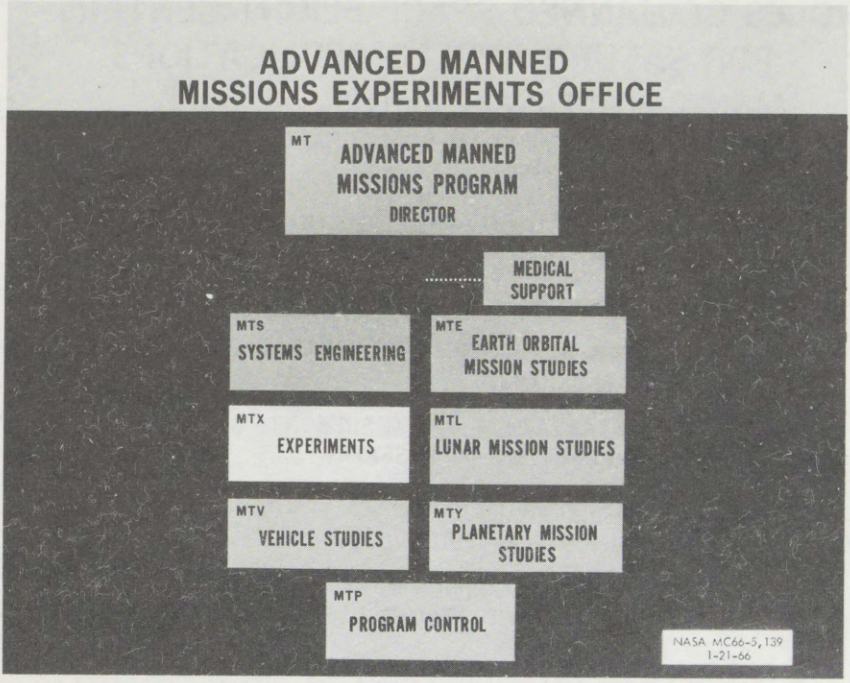

FIGURE 17

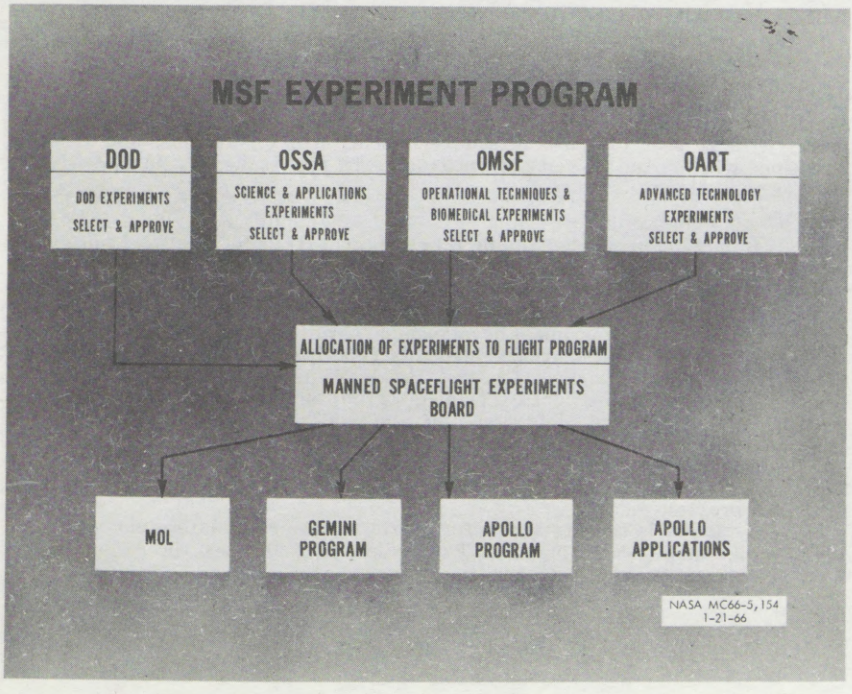

FIGURE 18

Phased project planning

As I mentioned earlier, the Apollo Applications program is now in the program definition phase. The planning process NASA uses for future programs involves four steps (fig. 19).

The first phase is Advanced Studies (fig. 20). In this first phase we conduct concept feasibility studies covering various approaches to accomplish the objective. We then make an engineering assessment, identify research and technology requirements, and study gross schedules and cost. Finally, we assess the favorable and unfavorable factors and prepare an analytical report with recommendations for the next phase.

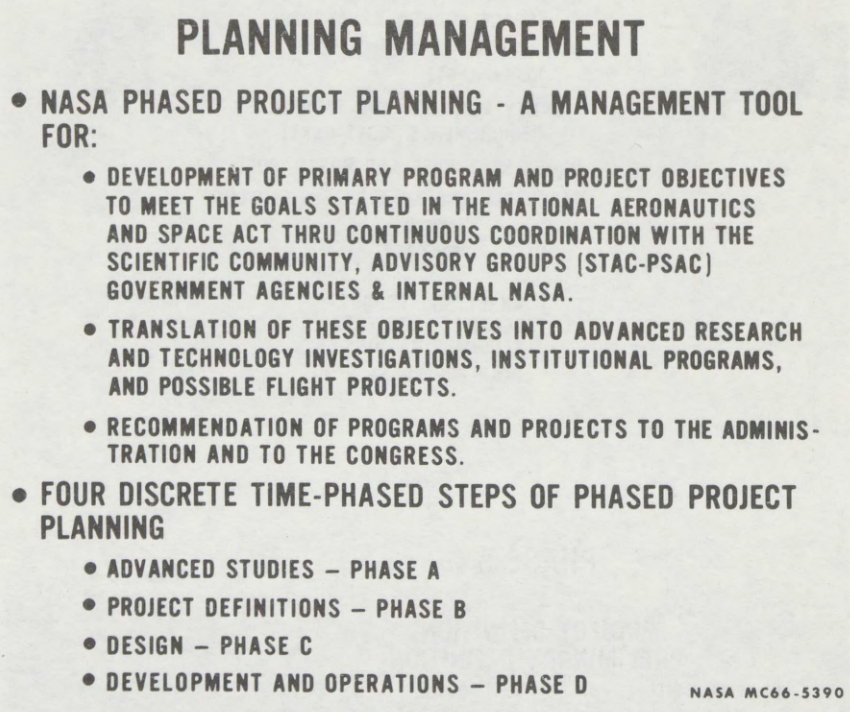

FIGURE 19

We next go through the project definition phase (fig. 21) in which we refine selected concepts, assess total mission requirements, and make a system analysis. We then prepare preliminary design and specifications; make a manufacturing and test assessment; prepare research, technology and advance development requirements; refine resources estimates and schedules; prepare our management and procurement approach; and issue an analytical report and recommend a choice for the next phase.

In this next phase, final definition (fig. 22), we arrive at our finalized concept, make a total systems analysis and prepare designs and specifications. We initiate supporting development activities and prepare plans for facilities, test operations and specifications.

We then determine resources requirements and issue an analytical report with the finalized Project Development Plan (PDP). At this point we can start contractor selection.

The last phase is Development and Operations (fig. 23). In this phase we manufacture and test the system and subsystem and enter operations to complete the project.

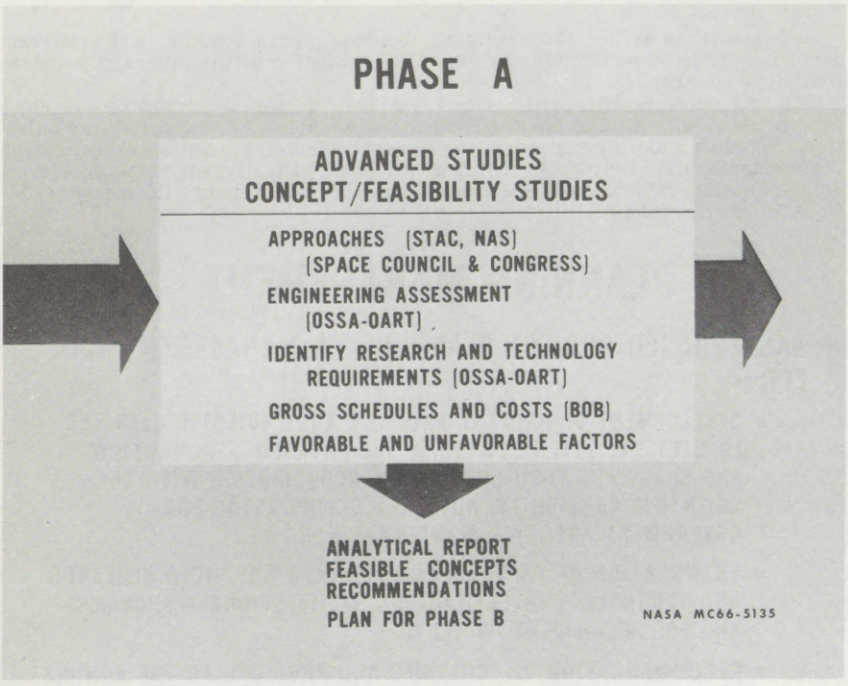

FIGURE 20

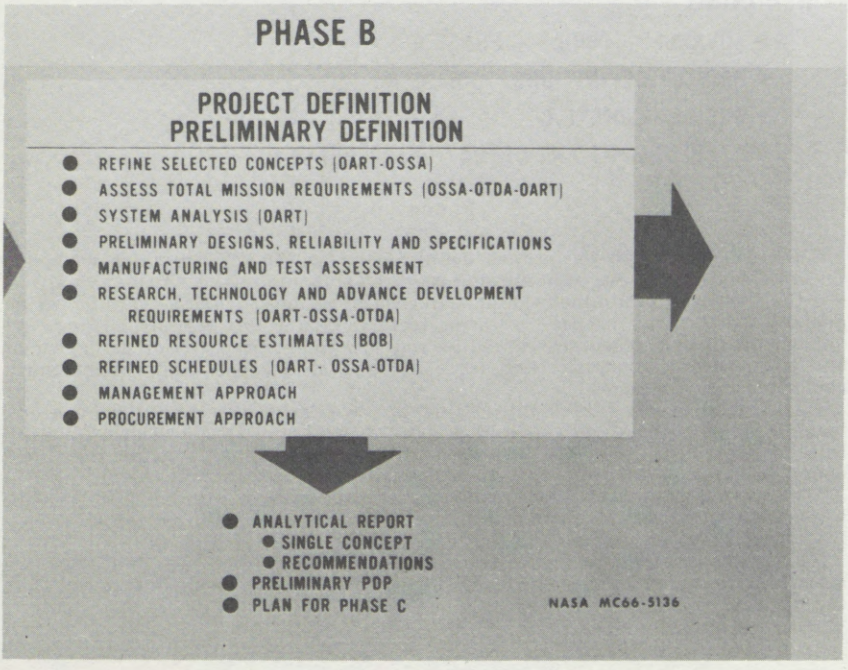

FIGURE 21

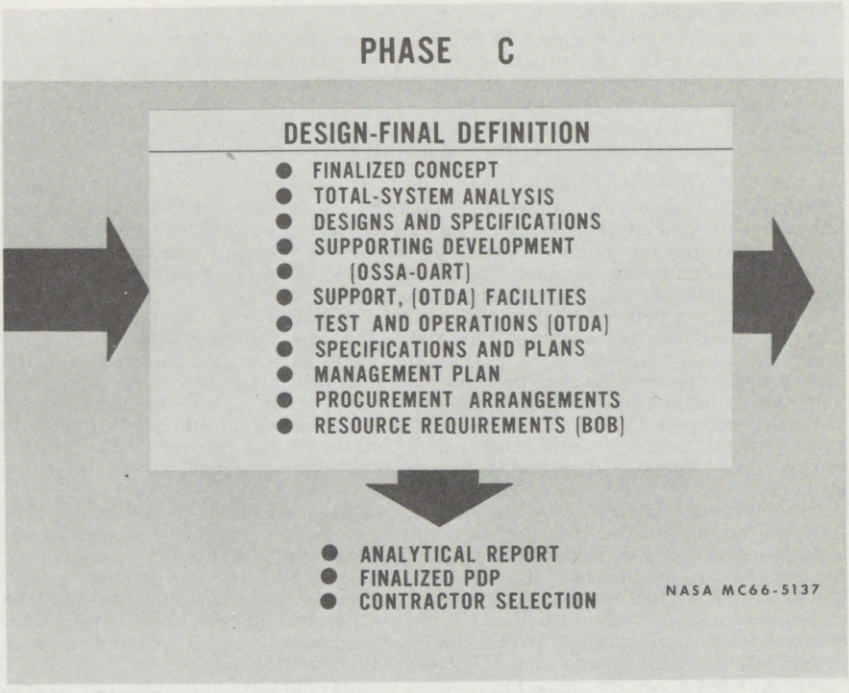

FIGURE 22

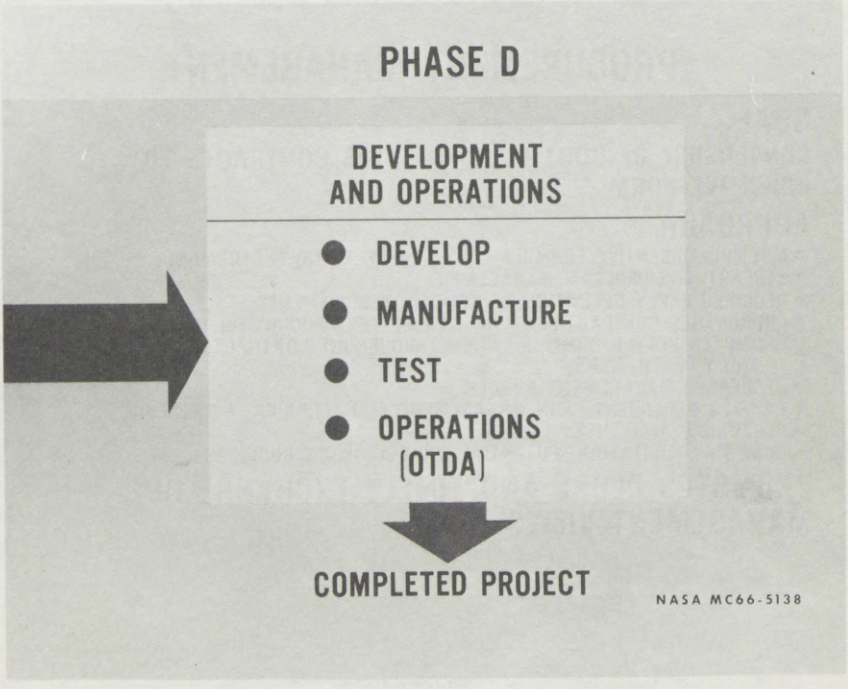

FIGURE 23

Procurement management

The Office of Manned Space Flight recognizes the importance of the procurement function to the realization of its program management objectives. This is particularly true with respect to the use of incentive contracts for major program hardware procurement, since the effect of incentive contracts is to motivate the contractor toward more efficient management of the effort throughout his organization to meet specific cost, schedules and performance objectives.

Use of Incentive Contracts

In late 1963 we began a drive to reduce the number of cost-plus-fixed-fee contracts. This was accomplished by employing incentive provisions in new contracts and in the conversion of cost-plus-fixed-fee contracts to an incentive form.

In our incentivizing of contracts, we have elected to use a multiple incentive formula combining cost, schedule and performance (fig. 24).

A properly structured multiple-incentive contract serves two basic purposes. First, it motivates the contractor to strive for outstanding results in all three incentive areas. His objective at the outset is to earn maximum profit and the contract is structured so that there is some possibility that he can do this. Second, when outstanding results cannot be achieved in all areas, the incentive structure compels logical tradeoffs between cost, schedule and performance in consonance with the overall prestated objectives of the program. Realization of this second purpose turns mainly on relative weights assigned to each incentive element.

In weighting our incentives we have emphasized schedules to the extent that they can be maintained in a proper dollar/performance balance. Based on our experience, this is a reasonable and logical ordering of the incentive parameters. Because we are dealing here with Manned Space Flight, there is an intense feeling of responsibility on the part of all the people designing and building the systems and subsystems to achieve a level of performance commensurate with man's safety. As a matter of fact, because everyone is trying to build the best possible item, schedules and costs require special attention.

Many, if not all of the items highlighted in this chart are quite familiar to you. An incentive contract is an important tool of program management techniques if for no other reason than it forces more timely management attention, decision, and action on any required change of direction—since each of these has or may have an impact upon the originally structured incentive formula. Since the

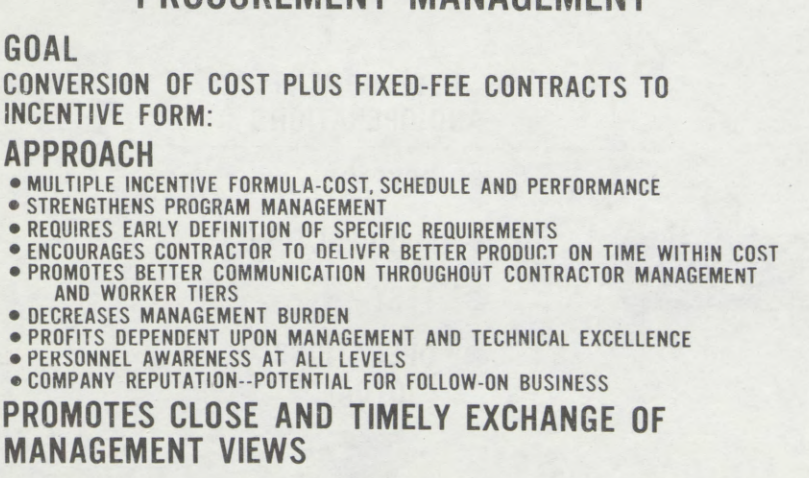

FIGURE 24

incentive formula discourages contract change except under the most compelling circumstances, we have a measure of built-in stability not generally found in cost-plus-fixed-fee contracts. This stability is of course dependent upon how well we are able to define our specific requirements at the outset. The incentive approach promotes this early definition; and we are continuing with concerted efforts in this promising area. Because the contractor is encouraged to maximize his earned fee, we received a better product, on time, and within acceptable cost levels. Communication with the contractor organization, from the management stratum clear through the working elements, is improved simply because all persons of the organization have a stake in final rewards or penalties. This also comes under the heading of Contractor Advantages.

Not the least of the incentive is the contractor's need to maintain or build up company reputation for favorable consideration for future contracts. Incentives automatically and quickly promote the closest interchange of contractor and Government management views so that few required decisions can be postponed by either party. An incentive provides no luxury of deferral.

In summation, I am pleased to report that the Agency's goal of $1 billion to be incentivized during fiscal year 1965 was realized (fig. 25). On June 30, 1965, OMSF had 54 Incentive Contracts totaling $1.190 billion. As of January 1966 negotiations had been completed for contracts with a cumulative total of $4 billion.

I will discuss our weighting of incentives further when I review the Gemini program.

Science community/MSF report and review activities

The management of Manned Space Flight research and development programs involves a number of relationships with the scientific and technical community (fig. 26). Through these relationships, we report the results of flight experiments, review ongoing programs with scientific advisory bodies, and obtain outside scientific and technical advice regarding future plans.

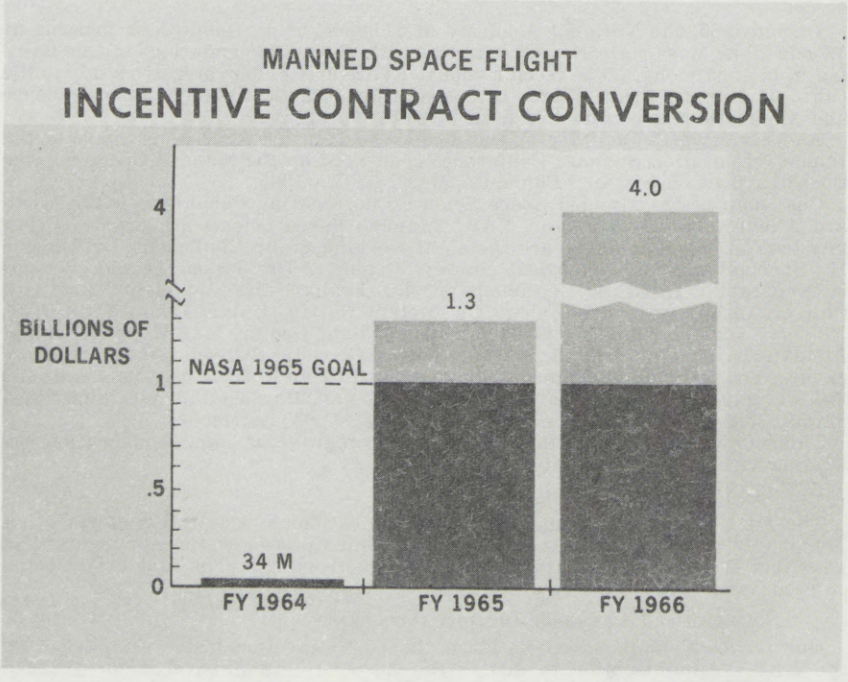

FIGURE 25

SCIENCE COMMUNITY/MANNED SPACE FLIGHT REPORTING AND REVIEW ACTIVITIES

- PRESIDENT'S SCIENTIFIC ADVISORY COMMITTEE
- SCIENCE & TECHNOLOGY ADVISORY COMMITTEE
  - PERIODIC REVIEW OF ALL MSF PROGRAMS
- NATIONAL ACADEMY OF SCIENCE
  - SPACE SCIENCE SUMMER STUDY, WOOD'S HOLE, MASS.
  - NASA 1965 SUMMER CONFERENCE ON LUNAR EXPLORATION AND SCIENCE, FALMOUTH, MASS.
    - 10 YEAR PROGRAM OF LUNAR EXPLORATION RECOMMENDED
  - SCIENTIST/ASTRONAUT SELECTION
- MEDICAL EXPERIMENTS PANEL
  - MEDICAL EXPERIMENTS DEFINITION
- GEMINI SYMPOSIUM AND REPORT

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FIGURE 26

In mid-1965, the National Academy of Sciences held a monthlong meeting at Woods Hole, Mass. Dr. Newell will deal with the recommendations of this meeting in his testimony. The recommendations are now under intensive study in the Office of Manned Space Flight in cooperation with the Office of Space Science and Applications in conjunction with our future programs.

Another scientific activity of significance to future NASA programs was the Lunar Exploration Summer Conference conducted by the Manned Space Science Coordinating Committee at Falmouth, Mass., in July 1965.

Chairman of the Manned Space Science Coordinating Committee is Dr. Richard Allenby, Deputy Director, NASA Manned Space Science programs. Other members of the Committee are the eight working group Chairmen: Dr. Eugene M. Shoemaker, U.S. Geological Survey, Geology; Dr. James Arnold, Scripps Oceanographic Institute, Geochemistry; Dr. Frank Press, Massachusetts Institute of Technology, Geophysics; Dr. Melvin Calvin, University of California, Biology; Dr. Wilmot Hess, Goddard Space Flight Center, NASA, Particles and Fields; Dr. Helmut Schmid, U.S. Coast and Geodetic Survey, Geodesy/Cartography; Dr. Francis S. Johnson, Southwest Research Institute, San Antonio, Tex., Lunar Atmospheres; and Dr. Nancy Roman, Physics and Astronomy programs, Office of Space Science and Applications, NASA, Astronomy.

This conference recommended a 10-year program of lunar exploration beginning with the first manned lunar landing.

Scientist-astronaut selection

The Ad Hoc Committee on Scientific Qualifications and Selection of Scientist-Astronauts of the National Academy of Science processes the applicants who have met the NASA standards for scientists-astronauts. The first five selected entered training in the later half of 1965.

Science and Technology Advisory Committee

Our technical management is strengthened by the Committee established by the NASA Administrator to advise the Associate Administrator for Manned Space Flight. This Committee, the Science and Technology Advisory Committee, provides objectives and critical analyses of our scientific and technical decisions.

During the past year, the Science and Technology Advisory Committee reviewed the major contractor effort on the Apollo spacecraft systems, including the Command Module and the Service Module, which is the spacecraft propulsion module. In conjunction with the President's Scientific Advisory Committee, the Science and Technology Advisory Committee reviewed the total Apollo program from the standpoint of reliability. The Committee suggested approaches for the solution of specific problems such as the bearing strength of lose material with respect to the angle of repose of the Lunar Landing Vehicle. They also carried out an extensive review of the Apollo spacecraft design.

In another action, the Committee reviewed the objectives and preliminary development plans and schedules for Apollo Applications. Without supporting specific experiments, the Committee as a whole endorsed Apollo Applications. As a result of its review, the Committee sees the applications effort as a necessary and logical step in continuing the development of a flexible, space operational capability on the one hand and in carrying out the exploration of space on the other.

Medical Experiments Panel

The Medical Experiments Panel, a group of consultants, assists the Director, Space Medicine in the review and selection of medical experiments. It is responsible for (1) reviewing proposed inflight experiments for feasibility and scientific merit; (2) serving as a forum to clarify procedures, and purposes of inflight medical experiments; and (3) recommending to the Director, Space Medicine medical experiments for each flight.

Gemini symposium and reports

The Gemini program has reached the phase at which results are reported to the scientific community. The first of a series of reports on Gemini flight experiments was held at the Museum of Natural History in Washington, D.C., on October 18 and 19, 1965, to report on the Gemini III and IV flights. A second symposium reported on experiments conducted on the Gemini V mission. The results of Gemini VI–A and VII flight experiments will be presented in conjunction with the Gemini Mid-Program Conference to be held in February 1966. It is planned to hold such symposia at regular intervals, ordinarily within 90 days after the completion of a mission.

President's Scientific Advisory Committee

During the past 9 months the President's Scientific Advisory Committee has held a series of meetings at selected Center and contractor facilities to discuss major elements of the Apollo program. Their participation has in the main encompassed two levels of activity.

Main panels have conducted management reviews at North America Aviation, Marshall Space Flight Center, Grumman Aircraft Engineering Corp., Kennedy Space Center, and the Manned Spacecraft Center.

Subpanel activities include technical reviews of reliability analyses, structures and heat shield, propulsion systems including liquid and solid, crew systems including environmental control system and suit, and fuel cells.

Subject matter of these reviews was predetermined by the Committee and specific questions were directed to NASA.

In addition to the Apollo program aspects, the President's Scientific Advisory Committee has reviewed the development program conducted by Gemini as it relates to support of the Apollo program.

Manned Space Flight medicine program coordination

NASA is continuing to assure that its programs are aligned with those of other Federal agencies engaged in research and development in the life sciences area (fig. 27). Particular attention has been directed toward coordination with the U.S. Air Force, whose program in Bioastronautics supports the Manned Space Flight life support research and development effort.

Beginning in fiscal year 1964, the related medical research and development programs were subjected to close scrutiny by NASA and the Air Force. As a result, 55 of 900 tasks analyzed in detail were considered to be in duplication and were eliminated. The following year, almost 1,200 tasks were reviewed under the same ground rules and of these, 68 were canceled.

At that time 43 research and development efforts funded and monitored by both agencies to meet common objectives were identified and detailed to joint sponsorship. Implicit in the concept of joint funding are closer interagency

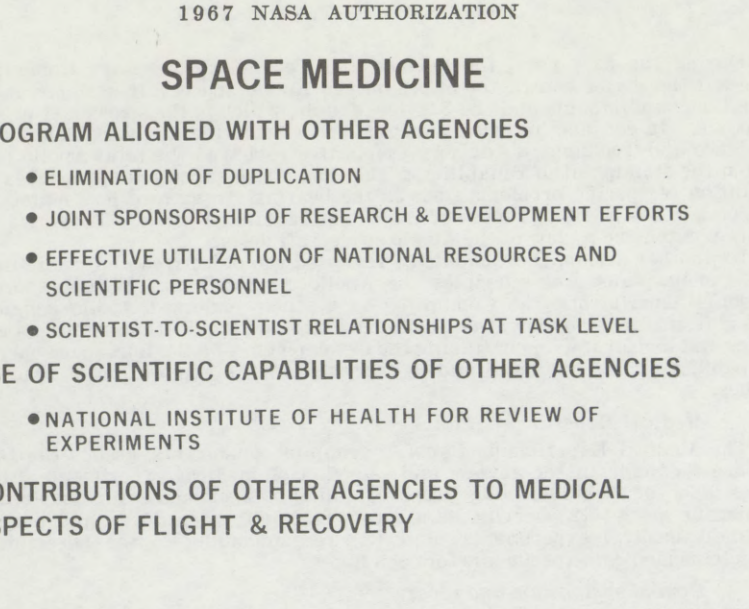

FIGURE 27

working relationships, better utilization of facilities, and savings in both manpower and funds. The fiscal year 1966 formal coordination activity covered 781 Air Force and 212 NASA tasks, with no duplication of effort.

The cooperation and contributions of other Government agencies extends to the medical aspects of the launch flight and recovery phases of the Gemini missions. The services of medical personnel as monitors and members of Gemini recovery and standby teams have been made available by the Army, Navy, Air Force, and Public Health Service. This is a most significant area of cooperation, since NASA medical personnel alone could not meet the requirements imposed during the launch, flight, and recovery periods of any manned mission.

In the course of achieving our Manned Space Flight medical objectives in the field of data analysis, we have contributed to general medicine as well by acquiring and analyzing available information from each of the 84 medical schools in the United States on the use of computers in the medical field.

This information was published and distributed in all of the medical schools.

Manned space flight/government relationships

An important consideration in the management of Manned Space Flight activities is our relationship with other Government agencies (figs. 28 and 29).

Without attempting to describe all of our many Government interfaces I would like to review some of these relationships for you now.

Aeronautics and astronautics coordinating board

The Aeronautics and Astronautics Coordinating Board was established to improve the close working relationships between decisionmaking officials within NASA and DOD. Where agency policy issues and management decisions are involved, it is important that the planning and coordination of activities, the identification of problems, and the exchange of information be facilitated between officials having the authority and responsibility for decisions within their respective offices. The Board is set up to accomplish these objectives.

Manned Space Flight Policy Committee

Last year I reported plans for an extension of our manned space flight agreement with the Air Force to provide maximum support to the Manned Orbiting Laboratory program.

MANNED SPACE FLIGHT/GOVERNMENT RELATION

DOD

- AERONAUTICS AND ASTRONAUTICS COORDINATING BOARD
  HOLD BI-MONTHLY MEETINGS. TO AVOID UNDESIRABLE DUPLICATION AND EFFECTIVE UTILIZATION OF RESOURCES
- MANNED SPACE FLIGHT POLICY COMMITTEE
  POLICY DECISION PERTAINING TO NASA'S MSF PROGRAM & MOL
- PERSONNEL
  TWO-WAY EXCHANGE
- CONTRACT ADMINISTRATION (DCAS)
  DELEGATE TO DOD ADMINISTRATION OF CONTRACTS

NASA MC66-5393

FIGURE 28

MANNED SPACE FLIGHT/GOVERNMENT RELATIONSHIP

- HEW
  - NATIONAL INSTITUTES OF HEALTH
    - REVIEW OF PROPOSED MEDICAL EXPERIMENTS
  - PUBLIC HEALTH SERVICES
    - PROVIDES MEDICAL OFFICERS FOR RECOVERY TEAMS
    - PARTICIPATES IN CARDIOLOGY STUDIES
    - CONTAMINATION
- DEPARTEMENT OF COMMERCE
  - ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
- ATOMIC ENERGY COMMISSION
  - RADIATION STUDIES
  - DEVELOP RADIOISOTOPE GENERATOR FOR LUNAR MODULE

NASA MC66-5384

FIGURE 29

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In January 1966 we entered into an agreement with the Department of Defense establishing a Manned Space Flight Policy Committee, with cochairman and committee membership equally divided between the DOD and NASA. The Committee's purpose is (1) to resolve matters concerning the mutual participation in and support of the Manner Space Flight programs of the two agencies which cannot be resolved at the program level; (2) arrive at agreements involving top policy determinations; and (3) facilitate top management level exchange of viewpoints and information for coordinated planning.

To this end, it is our policy to cooperate fully with the DOD in implementation of the Manned Orbiting Laboratory program. Without compromise to our own approved programs, full support will be given.

To facilitate the exchange of information between NASA programs and the Manned Orbiting Laboratory, we are considering the establishment of a technical liaison office at the Air Force Space Systems Division. This office could be staffed with personnel from the Manned Spacecraft Center with wide experience in Manned Space Flight development and operations planning and execution, thus providing direct technical support to the Manned Orbiting Laboratory Support program office. The basis for such an arrangement is provided by an agreement reached with the Air Force last year.

For some time there has been an Air Force System Command Liaison Office in residence at the Manned Spacecraft Center to coordinate DOD experiments in the Gemini program. The Air Force has recently proposed broadening the responsibilities of this office for coordination of the Manned Orbiting Laboratory, Apollo, and Apollo Applications mutual support. We are in complete agreement with this plan as a means of achieving the coordination needed.

Dr. M. I. Yarymovych of the Office of Manned Space Flight was detailed to the staff of the Vice Director Manned Orbiting Laboratory to provide immediate assistance in planning initial phases of implementation. Subsequently, he was named Technical Director of the Manned Orbiting Laboratory program office in Washington. The broad experience gained by Dr.Yarymovych in the Advanced Missions area of OMSF makes him particularly suited for this role. In addition to expertise in Manned Space Flight, Dr. Yarymovych brings to the Manned Orbiting Laboratory program a thorough knowledge of the NASA organization and programs plus an ideal base of identifying applications of NASA developments and experience to the Manned Orbiting Laboratory.

Pursuant to the agreement there has been transferred to the Manned Orbiting Laboratory program a flown Gemini spacecraft, Gemini 2, and a static article spacecraft, number 4A and other test spacecraft. Similarly numerous items of ground equipment, checkout equipment and spare parts have been transferred.

The early flight test program for the Manned Orbiting Laboratory is to accomplish, among other things, the reentry qualification of a new Gemini heat shield. Under the overall management and direction of the Manned Orbiting Laboratory Systems Program Office, the engineering, contract management, and procurement associated with heat shield qualification is being accomplished by the Gemini Program Office at Manned Spacecraft Center. In July NASA will deliver the flight-ready spacecraft to the Air Force for the test program.

An estimate of the cost savings to the Government represented by the Manned Orbiting Laboratory program use of this Gemini program equipment is about $25 million.

It is NASA's policy that any portion of the Gemini program that becomes excess to our needs will be transferred to the Air Force. Studies are now going on in both Apollo and Manned Orbiting Laboratory programs to determine the applicability of subsystems under development in Apollo to the latter program. If it develops that common use of some of these subsystems is practicable, the Manned Orbiting Laboratory program may realize considerable savings in both time and money.

Delegation of Contract Administration Services

In consonance with the stated policy of NASA, the office of Manned Space Flight is making maximum use of contract administration services and related field support capabilities of not only the Department of Defense but other Government agencies as well. Among the more significant functions performed for NASA through delegation to the Defense Contract Administration Services are quality and reliability, contract administration, industrial property administration, production monitoring, transportation, industrial security, and audit services.

Support of Other Agencies

The National Institutes of Health assists in reviewing proposed medical experiments. The Public Health Service along with the Navy, Army, and Air Force provide medical offices for recovery teams and participates in cardiology studies.

The U.S. Public Health Service also is in the process of establishing an Interdepartmental Advisory Committee which will guide NASA in the development and conduct of programs related to lunar substances returned with the Apollo spacecraft, personnel, or lunar samples.

The establishment of the Environmental Science Services Administration of the Department of Commerce last summer has already resulted in close working relationships with us. The strong ties that will exist between the Environmental Science Services Administration and NASA were expressed by the Honorable John T. Connor, Secretary of Commerce, during the hearings on Environmental Science Services Administration last spring when he stated:

"Our space technology is still under development, and the use of the space satellite to probe and observe the environment is still experimental. But what I want to stress is that we now have for the first time the physical means with which we may eventually be able to observe and collect data about the entire surface of the Earth, the entire Earth's atmosphere, and the space environment."

The Atomic Energy Commission is conducting total body irradiation studies for NASA and developing the radioisotope generator for the lunar landing module.

Industry Executive Groups

At this time last year in my appearance before this subcommittee, I reported on the working relationships we had built up through the industry executive groups (fig. 30). The Gemini and Apollo groups, comprising top management of the industrial contractors and Manned Space Flight management, have been meeting at regular intervals and are making a substantial contribution in solving our mutual management problems (figs. 31 and 32).

The industry executive group meetings provide policy briefings, status reports, and actual examination of the physical progress in producing facilities and hardware for the program.

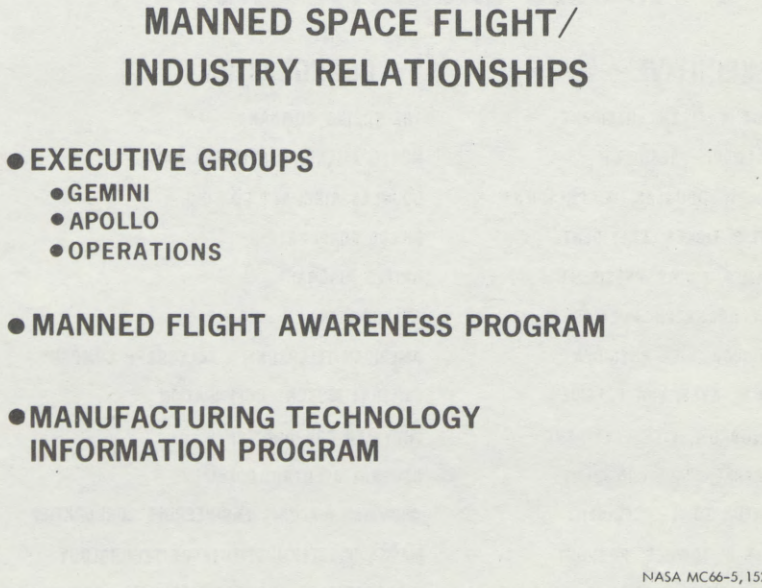

FIGURE 30

GEMINI EXECUTIVE GROUP

NAME	
MR. WILLIAM B. BERGEN PRESIDENT	MARTIN COMPANY
MR. DAVID S. LEWIS PRESIDENT	McDONNELL AIRCRAFT CORPORATION
MR. JAMES S. McDONNELL CHAIRMAN & CHIEF EXECUTIVE OFFICER	McDONNELL AIRCRAFT CORPORATION
MR. L. EUGENE ROOT PRESIDENT (GROUP V.P., LOCKHEED AIRCRAFT CORPORATION)	LOCKHEED MISSILES & SPACE CO.
MR. WILLIAM E. ZISCH PRESIDENT	AEROJET-GENERAL CORPORATION
MAJ. GEN. BEN I. FUNK COMMANDER	HEADQUARTERS SPACE SYSTEMS DIVISION AIR FORCE SYSTEMS COMMAND
MR. JAMES R. DEMPSEY PRESIDENT	GENERAL DYNAMICS/CONVAIR

NASA MC66-5381

FIGURE 31

APOLLO EXECUTIVE GROUP

EXECUTIVE	CORPORATION
WILLIAM M. ALLEN, PRESIDENT	THE BOEING COMPANY
J. L. ATWOOD, PRESIDENT	NORTH AMERICAN AVIATION, INC.
DONALD W. DOUGLAS, JR., PRESIDENT	DOUGLAS AIRCRAFT CO., INC.
ROBERT O. FICKES, PRESIDENT	PHILCO CORPORATION
WILLIAM P. GWINN, PRESIDENT	UNITED AIRCRAFT
JOHN A. HORNBECK, PRESIDENT	BELLCOM, INC.
R. R. HOUGH, VICE PRESIDENT	AMERICAN TELEPHONE & TELEGRAPH COMPANY
ROGER M. KYES, VICE PRESIDENT	GENERAL MOTORS CORPORATION
T. F. MORROW, VICE PRESIDENT	CHRYSLER CORPORATION
J. S. PARKER, VICE PRESIDENT	GENERAL ELECTRIC COMPANY
E. CLINTON TOWL, PRESIDENT	GRUMMAN AIRCRAFT ENGINEERING CORPORATION
CHARLES H. TOWNES, PROVOST	MASSACHUSETTS INSTITUTE OF TECHNOLOGY
A. L. WILLIAMS, PRESIDENT	INTERNATIONAL BUSINESS MACHINES CORPORATION

NASA MC66-5379

FIGURE 32

OPERATIONS EXECUTIVE GROUP

LT. GEN. JAMES FERGUSON
DEPUTY CHIEF OF STAFF (R&D)
UNITED STATES AIR FORCE

VICE ADM. JOHN B. COLWELL
DEP. CHIEF OF NAVAL OPERATIONS
(FLEET OPERATIONS & READINESS)
DEPARTMENT OF THE NAVY

LT. GEN. ALFRED D. STARBIRD
DIR., COMMUNICATIONS SATELLITES
DEFENSE COMMUNICATIONS AGENCY

LT. GEN. LEIGHTON I. DAVIS
DOD MANAGER, MANNED SPACE FLIGHT
SUPPORT OPERATIONS
HEADQUARTERS NRD (SCGR)

MR. L. F. GRAFFIS
PRESIDENT
BENDIX FIELD ENGINEERING

MR. L. F. WINGERT
VICE – PRESIDENT
LONG LINES DEPARTMENT
AMERICAN TELEPHONE & TELEGRAPH CO.

MR. JUAN TRIPPE
CHAIRMAN OF THE BOARD
PAN AMERICAN WORLD AIRWAYS

MR. EDMOND C. BUCKLEY
ASSOCIATE ADMINISTRATOR
OFFICE OF TRACKING & DATA ACQUISITION

NASA MC66-5392

FIGURE 33

Since a manned flight requires the active support of some 16,000 people from several organizations and agencies, an Operations Executive Group (fig. 33) was established by the Associate Administrator for Manned Space Flight on June 9, 1965. Members of the group are senior executives of NASA, DOD, and industry, whose organizations are significantly involved in Manned Space Flight operations. This group meets quarterly to review previous flight experience and to provide policy guidance as appropriate. Its purpose is to strengthen the interface between operational elements and to familiarize these executives with Manned Space Flight objectives and the anticipated problems in achieving them.

Manned Flight Awareness Program

As the Gemini and Apollo programs progressed, we realized the need for a Manned Space Flight employee motivational program (fig. 34). The objective of the new program was the elimination of errors and defects that could result in the loss of life or the destruction of space flight equipment during testing or launching. This goal was to be achieved through a program of individual motivation at all levels of organization.

The program in design and execution is quite similar to a program widely used by the aerospace industry and the Department of Defense. However, while we enjoy the benefits that accrue from reduced defects, reject rates, and scrap costs, our Manned Flight Awareness program emphasizes the insurance of astronaut safety.

When the awareness program was started, most of the contractors already had their own employee motivational program underway, the Mechanical Excellence program, for example.

The contractors agreed to incorporate into their company-sponsored programs the Manned Flight Awareness theme and to participate fully in the venture.

In seeking to motivate the individual, the Manned Flight Awareness program appeals to his sense of craftsmanship and personal responsibility. Pride in performance, coupled with a deep sense of personal involvement in the Nation's Manned Space Flight missions and the lives of its astronauts, is a powerful avenue of approach.

In addition to visits by astronauts and other NASA personnel, films, brochures, posters, and displays are used. Each of these activities stresses the importance

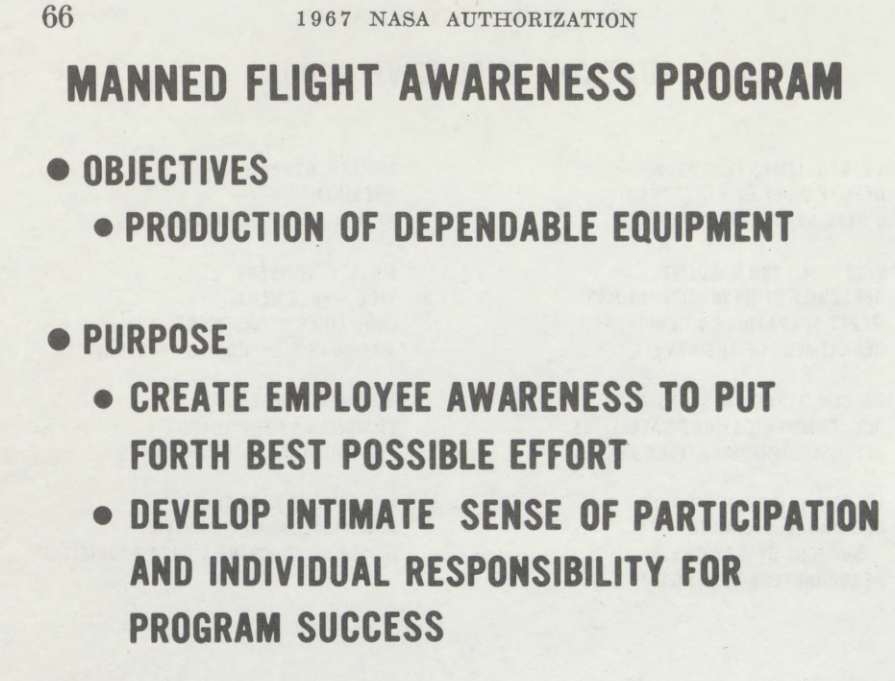

FIGURE 34

of personal repsonsibility for the safety of the astronauts and the success of the space mission through team effort.

Saturn Apollo Contractor Manufacturing Technology Information Program

Repeated reliability of our space vehicles can only be assured if all manufacturing management has immediate uninhibited access to the latest knowledge and experience to optimize decisionmaking in the factory environment (figs. 35 and 36). The NASA-industry manufacturing management team has developed and sustained communications for this purpose which have proved effective in fabricating hardware for the Saturn Apollo program. This has been brought about by the Manufacturing Engineering Liaison Office established in 1963 by the Manufacturing Engineering Laboratory at MSFC. Timely exchange of manufacturing technology between the Centers and all Saturn Apollo contractors is a prime responsibility of this office.

Field personnel of the Manufacturing Liaison Office work closely with Apollo contractor manufacturing personnel. As a problem is identified in the factory environment of a particular Apollo contractor, Manufacturing Liaison field personnel assigned to this contractor arrange for a specialist from another Apollo contractor or from one of the MSF centers to assist in solving the problem. In many cases, a given contractor or center has had prior experience in solving a similar manufacturing problem. The job of the field personnel of the Manufacturing Liaison Office is to be aware of this background of experience in the Apollo contractor complex and make it available to the particular Apollo contractor who needs help. Manufacturing personnel of the various Apollo contractors are encouraged to communicate with each other on day-to-day manufacturing problems. In addition, meetings are held on the basis of new manufacturing developments and recently acquired manufacturing experience. The most recent meeting of this type was held at Grumman Aircraft, Bethpage, N.Y., in November 1965.

Personnel from North American Aviation, Douglas Aircraft, General Electric, International Business Machines, McDonnell Aircraft, Boeing, Chrysler, A. C. Spark Plug and Lockheed participated, as well as representatives of Manned Space Flight Centers.

I have specifically mentioned this activity since we have experienced gratifying results and to date every Saturn Apollo contractor has benefited from this manu-



FIGURE 35

SATURN APOLLO CONTRACTOR MANUFACTURING TECHNOLOGY INFORMATION PROGRAM

- ESTABLISHED THREE YEARS AGO BY THE MANUFACTURING ENGINEERING LABORATORY AT MSFC, HUNTSVILLE, ALABAMA
- INSURES TIMELY EXCHANGE OF MANUFACTURING TECHNOLOGY AND KNOW-HOW BETWEEN MSF CENTERS AND SATURN APOLLO CONTRACTORS
- MEETING, PRESENTATIONS, DISCUSSIONS, FACTORY ENVIRONMENT
- DEMONSTRATIONS ARE HELD ON THE BASIS OF NEW MANUFACTURING DEVELOPMENTS AND RECENTLY ACQUIRED MANUFACTURING EXPERIENCE
- COMMUNICATE REGULARLY ON DAY-TO-DAY MANUFACTURING PROBLEMS

NASA MC66-5, 131

FIGURE 36

facturing technology information program, thus increasing the assurance of a manned lunar landing in this decade.

Summary

In summary, we have continued to strengthen our organization to insure maximum effectiveness of our work. We have intensified our efforts to improve our utilization of available manpower in light of the changing workload at our centers. I have reported on recently instituted internal organizational elements including the focus of all major NASA launch responsibility at Cape Kennedy. We have continued our drive to employ incentive provisions in all new contracts, as well as the conversion of existing contracts to incentive type.

Our relationships with other agencies have been reviewed in the areas of space medicine, manpower, contract administration, and the utilization of NASA achievements for the Nation's Manned Space Flight programs and other national programs.

I am pleased with our excellent relationships with the industrial community and gratified that technology developed in our Manned Space Flight programs is receiving application in the Nation's economy. Fine cooperation has been received from both labor and management in stimulating worker efficiency and stressing good workmanship.

We continue to seek methods of improving our management processes, not only for the attainment of our immediate objectives, but also to develop a proven management team capable of accepting greater challenges in the future.

GEMINI PROGRAM

Introduction

With Gemini, we have investigated the effects of prolonged Manned Space Flight on man's capabilities, and we are developing the overall operational base required to carry out Apollo mission objectives.

In one unmanned and five manned flights last year, Gemini has contributed to all major objectives of Manned Space Flight and has advanced this Nation's capability to perform useful tasks in space. As I mentioned earlier, Gemini has slipped forward to recover all the schedule losses we reported last year. During the coming year this operational capability will be developed further to increase our proficiency for rendezvous and docking, stationkeeping, extravehicular operations and performing experiments in space.

In support of these overall Manned Space Flight objectives, the Gemini program has its own specific objectives (fig. 37). Capability and proficiency in the

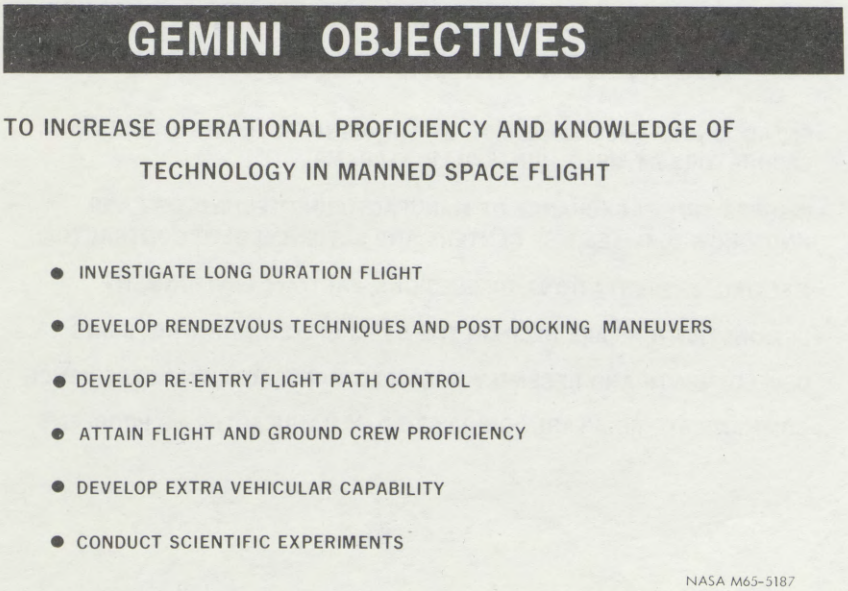

FIGURE 37

basic tasks of Manned Space Flight operations are the main objective of Gemini operations. The first 3 of Gemini's 12 missions, 2 of them unmanned, were primarily for flight qualification of the Gemini flight system for operational missions. Three flights accomplished the program objective of investigating the environment and effects of long-duration flight. Six flights have as their primary objective the development of operational proficiency in rendezvous and docking maneuvers.

Reentry flight path control development has been planned for all manned Gemini flights. All flights will contribute, in increasing degrees of sophistication, to the attainment of flight and ground crew proficiency and will insure the existence of a capability necessary for upcoming Manned Space Flight programs. On the second Gemini manned flight, Gemini IV, we established a capability for extravehicular activity. All Gemini manned flights include scientific experiments.

Summary of 1965 Major Accomplishments

At the close of 1964, Gemini design and development effort was essentially complete and extensive operational activity had already been accomplished. Most subsystem development testing was complete and production of flight hardware was well advanced. The spacecraft contract with McDonnell had been converted to a cost-plus-incentive-fee contract and strong, formalized configuration management procedures were in effect. Organizational changes had been made in the Office of Manned Space Flight and at the Manned Spacecraft Center to strengthen management of the program.

Gemini I was accomplished in April 1965 and Gemini II, which served as the unmanned flight qualification mission, was flown successfully on January 19, 1965. Hot-fire testing of the secondary propulsion system for the Agena Target Vehicle was completed early in 1965. Gemini III (fig. 38), the first manned Gemini flight, was conducted in March 1965 and established the Gemini system as an operational flight system. Gemini IV, the first of three successful long-duration missions, was conducted in June 1965. During this flight, Lt. Col. Edward H. White achieved a major program milestone in performing extravehicular activity for a period of 23 minutes (fig. 39). The Gemini IV flight

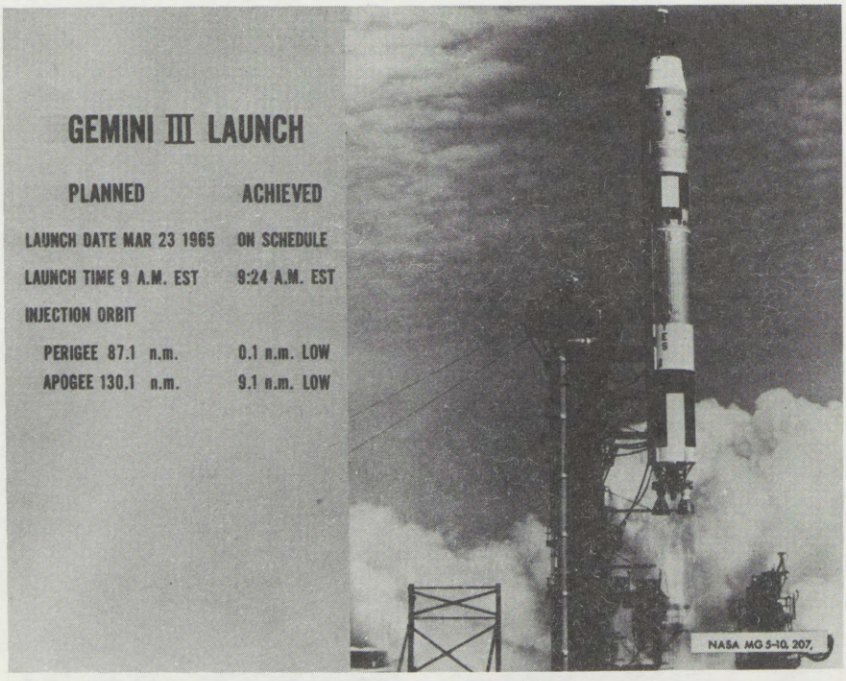

FIGURE 38

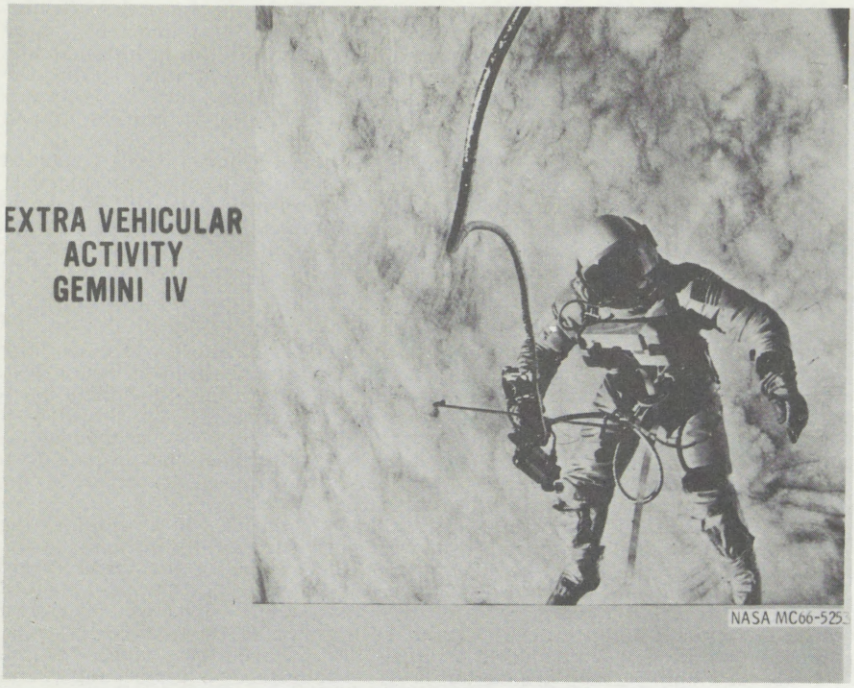

FIGURE 39

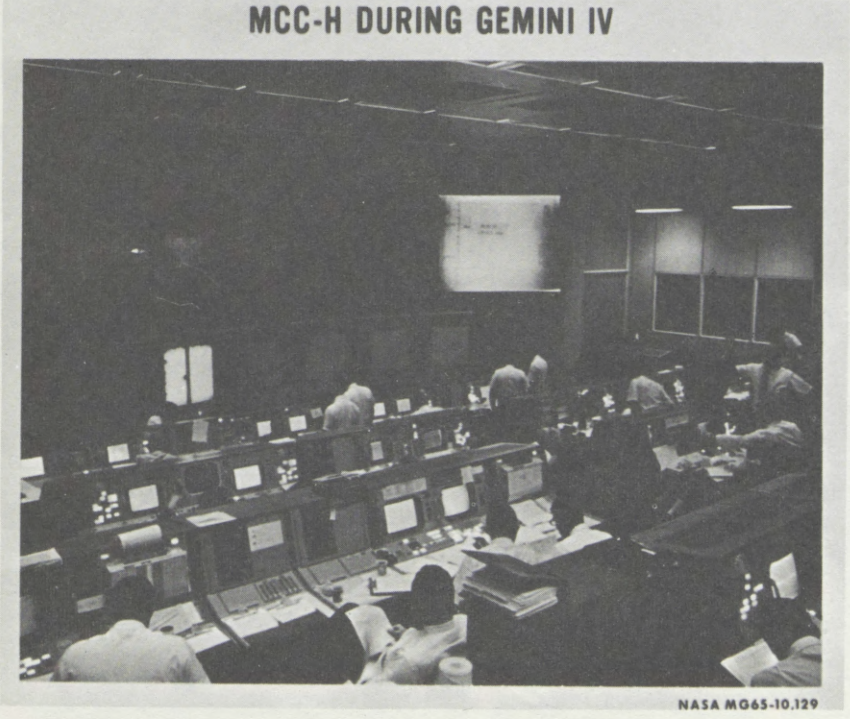

FIGURE 40

was the first flight to be controlled by the Mission Control Center at Houston (fig. 40). In August 1965, our second long-duration mission, Gemini V, proved the capability of man to function effectively in space for 8 days. (The Apollo lunar mission requires 7 days to the lunar surface and return.) In October the Gemini VI first rendezvous mission was rescheduled because of a failure of the Agena target to achieve an orbit 6 minutes after launch. In December 1965 the 14-day Gemini VII mission was accomplished successfully. Concurrent with the Gemini VII mission the rescheduled Gemini VI (designated Gemini VI–A) was conducted. The Gemini VI–A spacecraft was launched 11 days after Gemini VII and rendezvoused with the Gemini VII spacecraft on December 15 (fig. 41). This was the first successful rendezvous of two spacecraft in space, a major milestone for U.S. Manned Space Flight.

To support this intensive operational activity, production and delivery of Gemini flight hardware reached its peak in 1965. Four Spacecraft, five Gemini Launch Vehicles, two Agena Target Vehicles, and one Atlas Launch Vehicle were delivered to the program. Major subsystem deliveries are nearly completed and all remaining flight hardware is in production.

Gemini activity 1965

Management

The effectiveness of the Gemini program management was demonstrated by Gemini program achievement in 1965. A major schedule recovery was carried out and two missions were accomplished which were not planned last year at this time.



FIGURE 41

Effectiveness of Program Controls

One very effective tool in program control is the cost-plus-incentive-fee contract whereby the contractor directly benefits monetarily from his own efficiencies. Last year at this time negotiations had been completed on the conversion of the McDonnell contract from a cost-plus-fixed-fee contract to cost-plus-incentive-fee. With this conversion, all major Gemini contractors were working under incentive contracts. This chart of major contractors in the program (fig. 42) summarizes the basic incentive paramenters of the individual contracts.

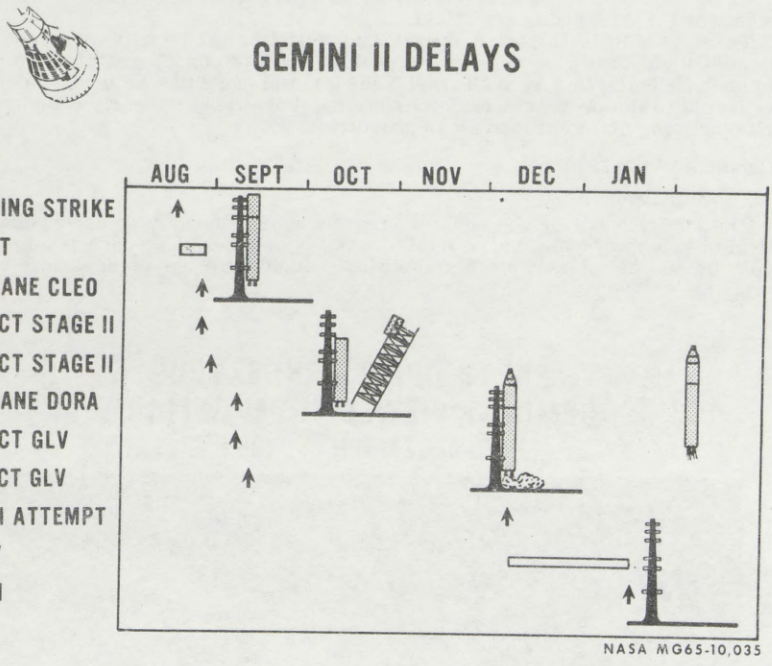

FIGURE 42

Launch Schedule Recovery

As an example of positive management action, I will cite a major program decision made to overcome the delays encountered with launching Gemini II (fig. 43). Because of problems with a lightning strike and two hurricanes, an extraordinary effort was required at that time to stay within the program schedule and dollar commitments.

These problems were reviewed and studied at the November 1964 meeting of the Gemini Executives Group, chaired by the Associate Administrator for Manned Space Flight and composed of the presidents of all the principal Gemini contractors and key Department of Defense personnel supporting Gemini. At this meeting, we established a target launch interval of 60 days and set up a NASA-implementing team to attack the problem. The objectives were to maintain the cost ceiling of $1.354 billion and program completion in the first quarter of 1967.

Delivery of flight-ready hardware to the Cape was a prime objective of the study. Rigorous enforcement of our established configuration control system was carried out to insure that all management levels recognized the necessity to minimize changes to the flight hardware. A thorough review of the program functions was made to identify and eliminate bottlenecks and to establish new and better ways to do the job.

Major management actions were taken in the program as a result. All spacecraft altitude chamber tests were to be conducted at the contractor's plant prior



INCENTIVE CONTRACT SUMMARY

CONTRACTOR	MAJOR ITEM	DATE EFFECTIVE	VALUE INCENTIVE	INCENTIVE PARAMETERS		
				COST	PERFORMANCE	SCHEDULE
LOCKHEED	AGENA	JAN. 1, 1963	$50 MIL.	40%	40%	20%
MARTIN-MARIETTA	GLV	JULY 1, 1963	$120 MIL.	45%	42%	13%
AEROJET	ENGINES (GLV)	JULY 1, 1963	$42 MIL.	45%	43%	12%
McDONNELL	SPACECRAFT	APRIL 1, 1964	$343 MIL.	INTEGRATED COST PERFORMANCE 90%		10%

NASA MG64-5979

FIGURE 43

to delivery of the spacecraft to NASA. The spacecraft contractor's systems test facility was augmented so that two complete spacecraft could be tested simultaneously while sections of a third spacecraft were in modular testing. The launch vehicle test complex was augmented by activating a second test cell, allowing two launch vehicles to be in test at the same time.

Certain tests were added, among them the simultaneous launch demonstration. This simultaneous countdown and checkout of the Atlas/Agena on Complex 14, along with the Gemini-Titan on Complex 19, provided valuable training for the launch team, the range personnel and operations personnel at the Mission Control Center in Houston.

The summary results of the 2-month launch interval activity are shown here (fig. 44). Parallel testing, improvements in test procedures, and a thorough integration of tests for the launch vehicle and spacecraft resulted in substantial reduction in test time. The tight control of changes during this period provided a minimum of interruption to testing and prevented extensive retesting required when changes are incorporated. Crew readiness and training were optimized along with the mission-planning and flight control activities to support the proposed 2-month launch interval.

Mission Results

Gemini III Through VII

The flight qualification phase of the Gemini program was completed in March 1965 with the successful flight of Gemini III.

On Gemini IV, extravehicular activity (EVA) was conducted. The Mission Control Center at Houston was utilized on Gemini IV for the first time to control and direct an operational mission. The excellent performance of the fuel cell as an operational power source on Gemini V and VII was a major advance in space technology.

The Gemini VI–A launch within 11 days of Gemini VII launch and from the same launch complex used for Gemini VII demonstrated the high degree of proficiency in launch and preflight operations developed in 1965. The rendezvous of the Gemini VI–A spacecraft with the Gemini VII spacecraft was the first major step toward the successful attainment of proficiency in rendezvous operations required for a round trip to the Moon.



TWO-MONTH LAUNCH INTERVAL STUDY

RESULTS

- REDUCED TEST TIME
- REDUCED NUMBER OF CHANGES
- INCREASED CONFIDENCE IN FLIGHT VEHICLE READINESS
- EXCELLENT FLIGHT PERFORMANCE
- RECOVERED LAUNCH SCHEDULE SLIPS

NASA MG5-10,021

FIGURE 44

Gemini IV, V, and VII proved that men and equipment could operate successfully for periods of long duration in the space environment. An extensive experiments program was conducted on these missions in the medical, scientific and technological fields, greatly increasing our knowledge of the near space environment, and providing concrete evidence of man's usefulness in space as an experimenter.

Man's Capability—Medical Experience

The two major sources of medical information from space flight can be categorized as medical operational information and information obtained from medical experiments. The former is concerned with the safety and welfare of the astronauts during a flight mission, and the latter with their safety and welfare in future flights. Medical operations, therefore, tend to emphasize symptoms or telemetered variations from established norms since these indicate the need for treatment during the mission. The medical experiments program, on the other hand, emphasizes detailed measurement in the gathering of trend information to predict and prevent undesirable effects during future manned space flight missions.

In Gemini IV, the primary medical objectives were to provide additional data points in the store of scientific information on man's response to space flight and to give additional assurance that man can be committed to longer duration missions aboard the Gemini spacecraft.

The major medical objective of Gemini V was to observe what physiological effects a 4-day exposure to the space flight environment might have on the flight crew. Gemini IV also provided the unique opportunities of observing the two crewmen in pressurized suits while the cabin was at zero pressure for about an hour and to observe one crewman outside the spacecraft for 23 minutes.

Inflight medical measurements were within expected ranges. No changes in the electrocardiogram of either crewman, as compared to baseline studies made prior to flight, occurred. Rates and patterns were within normal limits.

During the extravehicular activity the pilot experienced no disorientation. There was no sensation of falling as he left the spacecraft and no discomfort from temperature while outside.

Gemini V provided the opportunity to study the physiological effects of space flight on two crewmen for 8 days. The 8-day flight showed that men easily adapts to normal gravitational forces after extended flight.

Gemini VII, the 14-day mission conducted last December, was the third and final step in the investigation of the medical effects of long duration flight in the Gemini program. The preliminary results of this mission indicate no adverse effects on the crew.

I will not dwell on the medical aspects of the program except to summarize accomplishments to date in terms of their significance (fig. 45). The various findings to date by areas of interest are tabulated here (fig. 46). The Gemini program has now demonstrated that man can function well in space for the duration of the planned Apollo lunar mission without inflight or postflight disability or degradation of practical consequence. Our confidence in the safety of missions, beyond 14 days now enables us to suggest that the first orbiting research laboratory mission can be programed for 30 days.

Second, the environmental control system, food, water and waste systems, space suits, and other life support techniques and equipment have now been flight validated for 14 days.

Third, radiation measurements have indicated that there is a relatively low level hazard for near Earth equatorial orbits, enhancing extended duration manned Earth orbital missions from the standpoint of medical safety.

Fourth, we now have an improved definition of the cardiovascular, musculoskeletal, water balance, and vestibular problem areas, their time courses, and corrective measures which may be required.

Fifth, the Gemini program has established that man can function normally and without ill effect outside the spacecraft, and has validated the personal support equipment used.

Sixth, our flight medical monitoring system has been verified, an important contribution to all future Manned Space Flight missions.



SIGNIFICANCE OF MEDICAL DATA THROUGH GEMINI- VII

- VALIDATION OF MAN FOR SPACE FLIGHT OF 14 DAYS
- VALIDATION OF LIFE SUPPORT TECHNOLOGY FOR SPACE FLIGHTS IN EXCESS OF 14 DAYS
- RADIATION HAZARD SMALL IN NEAR EARTH ORBIT
- CARDIOVASCULAR DECONDITIONING AND BONE DEMINERALIZATION TENDENCIES AND VESTIBULAR EFFECTS BETTER DEFINED
- EVA CAPABILITY DEMONSTRATED - CREW SUPPORT VALIDATED
- MEDICAL GROUND SUPPORT TECHNIQUES AND EQUIPMENT VALIDATED TO 14 DAYS
- GEMINI STANDARD BIOSENSORS VALIDATED TO 14 DAYS OF CONTINUOUS FUNCTION

NASA MG 5-10 15-1 A

FIGURE 45



CONTRIBUTION OF GEMINI MEDICAL INFORMATION (THRU GEMINI VII) TO PRE-GEMINI MEDICAL PROBLEM AREAS

CARDIOVASCULAR	DECONDITIONING TREND DEMONSTRATED NO DISABILITY - 14 DAYS
WATER BALANCE	DEHYDRATION TREND DEMONSTRATED NO DISABILITY - 14 DAYS
SKELETAL	EARLY ATROPHY SUGGESTED NO DISABILITY - 14 DAYS
MUSCULAR	EARLY ATROPHY NOTED; SYMPTOMS VERY MILD - 14 DAYS
BEHAVIORAL	NO DEGRADATION
VESTIBULAR	NO CHANGE
METABOLIC AND DIGESTIVE	NO DYSFUNCTION NOTED
RESPIRATORY	NO DYSFUNCTION NOTED
CELLULAR	(APOLLO)
SLEEP AND DIURNAL RHYTHMS	SLEEP PATTERNS ALTERED - THEN NORMALIZED IMPORTANCE OF W-R-S CYCLE STRESSED
VISUAL	ACUITY UNCHANGED – VISIBILITY EXCELLENT FROM EARTH ORBIT

NASA MG5-10.101

FIGURE 46

At least one aspect of Gemini medical research and development may benefit clinical medicine and medical research. Biosensors and techniques of applying them to the body have been developed to achieve continuous function for at least 14 days. We have had many inquiries into these methods from investigators conducting research into human function under dynamic, as opposed to static, conditions and from clinicians working with hospital intensive care units.

Experiments Program

A major utilization of the Gemini capability is to conduct scientific experiments, which now total 49. A substantial number of these are repeated to provide a broad sample of information and data. Including experiment repeats, 52 of 54 experiments planned thus far have been successfully conducted.

Experiments symposia

The first Gemini Experiments Symposium was held in Washington, D.C., on October 18 and 19, 1965. Its purpose was to disseminate to the Nation's scientific community the results of experiments conducted on Gemini III and IV.

Another symposium was held in January 1966 on experiments conducted on the Gemini V mission. The results of the Gemini VI–A and VII flight experiments will be presented in conjunction with the Gemini Mid-Program Conference.

Mission activity in 1966

We plan to deliver all remaining flight hardware into the program this year. Five Gemini spacecraft, five Gemini launch vehicles and the four Gemini Agena target vehicles will be completed by the end of September; four Atlas SLV–3 launch vehicles will be completed by the end of June.

We also are committed to assist the Air Force in getting their Gemini B Manned Orbiting Laboratory program underway expeditiously. The early flight test program for Manned Orbiting Laboratory includes the reentry qualification of a new Gemini heat shield. This heat shield will have a crew transfer hatch to permit passage of the astronauts between the Gemini B spacecraft and the lab-

oratory module. The Gemini Program Office is supporting the Air Force with accomplishment of the necessary engineering, contract management and procurement for the new heat shield.

Development of operational capability

In 1966, the intense operational activity that characterized the 1965 Gemini program will be continued, with four missions to be flown. Major objectives will be further development of various phases of rendezvous and docking including Apollo simulations; extravehicular activity; and extensive experiments.

As a backup for the Agena target vehicle, an augmented target docking adapter has been added to the Gemini program. This vehicle is being manufactured by McDonnell, the Gemini spacecraft manufacturer. All of its critical components are qualified spacecraft components presently available in the Gemini inventory. In the event of another Agena failure or serious schedule delay, this vehicle will be used as a rendezvous and docking target for the spacecraft.

Rendezvous and Docking

The rendezvous of two Gemini spacecraft last December demonstrated this Nation's capability to rendezvous two-manned vehicles. The Gemini VIII mission provides for the spacecraft to rendezvous and dock with an Agena target vehicle.

Rendezvous will be repeated and expanded in the remaining missions of 1966. Our objective will be to develop a high degree of knowledge and operational capability in all facets of rendezvous, docking, and maneuvering of space vehicles required for a successful lunar landing and return. Various operational maneuvers will be executed to simulate the lunar module rendezvous maneuvers presently planned in the Apollo lunar mission.

Extravehicular Activity

Extravehicular activity also will be conducted on the flights planned for 1966. The objective is to evaluate extravehicular life support systems, maneuvering devices, tethers, and handtools for use in space; to develop operational techniques for extravehicular tasks such as crew transfers, equipment retrieval and satellite inspection and repair, and to demonstrate extravehicular capability by specific application of equipment and techniques to operational tasks. The first evaluation and demonstration of the modular maneuvering unit being developed by the Air Force will be carried out in this period.

Experiments

Typical experiment activity will include micrometeorite cratering measurement and collection, evaluation of the DOD astronaut maneuvering unit and power tool, and a series of experiments that will measure the Earth's magnetic field, ultraviolet reflection from the lunar surface, and the radiation environment around the spacecraft. Medical experiments also will be continued on all flights. Much of the experiments information obtained will provide support to Apollo and future programs.

Technology development and dissemination

The Gemini program is a logical step in developing the technology and operational proficiency for all future manned missions. Gemini has made and is making many direct contributions to the Apollo program.

Hardware development and technology applicable to future manned programs

Bioinstrumentation and crew life support equipment developed and qualified in Gemini flights will be used in Apollo missions.

While new communications systems will be needed for the deep-space requirements of the Apollo program, many existing components of the Manned Space Flight network will be used for communications, network, and data functions and near-Earth tracking phases of the Apollo mission.

Spacecraft components to be used include telemetary, communication and intercommunication equipment. Ground equipment includes equipment for transmission of data from telemetry, radar, digital command, and for display purposes and voice and TV communications. Also included landline and cable

with some use of microwave link and HF single sideband, and the specially engineered switching and subswitching centers.

Failure information generated in the Gemini program is being reviewed, analyzed, and fed into the Apollo management system and all Gemini flight anomolies are studies for the impact of a similar condition during Apollo missions.

Crew training and safety assurances are major Gemini contributions to the Apollo program. The long-duration missions have qualified man for weightless flight for durations up to and beyond Apollo lunar mission times. Pre-flight and in-flight medical procedures for crew safety have been thoroughly developed and demonstrated.

The handling and loading of spacecraft storable propellants have been developed and perfected and the handling and servicing of cryogenic oxygen and hydrogen for the fuel cell have been advanced. The acceptability of fuel cells as a power generator for space systems was conclusively demonstrated during the Gemini V and VII missions.

Environmental control and inertial guidance experience from Gemini will support Apollo. The environmental control systems for Apollo will have many qualified in Gemina flights. Blunt lifting body aerodynamic flight data and experience from Gemini flights will be used for reentry of the Apollo and Manned Orbiting Laboratory spacecraft.

Mission simulators with visual display attachments developed for Gemini will support Apollo simulator development. Several scientific experiments have direct application to Apollo missions.

Operational capability applicable to Apollo and Manned Orbiting Laboratory

Extensive operational capability for Apollo is being developed in the Gemini program.

Nominal trajectory design data, including rendezvous maneuver requirements, are prepared prior to each mission and the capability of the crew and spacecraft systems to perform these maneuvers to the precise degree planned is evaluated during the course of the mission. Revisions to the trajectory design or flight crew procedures contained in the flight plan are made based on the mission results.

Real-time programs have been developed for the Gemini rendezvous missions which will allow the ground computer complex to determine backup procedures for rendezvous in the event of on-board system failure.

A future Gemini rendezvous mission will duplicate as nearly as possible the Apollo lunar module rendezvous.

Planning procedures and requirements have been established for launch area abort recovery, and the zone concept for normal end-of-mission recovery has been successfully utilized. These gains were made possible by past mission successes and improved recovery operations and training.

Common-use facilities activation, shakedown, and personnel training also directly benefit the Apollo program. The Mission Control Center at Houston, which is operational for Gemini, will be used for Apollo.

Three separate flight control teams have been trained, each capable of assuming complete control of a mission. They will be capable of controlling the Apollo Earth orbital and translunar missions with the proper Apollo systems indoctrination.

Mission rules for Apollo will be based upon Gemini experience. These rules list actions to be taken during or immediately prior to a mission in the event of an anomaly or failure of a flight support system, to expedite the decision process.

Any portion of the Gemini program that becomes excess to our needs may be transferred to the Air Force if it will satisfy a Manned Orbiting Laboratory requirement. Certain of the Gemini hardware such as crew trainers and simulators would be applicable both to the Apollo and Manned Orbiting Laboratory programs as part task simulators. We are also taking action to assign a number of highly skilled civilian employees from the Gemini Program Office at the Manned Spacecraft Center to the Manned Orbiting Laboratory Systems Program Office in Los Angeles.

Summary

In summary, 1965 was a year of flight success for the Gemini program. The program objective of investigating long-duration flight was successfully com-

pleted. The first step in developing extra-vehicular activity was taken; a sound base of operational proficiency in launch and flight operations was established; seven new astronauts gained flight experience; a new electrical power source for extended space flight was successfully utilized on two long-duration missions; and the rendezvous of two manned spacecraft was demonstrated for the first time.

In 1966, the operational development of the Gemini flight system will be continued to broaden our proficiency in Manned Space Flight operations and to increase our knowledge of the space environment, in continuous preparation for the manned Apollo missions that will follow.

APOLLO PROGRAM

Introduction

The year 1965 has been a year of substantial progress in the Apollo program. We have built a dedicated, competent organization both technically and managerially. Apollo has become a stable program and is essentially defined, with the heavy testing of the past year to continue for several months ahead. We have had our share of problems, but believe that we understand them and we are attacking them vigorously.



APOLLO PROGRAM OBJECTIVES

- **TO MAKE THE UNITED STATES PRE-EMINENT IN SPACE BY BUILDING A BROAD-BASED CAPABILITY FOR MANNED SPACE FLIGHT.**
- **TO DEMONSTRATE THIS CAPABILITY BY LANDING MEN ON THE MOON, AND RETURNING THEM SAFELY TO EARTH, WITHIN THIS DECADE.**

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FIGURE 47

Objectives

The objectives of the Apollo program shown here (fig. 47) have not changed. This very important factor helps tremendously to build and maintain a stable program. It is our objective to build the broad-based capability to make the United States preeminent in Manned Space Flight operations. The focal point for this objective is to demonstrate that we have, in fact, developed this operational capability by completing a manned lunar mission within this decade.

Launch vehicles

Included in the Apollo program (fig. 48) are the Saturn launch vehicles and the Little Joe II booster. The first phase of the Saturn I program, completed last July, was eminently successful in providing the base on which the large launch vehicle technology is built.

Spacecraft

With the program using Little Joe II completed in January 1966, we have developed and qualified the Apollo launch escape system and the Apollo spacecraft

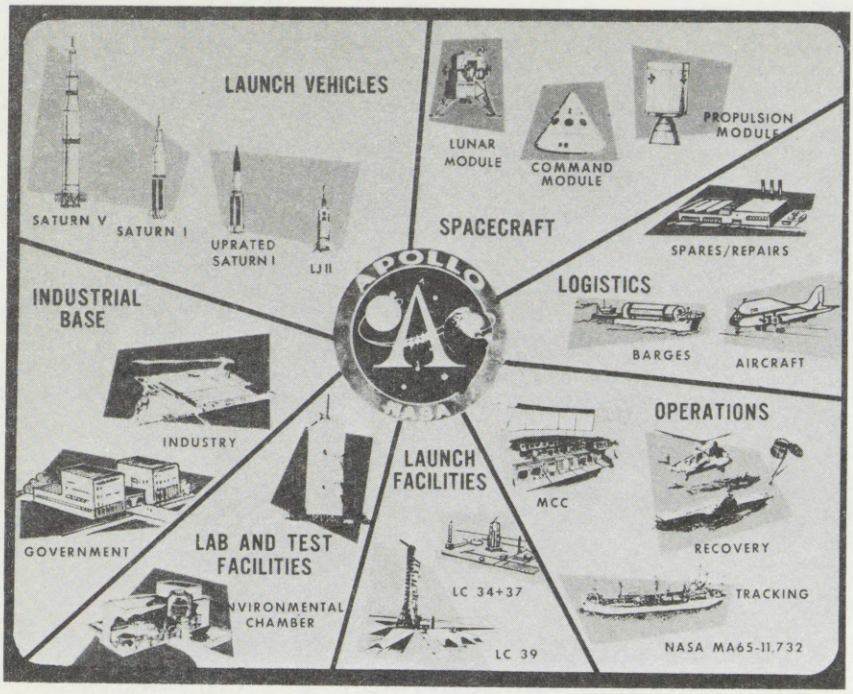

FIGURE 48

Earth landing system. The first phase of our flight program, the base on which the rest is built, has been completed and we are moving into the payoff part of the program.

Logistics

There has been a great deal of progress in building the logistics base, such as the barges for the west coast and transportation service from the west coast to the east coast, which are now in operation. We have barged the first second stage (S–IVB) for the uprated Saturn I (Saturn IB) and the first second stages (S–II) for the Saturn V. We have also barged the first of the big Saturn V first stages (S–IC) from Michoud Test Facility up to Marshall Space Flight Center.

Operations

In the operations area, our capability has been built in terms of recovery and basic mission control. The basic demonstrations have been made in association with the Gemini program. We are building the five ships and the aircraft associated with the Apollo network.

Launch facilities

At Launch Complex 34, we have completed the conversion from the first phase Saturn I configuration for launch of the first phase B Saturn I. We have started the conversion of Launch Complex 37, the other Saturn I launch facility. Construction of Launch Complex 39 for the Saturn V launch vehicle is well along, as we move toward the start of checkout operations on that facility.

Laboratory and test facilities

Much of our laboratory and test facilities capability is now in operation, and the last elements are being completed. An example of work remaining is the thermal-vacuum chamber at Houston, a key test facility in qualifying the Apollo spacecraft and Lunar Module for manned flight.

Industrial base

The Government-industry base that gives us the ability to fabricate and produce hardware is completed, although certain assembly and test positions remain to be finalized.

Apollo hardware capability has continued to grow (fig. 49). The capability of the uprated Saturn I (Saturn I–B) to put payload into Earth orbit is essentially 40,000 pounds, an increase of about 5,000 pounds.

The Saturn V has a 95,000-pound payload capability requirement. We will soon achieve or exceed this goal which is necessary to carry out the basic Apollo program.

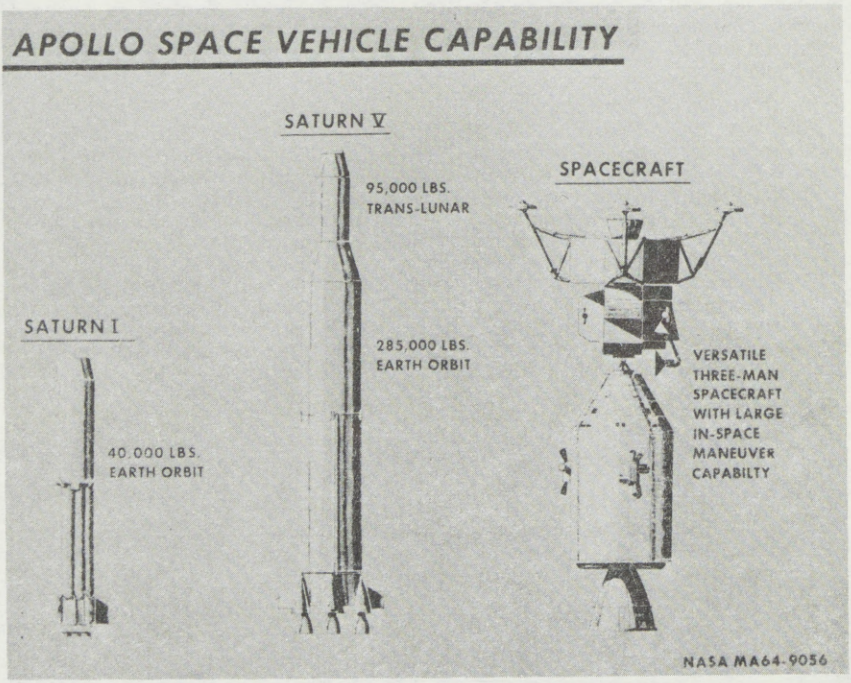

FIGURE 49

In the spacecraft payload area, it has been difficult to maintain the control weights in both the Apollo Command Module, Service Module, which is the spacecraft propulsion module, and the Lunar Excursion Module (LEM), hereafter referred to as the Lunar Module. Yet, our program objectives are attainable.

Organization

The organization of the Apollo Government-industry team today adds up to some 225,000 people throughout the Government and industrial contractors. However, this number fails to tabulate all of the effort that goes into Apollo. One category not represented is the team of more than 30,000 construction of facilities personnel. Our organization can be divided into science and engineering and various other skills, or by organizations which involve service contractors, material suppliers, the major subsystem subcontractors, our large prime contractors, our Center workers of nearly 12,000 people, and the Apollo program organization of 200 persons here in Washington.

Support from other programs

The Gemini role has been extremely important to Apollo. The qualification of the spacecraft and subsystems in long-term orbital operation is a great benefit that we have already realized. We expect to obtain even more data required

in building the Apollo operational system. The basic building of that system, demonstrating its capabilities and getting it operating on a sound basis, has been achieved and is being refined in the Gemini program.

A year ago, there was considerable concern about extended manned operations in space and weightlessness. We now know that the effects of extended weightlessness are not going to interfere with the progress of Apollo. We now have demonstrated with Gemini VII and VI the techniques required both in space and on the ground to achieve rendezvous.

The Ranger has put to rest certain concern over the hospitability of the lunar surface. It has shown us that a significant percentage of the lunar surface will be acceptable for landing sites insofar as topography is concerned. We are looking forward to the data that Surveyor is expected to obtain. Such information will be helpful in qualifying our designs and plans in terms of surface characteristics and bearing strengths and other details. The Lunar Orbiter also will assist in landing-site planning and map-making for extended lunar operations.

Program Phasing

The basic Apollo Program Phasing (fig. 50) involves getting spacecraft ground tests underway with the boilerplate spacecraft. This program has now been essentially completed. The airframe test program, which started early in 1965, consists of flight-weight structures tests launched with Little Joe II, as well as a number of other system tests. The Lunar Module program also has a flight-weight article on which ground testing for the uprated Saturn I (Saturn IB) and Saturn V launch vehicles is nearly two-thirds complete.

In our flight-test program, the role of the Little Joe was to develop the launch escape system and to carry out certain of the structural tests on the spacecraft. The early Saturn I played a vital role in developing the first stage of the uprated Saturn I and in leading the way in the developing the upper stages of the uprated Saturn I launch vehicle leading into the Saturn V.

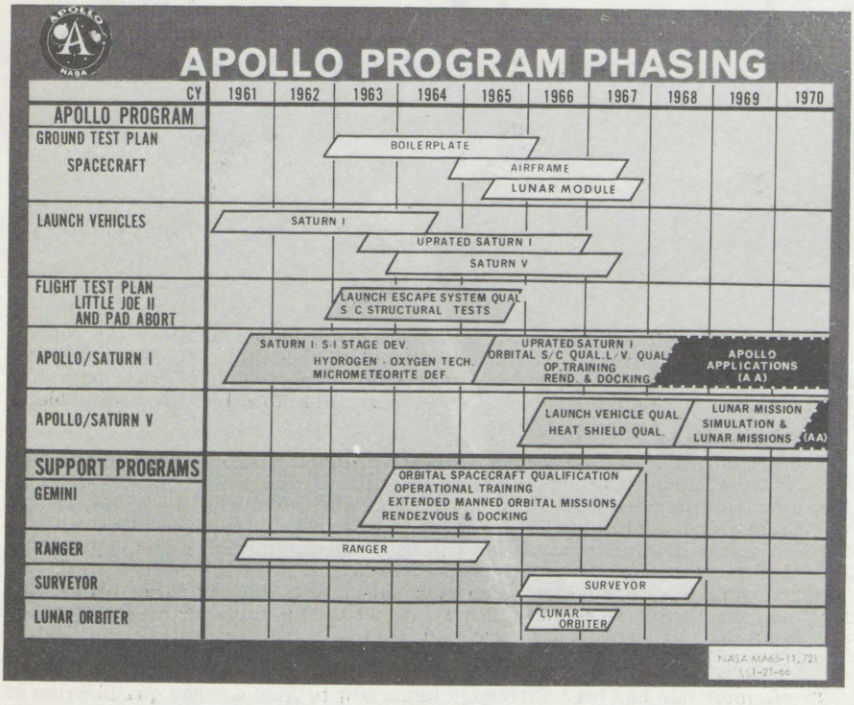

FIGURE 50

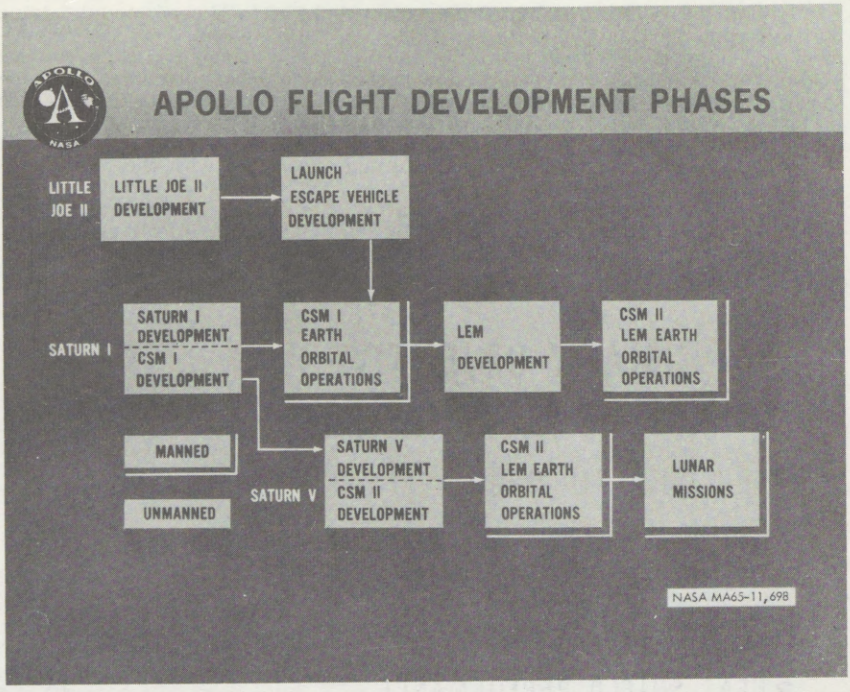

FIGURE 51

The basic logic of our flight program (fig. 51), starting with the Little Joe, on the uprated Saturn I is to develop the upper stages and instrument unit of the Saturn V and carry out the basic development of the Block I series of our Command and Service Module on the smaller, less expensive launch vehicle. The first unmanned flights of the Apollo Saturn I lead into manned-orbital operations. We will carry out with this uprated Saturn I launch vehicle the initial development and verification testing of the Lunar Module. Unmanned lunar module flights will precede flights of the Block II Command and Service Module with the Lunar Module in Earth orbit for up to 14 days.

Concurrent with our manned operations on Saturn I, we will be getting started with the Saturn V in an unmanned role to complete and prove the development of the large lower stages. We will be flying the upper stage and the instrument unit on the Saturn I. You recall the second stage of the uprated Saturn I (Saturn IB) is used as the third stage of Saturn V. Also, the instrument unit of the two vehicles is essentially the same.

Then we will proceed from the Saturn I with the lunar-capable spacecraft on the Saturn V manned operations, to complete the verification of this development and to proceed with our ultimate operations.

Mission objectives

The series of key Apollo missions begins with unmanned flights of the spacecraft on the Saturn I, and proceeds to manned status as rapidly as possible before the end of 1967. However, we have sufficient flexibility in the program to make the changes necessary to maintain unmanned status for a longer period of time if the events prove this to be necessary.

Saturn I Flights

A little over a year ago, we were concerned over the orbital operation for relatively extended periods of the large upper stage of the uprated Saturn I (Saturn IB) and Saturn V, which has to be checked out and restarted in Earth orbit. This concern led us to set up a launch vehicle development flight on the thirteenth (AS–203) Saturn I.

We plan to carry out the first development flight of the Lunar Module, flying by itself unmanned, in 1967. By early 1968 we will have completed the development and basic qualification testing of the Block II Command Module, Service Module, and the Lunar Module, and will then have a complete lunar capable spacecraft. Apollo-Saturn Mission 207 will be a key milestone to demonstrate performance of these spacecraft modules.

The development plan of the Saturn I includes launches into 1968 in basic support of Apollo, and developing and gaining experience with the total space systems and the organization.

Now I would like to discuss the key Saturn I missions. We have made tremendous progress this year in defining in detail what the objectives are that we have to achieve in order to build the capability that constitutes the lunar-capable system.

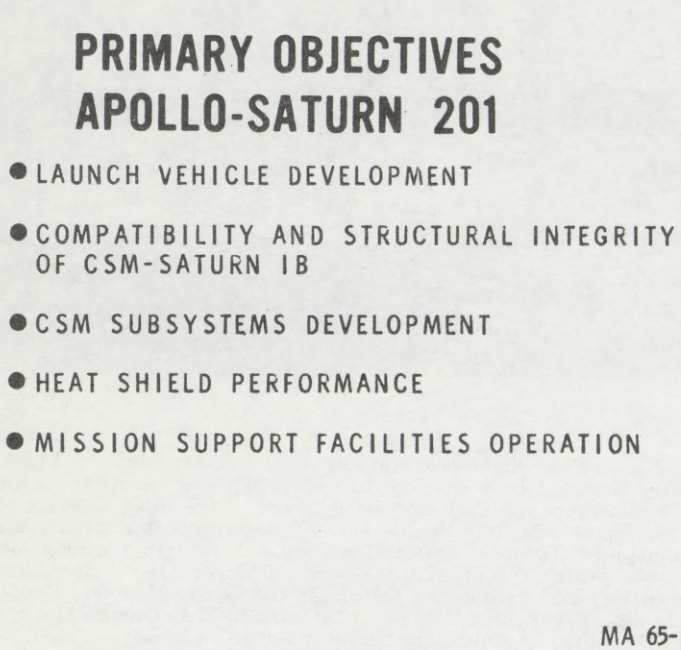

FIGURE 52

The objectives of the first uprated Saturn I (Saturn IB) flight (fig. 52), a suborbital flight to the Ascension area, are development of the launch vehicle, verification of the compatibility and structural integrity of the Command/Service Module and the Saturn I vehicle, the development of the spacecraft subsystems, the demonstration of spacecraft heat shield performance, and the operation of mission support facilities. This suborbital operation will be a relatively high angle reentry to obtain a high heating rate on the spacecraft head shield and substructure. Such information gives one corner of the envelope of performance at the lunar return velocities.

The next suborbital Saturn I launch will be a longer flight to reenter in the Pacific, obtaining a high heat load with its flatter entry. This will give another corner of the performance envelope for the 36,000-feet-per-second lunar return velocity. Therefore, these first two flights of the Apollo Saturn I space vehicle will demonstrate the heat shield performance at high velocities about a year ahead of the final demonstrations on Saturn V. The actual velocity will be in the order of 28,000 feet per second, steep and then shallow, to get these two performance points.

The first Saturn I manned flight (fig. 53) will be to demonstrate the man/system interfaces. It will be orbital. The mission is now open-ended in terms of time. This flight might be up to full duration of the system, 14 days in Earth orbit. Many maneuvers will be carried out in the mission to demonstrate the crew, the spacecraft, and the ground system performance on an extended mission. The flight will also demonstrate the upper stage of the launch vehicle, its electronics and further checkout in orbit. Orbital checkout will be vital in the Saturn V series.

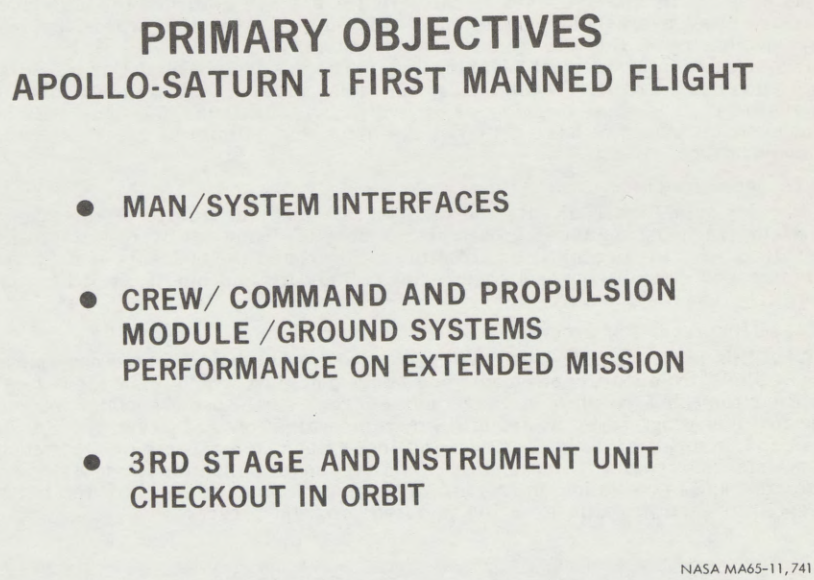

FIGURE 53

In our program plan, the first all-up lunar capable spacecraft system includes the Block II Command/Service Module, the Lunar Module, the Instrument Unit, and the upper stage of the launch vehicle. The demonstrations here will include transposition and docking. Our objectives include subsystems operation of the Block II Command/Service Module and the Lunar Module rendezvous and docking, and the total space system operation of covering the hardware and the interfaces involving man in the system. In all these areas, the Gemini program will have provided much experience for us.

Saturn V Flights

By 1967 we expect to have the Saturn V flying with the first of its key missions, starting off with an unmanned flight, leading to a manned flight in early 1968. At that point we will have developed and qualified all elements of the Apollo system needed to carry out lunar operations. We will then be ready to make the decision as to when this is carried out, having built the capability, and having carefully postured the total test, verification, and experience of the programs behind it. As far as we are able to forecast, we feel that we will have developed the total capability for lunar operations by that time. Beyond that, our experience will tell us when we can consider this system operational.

The first Saturn V flight, scheduled in 1967, provides verification of the launch vehicle development. With certain exceptions, e.g., weightlessness and combining the systems environments in their exact relationships, we have learned how to develop our systems on the ground.

Other objectives include demonstrating the compatibility and structural integrity of the total vehicle. Also, in the first two unmanned Saturn V flights, we will conduct the final demonstrations of the spacecraft heat shield design at the actual lunar return velocities and heating conditions.

The mission details for Earth orbital flight are still being refined. It will be an elliptical orbit with an apogee on the order of five or six thousand miles. The apogee chosen will provide safe radiation levels and allow the demonstration of spacecraft system operations such as deboosting back into low Earth orbit to a simulation of deboost into the lunar orbit. Actually, the conditions required to demonstrate lunar orbit entry determine the height of this mission's orbit because of the energy which must be retained to get back into the low orbit. It appears today that we will have built up a demonstration of the systems capabilities, built up the elements of experience, and accomplished the objectives that are necessary by the completion of this mission. In other words, we will have demonstrated the total lunar-capable system.

In our mission assignment planning today, the missions beyond Earth orbital flight involving Saturn V contemplate the lunar mission and/or lunar mission simulations. The final decision as to which will be lunar missions will be dependent on when we have achieved the necessary buildup of experience and demonstrations.

Apollo management

Now I would like to discuss the manner in which the affairs of the Apollo program are being managed. Last year I described how we were set up and operating, with the organization structure built around the elements of program planning and control, systems engineering, reliability and quality, testing, and operations (fig. 54).

Measurement of progress

With this basic structure, we have proceeded to establish the necessary baseline of plans, technical requirements and budgets against which all of the several hundred thousand people can gear their efforts. Against these plans we can measure our progress by systematic program evaluation and review, financial reporting, a series of design reviews and inspections, and reports in areas such as weight and engine performance. The Apollo organization then assesses, evaluates, and takes action on this information, with management accountability accepted at each program level for required program progress.

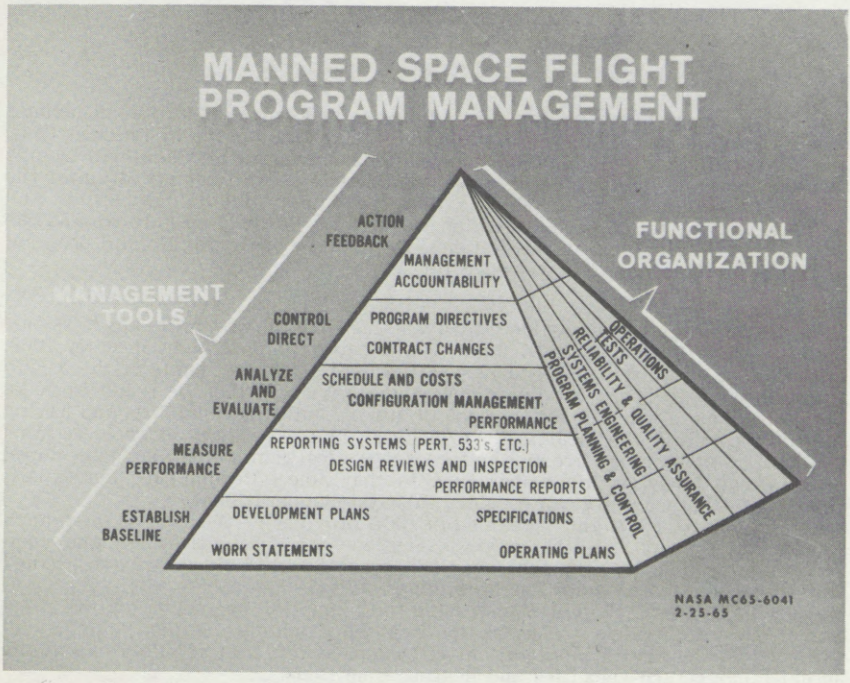

FIGURE 54

People are the essential ingredient for the whole operation. These people, of course, must have the plans, whether they be program, financial or technical, and the ability, including the system of information flow, to review and assess how the program is going. Then they must do something about it.

The project organization, as I reported at the outset, is a solid organization, manned with eminently qualified people.

Both our program and technical plans are in fact working. The documentation of what the program is, and what the plan is to carry it out, has been communicated throughout the NASA organization. The same statement can be made about the specification program. At this point in time the specification structure includes a solidly built set of contract end item specifications which define with the hardware that we are testing and delivering.

We have a well ordered set of mission assignments which we keep up to date as the process refines. There is a stable set of well integrated schedules from the top of the organization to the bottom. The financial operating plans have been working extremely well. In terms of change controls, I can report that the system is working effectively from the contractors through the Center program organizations to the Apollo program office here in Washington.

Reviews

Review and assessment have become an important part of the management process. It is therefore important for us to understand what the progress is against that which was set up for us to achieve. We do this by assessing how the program stands in terms of schedule, costs and performance.

Taking action is an item on which we can yet make much progress. We are at the point where we clearly know what our program means and how we are doing on it. However, we are still working to improve our ability to take appropriate and timely action on known program problems.

Part of this review process, which is refined progressively over the history of the Apollo program, is working in each of the Center program offices, as shown in this chart (fig. 55). Here you have the technical reviews of the develop-

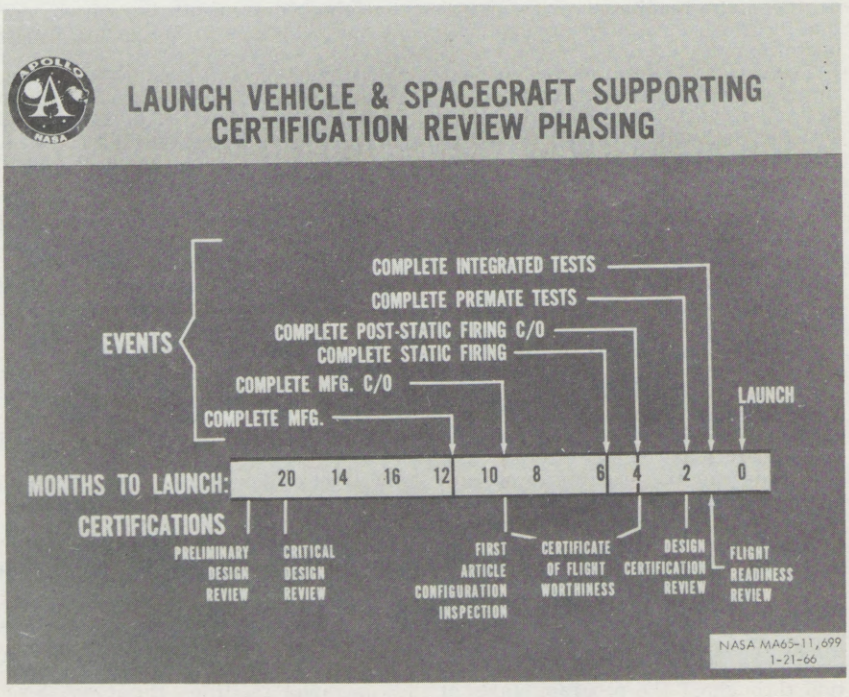

FIGURE 55

ment of the end item hardware, whether they are pieces of the space vehicle or pieces of the ground system that have to support it. They form a series of milestones such as completion of manufacturing and manufacturing checkout, static firing, and the other steps leading to the launch.

Preliminary Design Review

The first review step is the preliminary design review in which the objective of our organization is to see whether or not the contractor has, in fact, laid out a design that can be expected to achieve the end result that we said we wanted to buy. Before a lot of commitments are made, we are able to look at and approve what the contractor is going to do for us or else ask him to change it.

These reviews are mostly completed in the Apollo program, except for some end items of ground hardware. This review technique is working well and will come into play as the Apollo Applications missions assume greater definition and as the differences that are necessary to achieve orbits of 30 days, 45 days, and longer are identified.

In the critical design review, the contractor has developed the actual design drawings, has developed some of the hardware and demonstrated it in breadboard fashion, but has not yet made the commitments to fabricate the end items for the test program. The last of the large elements of the system will be the critical design review on the Block II spacecraft. With that milestone we will essentially complete the definition of the total Apollo system.

Checkout

Checkout of the Apollo hardware has already been completed in various parts of the program. First article configuration inspection has been completed for the uprated Saturn I (Saturn IB) launch vehicle stages which have been erected at Cape Kennedy, and for the Apollo Block I spacecraft being put through premate tests there prior to erection.

The checkout procedure calls for a certificate of flight worthiness to be issued, and to be updated or endorsed as subsequent events occur. A final endorsement at the flight readiness review certifies that the requirements have been met, qualifications have been accomplished, and the vehicle is in fact ready for its operation.

The design certification review board is chaired by me and includes the Center directors. It is a court of review to determine whether the design is a sound design, properly conceived to carry out the mission objectives in a safe and satisfactory manner. Using techniques applied in Gemini, we have built the basic requirements to establish design certification reviews on Apollo manned flights.

Scheduling

Much progress has been made in the Apollo scheduling system over the last year. This is an important element in the stability of the program and in the understanding of the progress and problems all the way from vendors and subcontractors up through the organization (fig. 56). It is now a single, integrated scheduling system to which the whole structure is geared. This system provides effective reporting reflecting the actual operating conditions, enabling all program elements to assess the actual status in time to do something about it.

The milestone structure built into our scheduling is based on levels, as shown here (fig. 57). Control milestones have to be reviewed with the Apollo Program Director before they can be changed. The top events of the program, the launch schedules, have to be reviewed with and approved by Dr. Seamans and myself before they can be altered.

In order for the program to operate at the level of delegation where it can be operated most effectively, the Center program managers control the schedules at the system and subsystem level (fig. 58). Also, they have assigned certain flexibilities in detailed operating schedules to the contractors. The integrated system is tiered so the milestone threads appear all the way from the vendors up to the top.

Change Control

Our change control system shown here (fig. 59) also is working well. I have previously described the basic philosophy behind it. The system now in operation throughout the program starts at the contractor facilities, the lowest level of control shown on this chart (fig. 60). The contractors have the authority

APOLLO SCHEDULING SYSTEM

- SINGLE INTEGRATED PERT/SCHEDULING SYSTEM
  - FIELD CENTERS TO HEADQUARTERS
  - CONTRACTORS TO FIELD CENTERS
  - SUBCONTRACTORS TO CONTRACTORS
- EFFECTIVE REPORTING REFLECTING ACTUAL OPERATING CONDITIONS
  - ABILITY TO ASSESS STATUS AND PREDICTED PERFORMANCE
  - ABILITY TO ASSESS PROGRAM CHANGES AND SLIPPAGES
  - ABILITY TO RELATE COSTS TO SCHEDULES

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FIGURE 56

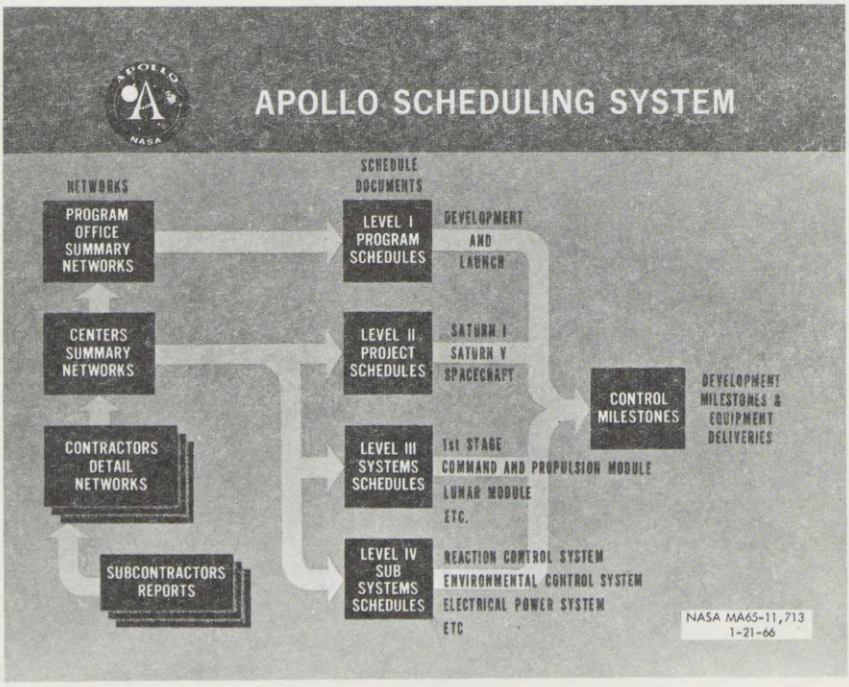


FIGURE 57

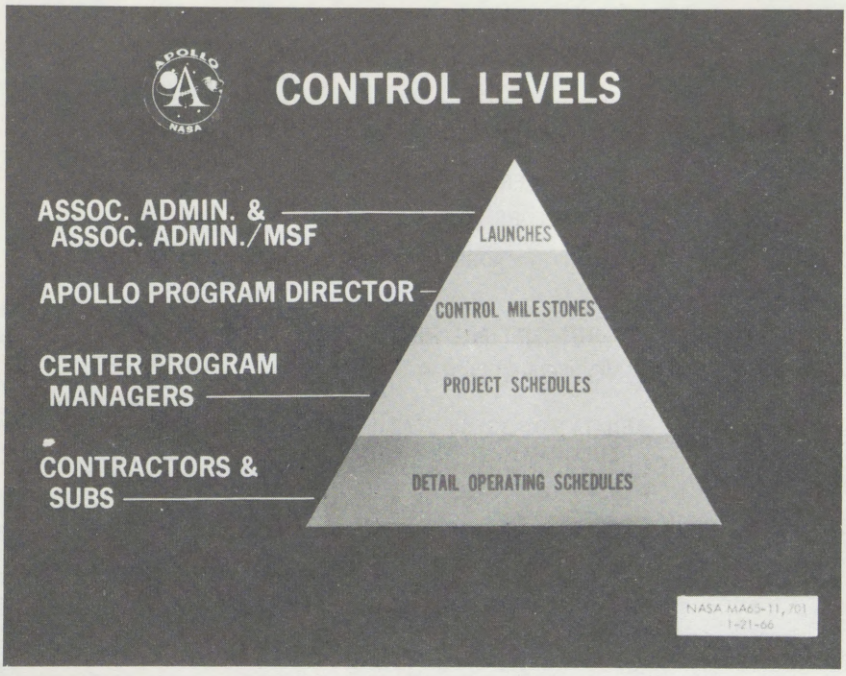


FIGURE 58

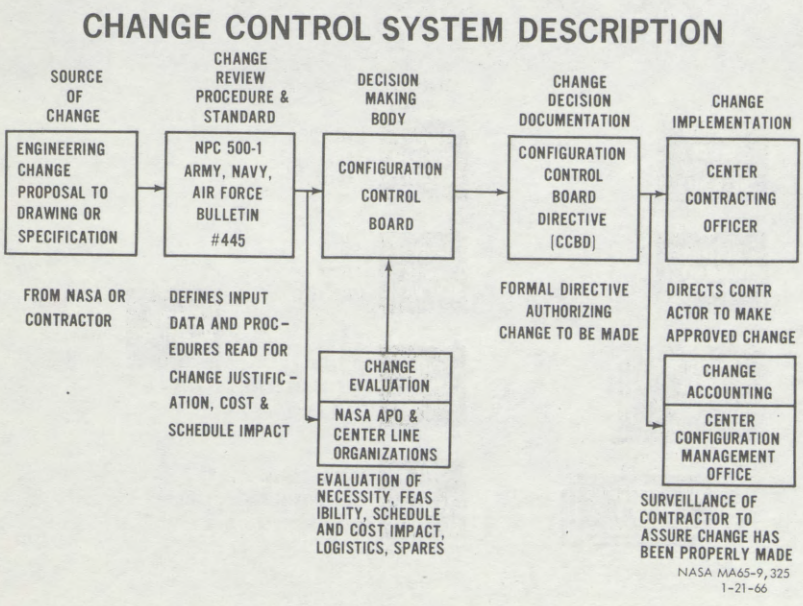


FIGURE 59

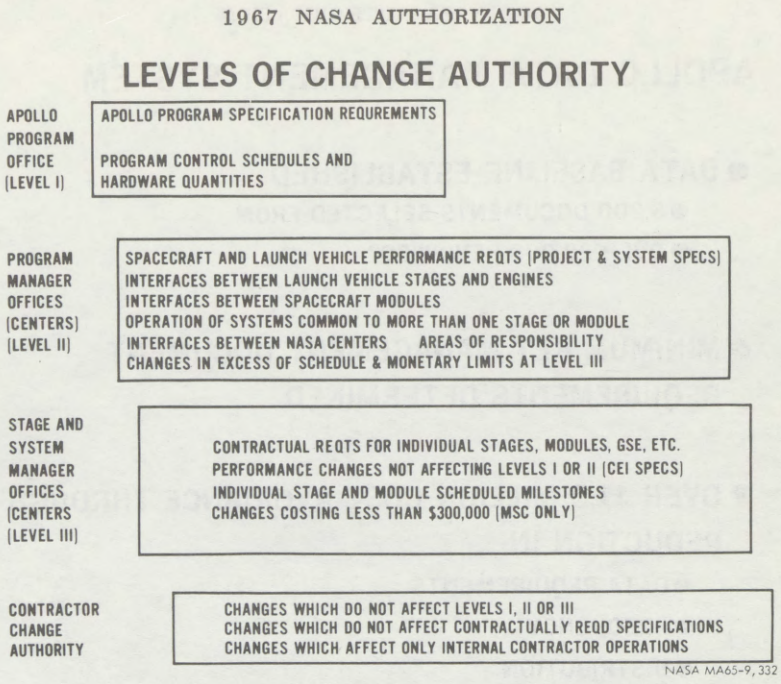


FIGURE 60

to make decisions on changes not affecting the areas of Center control. Changes at the stage or vehicle level, changes which require interface, or which change the basic program requirements are controlled at the appropriate higher levels.

Data Management

Over the last year and a half we have given considerable attention to data management (fig. 61). I mention this in part because a significant amount of money goes into data. It is a necessary part of any big development program involving large objectives in multiple organizations. Yet it tends to be one which can get out of hand and where a great deal of more money can be spent than really contributes to the progress of the program. We have made some progress, and I believe we can make more. We have shown that an inter-organizational activity forcing our attention on the data subject can, in fact, make some contribution.

Out of some 20,000 documents that were actually in the Apollo system when this effort started a year and a half ago, some 6,000 have been selected as the active use documents and have become the baseline. This figure is something which clearly can be audited. It has been achieved by reducing data requirements substantially, reducing the frequency of some of these documents, reducing the distribution to the people who really need them, and reducing violations in overpackaging and overtransporting.

We want to make more progress in this area because I want to use our funding on hardware which can be put in space and reduce the cost of paper to that which is really necessary.

Incentive Contracts

I discussed last year our intentions with respect to Apollo incentive contracts. Today, I can report great progress. Through efforts of the Centers, we have incorporated in the contracts what we are willing to pay for, and what we want in the way of contractor deliveries. The contracts recognize that certain of the vehicles have a relatively high premium for delivery on or ahead of schedule, as do certain of the common events in subsystem development, such as reaching a qualification status, or a particular point in time and thoroughness.

Different pieces of the program are treated differently in the contracts because of their status and history, or because of something that we feel is essen-

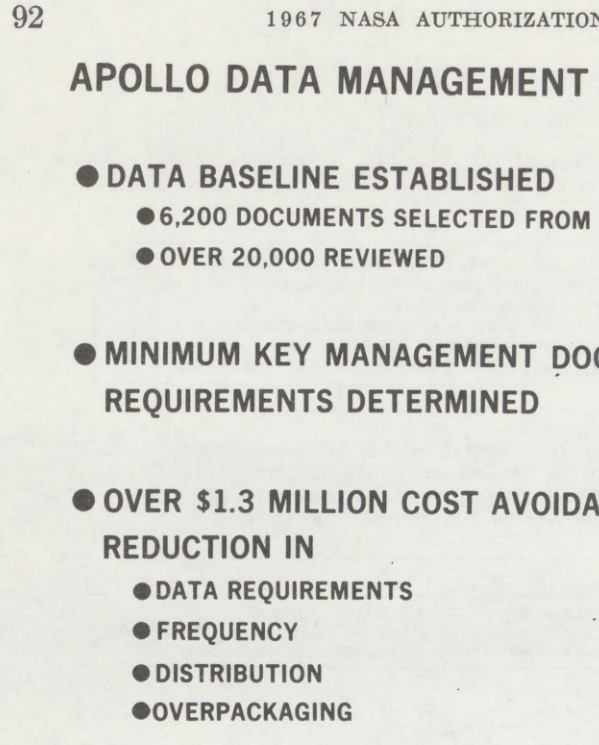


FIGURE 61

tial to balanced program progress. The incentive conversions encourage us as well as the contractors to better define the job, and to increase our joint attention to the schedule, cost, and technical performance balance. The incentive contracts also have spawned a great awareness of the impact of changes. This tends to make a contractor somewhat less responsive, but we think it is desirable at this time to have a greater impedance in the contractor organization to changes.

Last year we reported that we had contracts totalling some $200 million under an incentive arrangement (fig. 62). Today we are in the final stages of negotiations which will raise the incentive total to about $3.7 billion.

Management Interchange

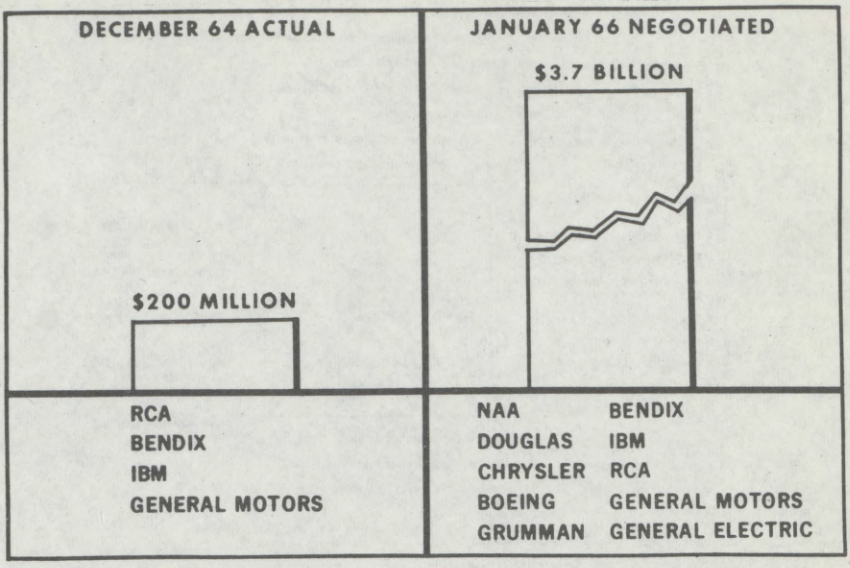
One final subject under Apollo management is the interchange that is going on in both management experience and techniques (fig. 63).

Within the NASA organization we have spent a fair amount of time talking and working with each other so as to be able to communicate our favorable and unfavorable experience in the several management areas. This has been valuable in the Apollo program, and is valuable to the entire Manned Space Flight organization.

There has been other interchange involving elements of the Department of Defense and the Federal Aviation Agency. We have discussed with the FAA the basic mechanisms of organization and planning and control which are operating throughout the Apollo program which they might wish to put into the basic management structure of the supersonic transport development. I think this is an important point. At least many basic techniques can be adopted by the contractor for dealing with several government organizations at a saving of both money and manpower.

The whole process of people circulation, and experience circulation, is causing the pattern to converge so that the best of what people are learning on various programs is being adopted by each. This is an important element of program progress. A basic structure (fig. 64) is operating on interorganizational technical support of Apollo wherein the resources of NASA, industry, consultants,

APOLLO INCENTIVE CONTRACT STATUS



NASA MA 65-11,700

FIGURE 62

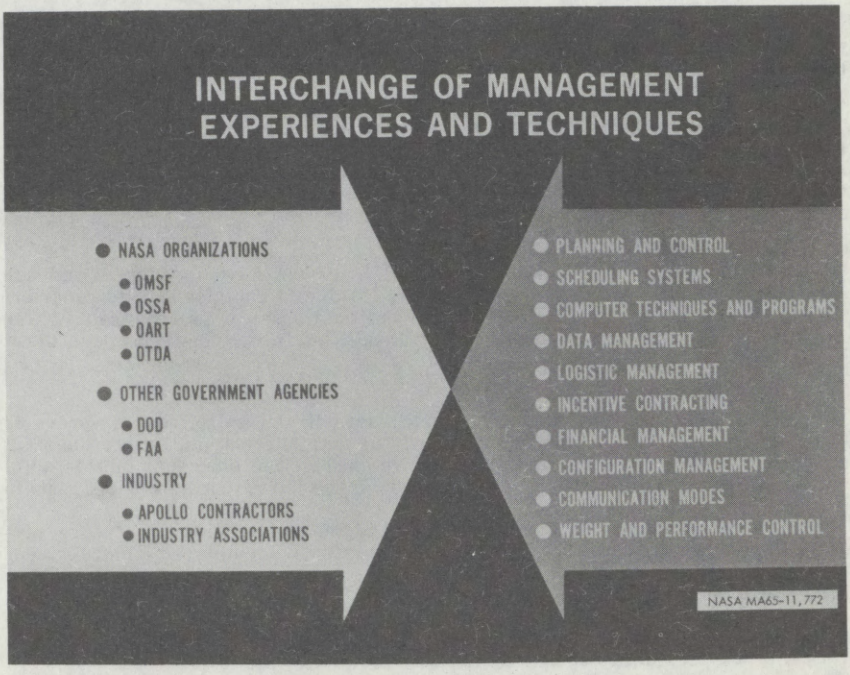


FIGURE 63

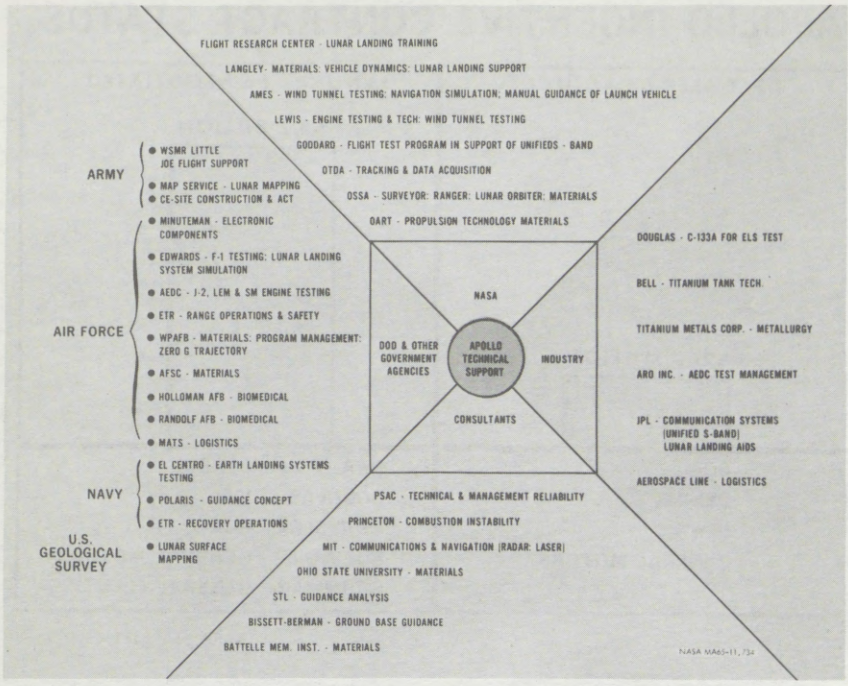


FIGURE 64

DOD, and other government agencies are brought to bear on critical technical problems. Through this structure we are able to mobilize the best resources of the nation in a very short time to help us solve our Apollo problems.

Resources capability

I would like to discuss now the total capabilities that exist in Manned Space Flight as the result of the Apollo program. As you know, considerable effort has been spent in providing the baseline from which the lunar landing capability will evolve. This baseline is in terms of funds, management, people, and facilities capabilities, both Government and industry.

Management Capability

I have discussed the management capabilities we have developed and are continuing to bring forward to manage the large and complex Apollo program. This management capability represents a national asset of immeasurable value capable of defining and accepting the challenges of future manned space flight programs.

Personnel Capability

This chart (fig. 65) is one that I am sure you will recognize from my previous testimony before this committee. It shows the manpower applicable to the MSF programs in various categories. I have sketched in the phase-out of this manpower as it will look with the completion of the currently authorized Apollo program.

Within these categories there are tremendous capabilities for future programs. For example, there are engineers and scientists employed who represent the major portion of this nation's knowledge in manned space flight. There are thousands of skilled mechanics throughout the nation who are well trained in the delicate art of forming the intricate hardware into a reliable space vehicle and there are skilled administrators and management personnel who are versed in the techniques of getting the best product at the lowest cost.

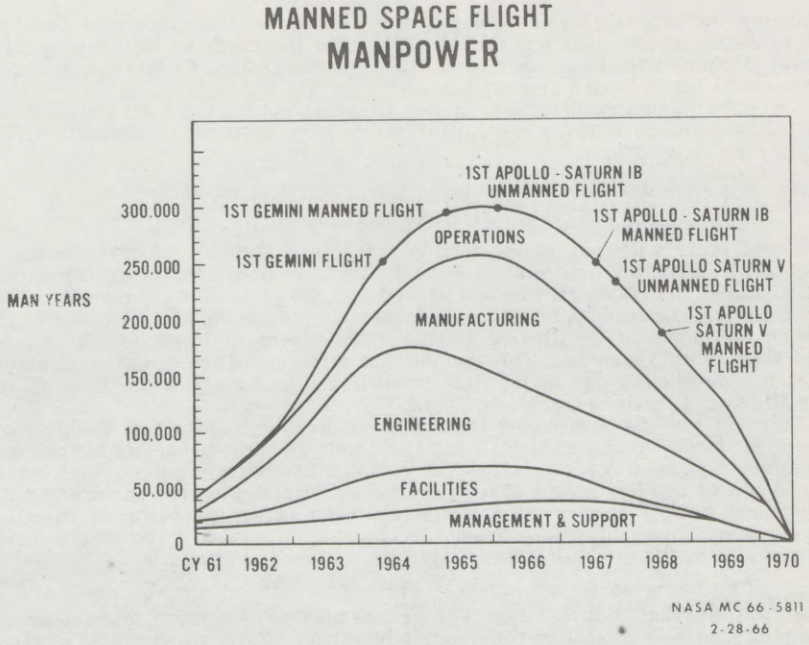


FIGURE 65

Facility Capability

During the past five years we have accomplished an orderly buildup of facilities to achieve our space objectives. Significant accomplishments have been made in the construction of facilities for the development, fabrication, test, checkout and launch of manned space vehicles. Major buildups were accomplished at our three Centers, the Marshall Space Flight Center at Huntsville, Alabama; the Manned Spacecraft Center at Houston, Texas; and Kennedy Space Center at Cape Kennedy, Florida. Additional facilities for space vehicle development, fabrication and test were constructed at other locations. Most facilities have now been completed. The remainder will be ready in time to support our testing and flight schedules.

In a program such as we have undertaken, there are many unknown factors. Much of our success is dependent upon an ability to incorporate the necessary adjustments in both the flight systems and the facilities which support them. To this end we have assigned the immediate management of the manned space programs to our three Centers. This assignment of responsibility provides a logical means of defining the roles and missions of the supporting elements. It allows a close coordination of the management groups which have the responsibility for the development of hardware and those who provide the supporting facilities. By recognizing that changes in vehicle configuration will occur as our program advances, we have incorporated a reasonable degree of flexibility in our supporting facilities. The wisdom of this is evidenced by the fact that we have been able to progress from the Mercury program into Gemini and well on our way toward Apollo, and still make use of most of the facilities that were constructed in support of earlier efforts.

By taking such steps, we have restricted our facilities commitments to date to $1.6 billion. We are now completing the complex which is required in support of the manned lunar landing program. Through use of the flexibility which is inherent in these facilities, we are also in position to support further space exploration. To date, we have capitalized on the resources of both the Department of Defense and the aerospace industry. We are making use of existing fabrication and test capabilities that were developed in conjunction with past aircraft and missile programs. For basic research and development, we are

utilizing the capabilities of both industry and universities. This has enabled us to reduce the cost of our facilities program inasmuch as new construction could be limited to those cases where the economics, size or other requirements of our vehicles dictated a new facility.

I would now like to review our facility progress, outline the work that remains to be done and to indicate the capability we have acquired to support present and future space efforts.

Launch vehicle development, manufacturing, and test capability

Development Capability at MSFC

I will start with our oldest facility, the Marshall Space Flight Center at Huntsville, Alabama, where as of June 30, 1965, we had a capital investment of $319,555,000. This Center, which is located on 1,800 acres of the Army's Redstone Arsenal, has the responsibility for the research and management leading to the design, development, production testing and delivery of large launch vehicles and their related systems. This includes the direction of the several contractors that are developing our major flight vehicles at locations on the West Coast, the Midwest, Louisiana and Mississippi.

At MSFC, we have provided the facilities that are required in the development of large launch vehicles and their related propulsion structural and guidance systems. A large laboratory complex has been developed that covers the fields of astrionics and space physics, materials research, engineering development, hazardous operations, component test, and manufacturing engineering. These laboratories provide a reservoir of capability in their respective fields that can be applied to both present and future space programs.

Manufacturing Capability at MSFC

At the Marshall Space Flight Center, we also have a large manufacturing complex that was established in support of earlier efforts when MSFC engaged in the fabrication of flight hardware. Most of these buildings were designed for the fabrication and assembly of boosters the size of the Saturn first stages. As a consequence, these very high bay structures can be readily adapted to a number of uses. Today we are using these facilities to develop new and advanced manufacturing techniques to improve the fabrication of our vehicles. Because of their size and configuration, these buildings represent a great potential in support of space programs.

Test Capability at MSFC

In the test area at Marshall Space Flight Center, a number of test stands and other facilities have been provided for engine and vehicle development work. Our most recent completion is the Advanced Saturn Static Test Facility constructed to test a vehicle with a thrust of seven and one-half million pounds (fig. 66). This stand has contributed to our test capability and has provided prototype information for the construction of the dual position Saturn V 1st stage (S–IC) stand at the Mississippi Test Facility.

Some idea of the inherent capability provided by this test complex can be gained from the history of the Static Test Stand, a dual position stand constructed for the Army's Redstone-Jupiter program. With very minor modification, one position has been adapted for the succesive testing of the Saturn I 1st stages (S–I and S–IB). Similarly, the second position is now used for development testing of the F–1 engine. With such flexibility to accept new requirements, this test complex can continue to support our space efforts in the future.

Test Capability at Mississippi Test Facility

The final acceptance testing of the Saturn V 1st stage (S–IC) and second stage (S–II) will be conducted under the cognizance of the Marshall Space Flight Center at the Mississippi Test Facility (MTF). This is an entirely new facility for whiich first authorization was received in fiscal year 1962. As of June 30, 1965, the Government investment was $164,854,000.

To establish the MTF test complex, 13,428 acres of land were acquired in fee. Because of the high sound energies that will develop during static test firings, it is also necessary to limit human habitation in the surrounding area. A sonic easement was therefore acquired on an additional 125,422 acres.

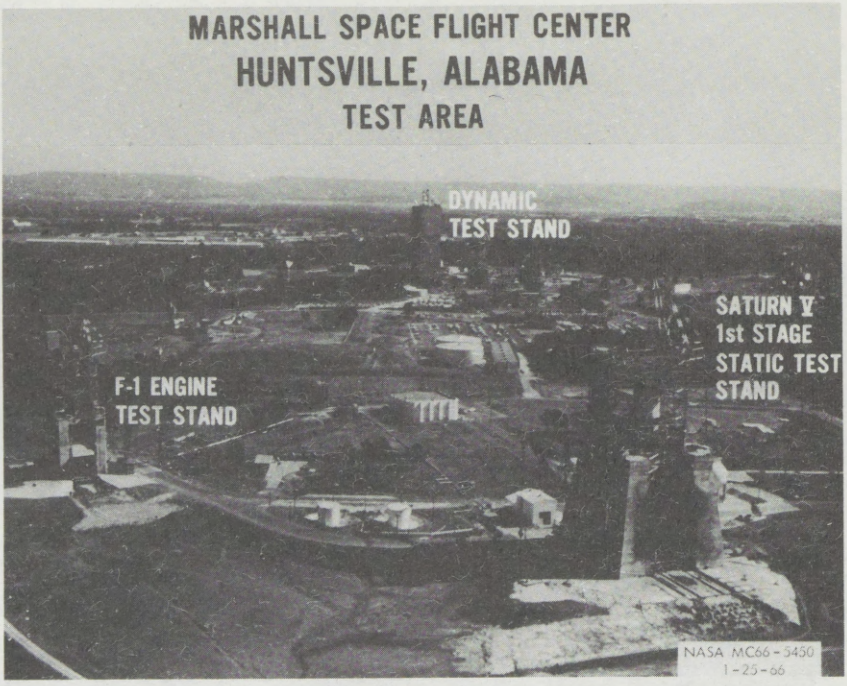


FIGURE 66

The Mississippi Test Facility is zoned into five functional areas, the most important of which is the Saturn V test complex (fig. 67). This complex consists of two Advanced Saturn 2nd Stage (S–II) test stands, a dual position Advanced Saturn 1st Stage (S–IC) test stand, test control centers, data acquisition facility, fuel, gas and water supply. Most of the facilities essential to the operation are now complete. In December 1965, the first S–II test stand was completed and the S–II All Systems Test Stage is now on the stand preparatory to first testing (fig. 68). In 1966 all presently authorized construction is scheduled for completion with the exception of the second S–IC test position. This position will be completed in mid-1967.

In our fiscal year 1967 budget we are requesting funds for some improvements to these facilities that generated from present testing experience. We anticipate future changes and improvements will be necessary as our program progresses.

The Mississippi Test Facility has the necessary land area to accommodate additional facilities. On the basis of present knowledge, we believe we have established a buffer zone which will provide public protection against sonic damage from vehicles having higher thrusts as well as from present vehicles.

Engine and stage contractor development, manufacturing and test capability

Next I would like to review the engine and vehicle fabrication capability that is operated by contract under the managerial cognizance of Marshall Space Flight Center.

H–1, F–1, and J–2 Engines

The engines which are used in our launch vehicles, the H–1, F–1 and J–2 are manufactured by the Rocketdyne Division of North American Aviation, Inc. All are developed, fabricated, assembled and tested at Government owned facilities. The development work takes place at Santa Susana. The H–1 engine is fabricated, assembled and tested at Neosho, Missouri. The F–1 and J–2 engines are fabricated and assembled at Canoga Park, California. The acceptance testing for the F–1 engine is conducted at Edwards Air Force Base and the testing for

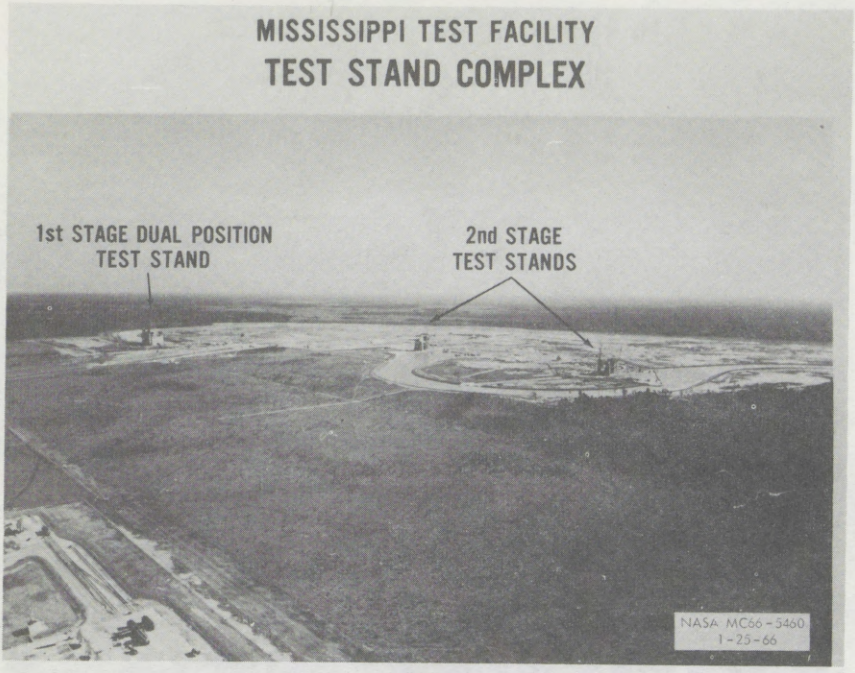


FIGURE 67



FIGURE 68

the J–2 takes place at Santa Susana, California. In each instance, we have capitalized on resources that were provided by the Department of Defense for their missile programs. We have augmented this capability and feel we have capability of satisfying foreseeable requirements without major new construction.

Saturn Stages

Turning then to the development, manufacturing and test of our Saturn launch vehicle stages, two are fabricated and assembled on the west coast. These are the 2d stage (S–II) of the Saturn V, and the upper stage (S–IVB) of the uprated Saturn I (Saturn IB) and Saturn V.

The S–IVB stage is manufactured by the Douglas Aircraft Company and is assembled in the company-owned plant at Huntington Beach, California. This plant is closely tailored to the present production schedule. However, Douglas has incorporated a capability for expansion in all of its facilities.

The acceptance testing of the completed stages take place at Sacramento, California at the NASA Sacramento Test Facility. This test complex includes two test stands that were originally constructed for stage development work and easily adapted later for acceptance testing. All of the major facilities have been completed at this location. A proposal to add a capability for large component testing is included in our present budget request.

Fabrication and assembly of the 2d stage (S–II) is performed in the NASA facility at Seal Beach by the Space and Information Systems Division of North American Aviation, Inc. The final acceptance testing and refurbishment of the 2d stage will take place at the Mississippi Test Facility. As part of the FY 1966 Construction of Facilities program, we are providing an additional assembly building. This will assure present production requirements and will allow a reasonable increase if it is needed.

The first, or booster stages, of our Saturn vehicles (S–IB and S–IC) are being produced by the Chrysler Corporation and the Boeing Company at the NASA Michoud Assembly Facility (fig. 69). This Government-owned plant, which as of June 30, 1965, represented a capital investment of $114,010,000, is located on a 900-acre site east of New Orleans on the Intercoastal Waterway. The 43-acre Manufacturing Building was constructed during World War II.

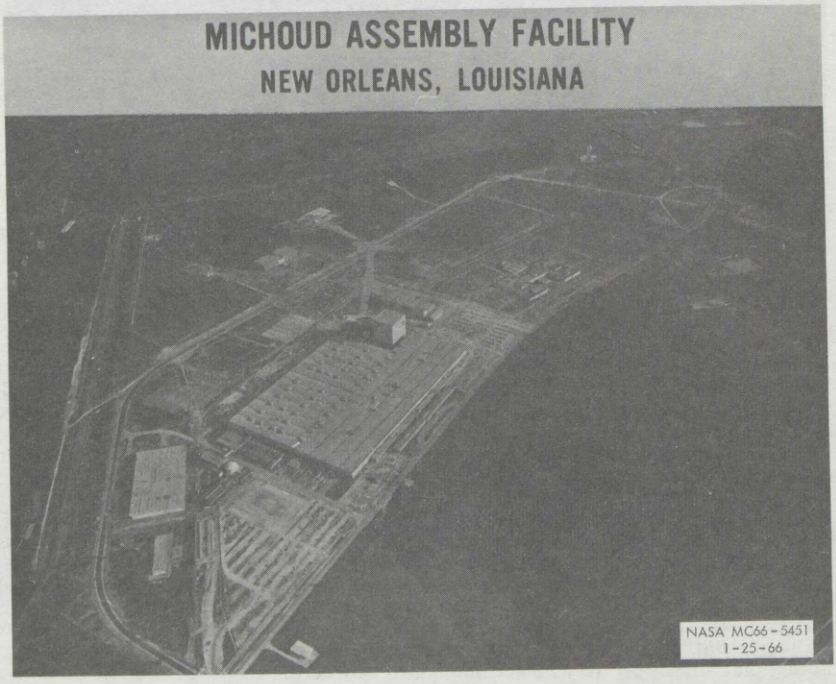


FIGURE 69

We have added a vertical assembly and vehicle checkout capability together with storage and engineering space to provide a facility that is well suited for the assembly of large space vehicles. If necessary, we could assemble stages up to 20 feet longer than the present first stages of Saturn. No major facility modifications would be necessary, provided the vehicle diameter is not increased materially.

Construction at Michoud is virtually complete except for some additional capacity for chemical waste disposal. Otherwise the facility can adequately support our space program.

Spacecraft development, manufacturing, test, and operation capability

Development and Test Capability at MSC

Responsibility for the development of Spacecraft for manned space flight programs and the conduct of manned flight operations, including astronaut training, is concentrated at the Manned Spacecraft Center at Houston, Tex. (fig. 70). The Government had an investment of $241,193,000 at MSC as of June 30, 1965.

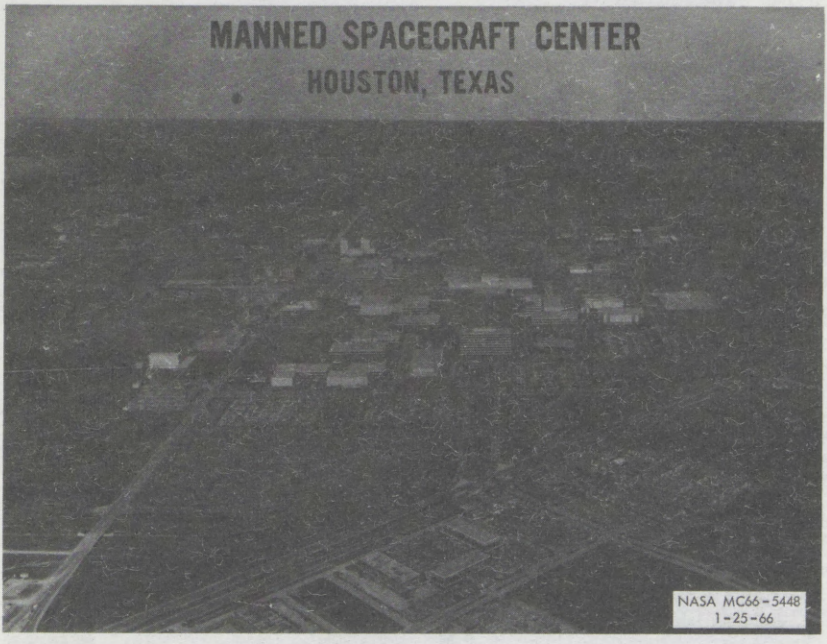


FIGURE 70

To accomplish the MSC mission, it has been necessary to provide the facilities required for the research, development, test and evaluation of manned spacecraft systems. Some of these facilities are unique in both size and capability. Initially they will be used in support of the Apollo program. These same facilities with very little modification can be used for post-Apollo programs.

To substantiate the integrity of spacecraft communications in radiation environments simulating free space, tests are conducted with full scale vehicles in a large anechoic chamber (fig. 71). This chamber has a quiet zone which is 20 feet in diameter and 57 feet long. This is ideal for the Apollo spacecraft. The facility has the capability of accepting larger vehicles with very little loss in the degree of sound free environment.

At the Manned Spacecraft Center, we have constructed the country's largest man rated space environment chamber with solar simulation (fig. 72). This chamber can simulate an altitude of about 80 miles and subject the spacecraft to the simulated thermal and solar radiation conditions which are expected during a lunar mission. It will accommodate spacecraft up to 35 feet in diameter

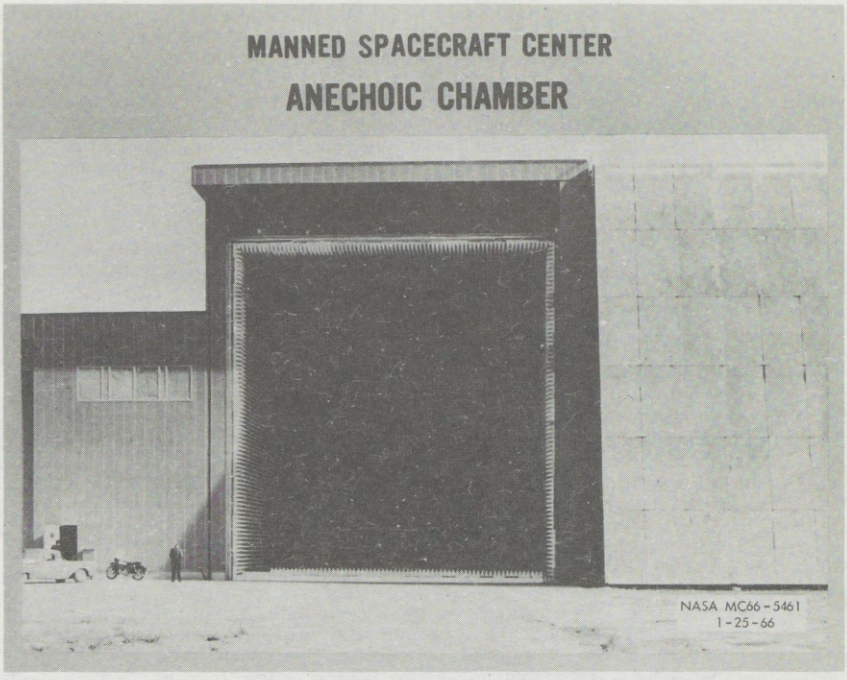


FIGURE 71

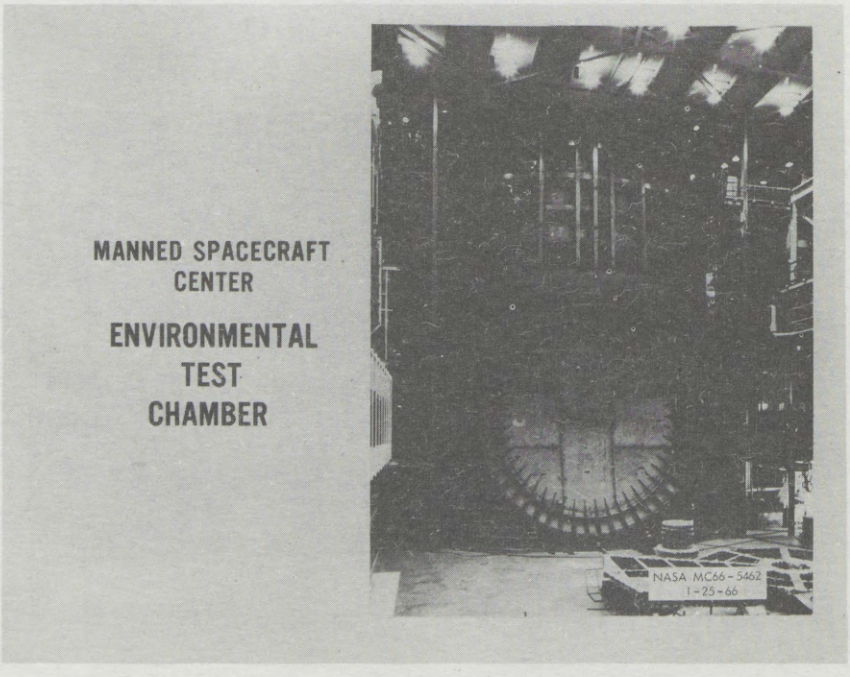


FIGURE 72

and 80 feet in length. A similar growth capability is available in our vibration and acoustic testing facilities. The last important complex at MSC is devoted to mission simulation and astronaut training. This complex includes a Flight Acceleration Facility which features probably the world's largest centrifuge with a man rated, environmentally controlled gondola at the end of a 50-feet arm (figs. 73 and 74). It also includes a Mission Simulation and Training Building, a Flight Operation Building and others housing simulators and trainers enabling the astronauts to become completely familiar with each mission prior to the actual flight.

Operational Capability at MSC

A facility most familiar to the American public is the Mission Control Center (fig. 75), which became completely operational in 1965, and was the primary control for the Gemini IV and subsequent flights. This facility, with reasonable augmentation, will be able to handle more complex future missions than those planned under the Gemini and Apollo programs.

Spacecraft contractor development, manufacturing, and test capability

The Apollo spacecraft modules are manufactured at two locations. The Command Module and the Service Module, which is the spacecraft propulsion module, are manufactured by the North American Aviation Company in the NASA Industrial Plant at Downey, Calif. This plant was acquired from the Air Force in 1964 and the major facility construction effort was completed in October 1965. The buildings range from a Plaster Master Facility, where spacecraft models are made, to the Systems Integration and Checkout Facility, where the spacecraft is integrated and subjected to final checkout prior to delivery to the Kennedy Space Center. The largest structure is the 750,000 square foot Assembly Building where the spacecraft is manufactured.

The Lunar Module is manufactured by the Grumman Aircraft Engineering Corporation at Bethpage, N.Y. All testing and fabrication are accomplished at this plant except developmental testing of the ascent and descent propulsion engines which is performed at the White Sands Test Facility in New Mexico.

MANNED SPACECRAFT CENTER

FLIGHT ACCELERATION FACILITY - CENTRIFUGE

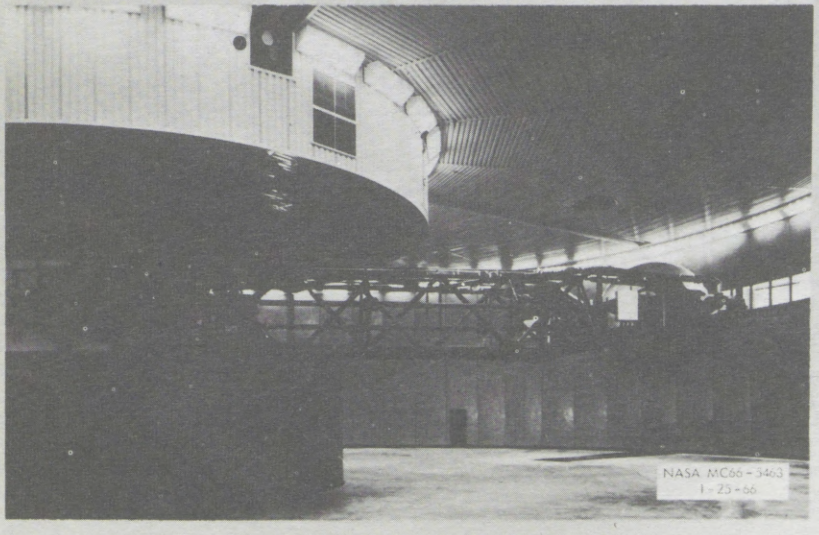


FIGURE 73

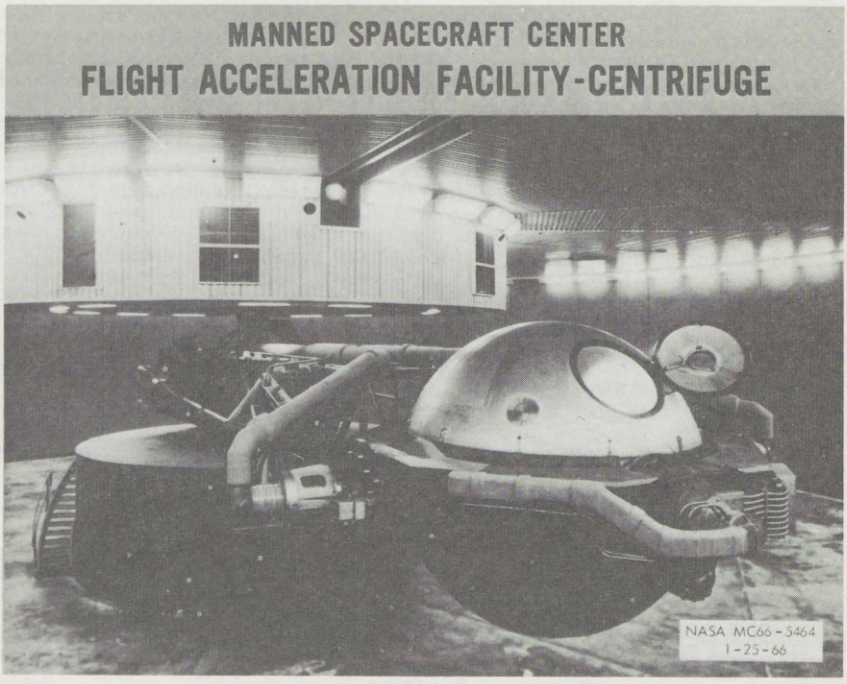


FIGURE 74



FIGURE 75

Some of the more important Grumman facilities for development art the Electronic Systems Development Laboratory, the Fuel Systems Laboratory, the Navigation and Guidance Laboratory and the Flight Control Systems Laboratory.

Developmental testing of the Apollo spacecraft propulsion systems is conducted at the NASA White Sands Test Facility in New Mexico (figs. 76 and 77). The three major areas at WSTF are the Apollo Propulsion Systems Development Facility, the Lunar Module Test Facilities, and the Little Joe II Launch Facilities. The Apollo Propulsion System Development Facility provides the capability for developmental static testing of the Apollo Command and Service Module propulsion systems. The test area consists of two single position static firing test stands which are being used at thrust levels of 22,000 pounds. Each stand has the capability of supporting a 40,000 pound thrust engine.

The Lunar Module Test Facilities are used for development testing of the ascent, descent and reaction control propulsion systems. The test area has three structurally identical, single position, static firing stands which are currently used to support the 10,500 pound thrust engines. Two have an altitude simulation capability of approximately 110,000 feet. With minor modification, the altitude stands could support an engine with a thrust level of 30,000 pounds.

The third complex provides the capability for flight qualification of spacecraft modules and systems prior to manned flight. These tests qualify the launch escape systems, earth landing system, stabilization system, and portions of the structural and propulsion systems.

Launch operations capability

Kennedy Space Center

Turning to our launch capability, the mission of the Kennedy Space Center is the integration, test, checkout and launch of NASA space vehicles. The Kennedy Space Center is divided into four areas that were established in relation to the potential hazard that will be created by the vehicles being launched from Merritt Island. Our most unusual facilities are located in the launch and launch support areas.



FIGURE 76

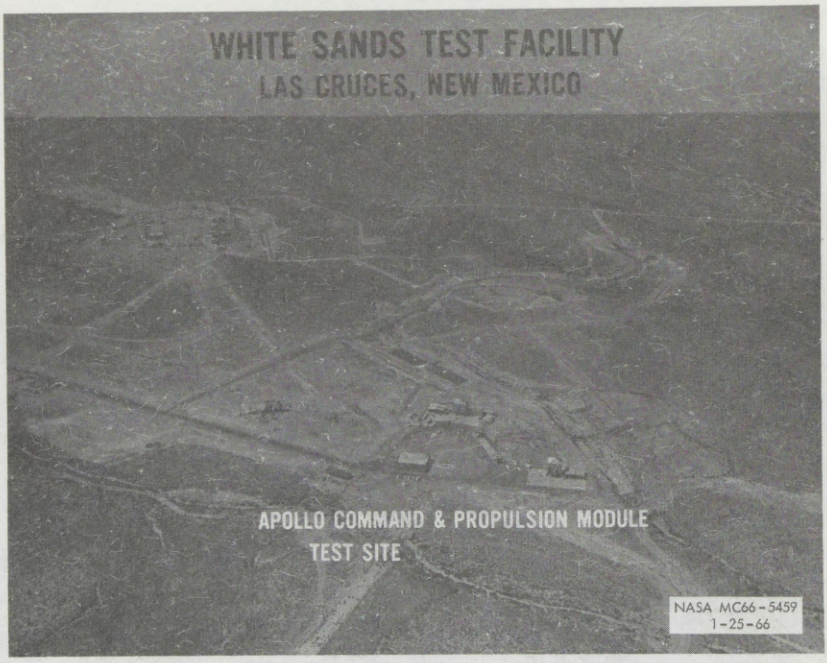


FIGURE 77

In the launch zone there are three Apollo launch complexes—34, 37, and 39. Launch complex 39 was planned for launch of Saturn V vehicles with the Apollo spacecraft. At this complex, two launch pads are under construction (figs. 78 and 79). Each pad has the inherent capability of launching about 12 vehicles per year if required.

Associated with this launch complex is the Vehicle Assembly Building, which has a low bay area 209 feet high and a 524-foot high bay area (fig. 80). The low bay area will be used to receive and hold the 2d (S–II) and 3d (S–IVB) stages prior to their mating with the 1st (S–IC) stage.

In the high bay area, the 1st stage will be positioned, checked and mated with the upper stages, the instrument unit and the spacecraft prior to a final integrated checkout. The Vehicle Assembly Building has a clear door opening of 456 feet. With minor modifications the four bays in the high portion of the building can accomodate larger vehicles than the Saturn V.

Launch Complex 34 currently has the capability of launching the uprated Saturn I with the Apollo Command and Propulsion Modules (fig. 81). Launch Complex 37 (fig. 82) which is located at the northern boundary of the original Cape Kennedy launch area, is currently being modified to launch the uprated Saturn I vehicle with the Apollo Command Service and Lunar Modules. The complex has two launch pads, one of which is operational.

Most of the major construction at Kennedy Space Center will be substantially completed by the end of 1966. The Pad B area of launch Complex 39 is scheduled to become operational by the end of fiscal year 1967. As of June 30, 1965, the Government's capital investment at Kennedy Space Center was $561,762,000.

Future program potential

The three Manned Space Flight Centers and the contractors under their direction have the capability for the overall development, manufacture, test, delivery and launch of large space vehicles and their related systems. For Apollo Applications, which is the proposed follow-on to Apollo, one of the prime considerations has been that no modifications will be required for the Saturn I and Saturn V launch vehicles assigned to Apollo Application flights. As a result, the facilities which have been provided in support of our present program can be utilized with only limited modification or add-on capabilities.



FIGURE 78



FIGURE 79



FIGURE 80

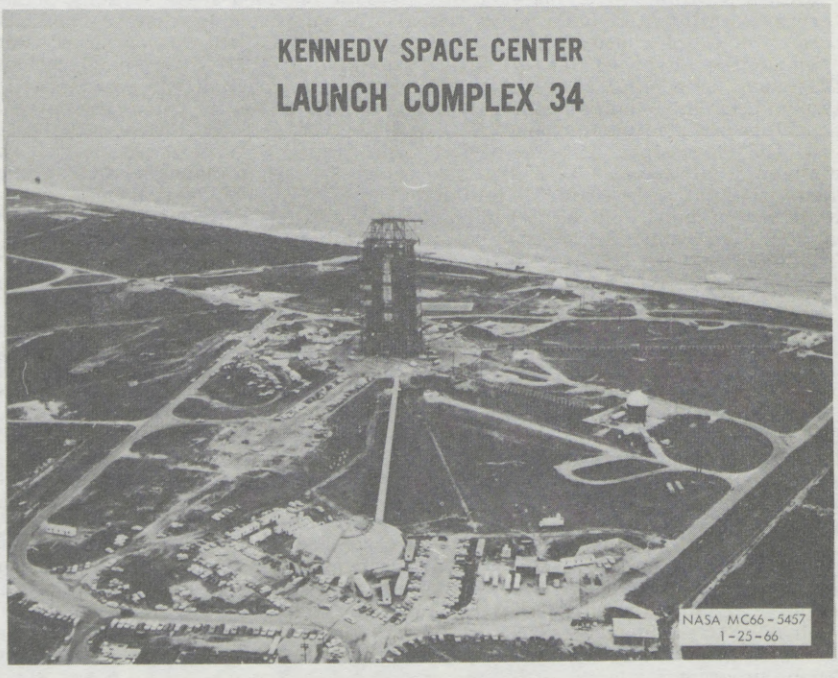


FIGURE 81

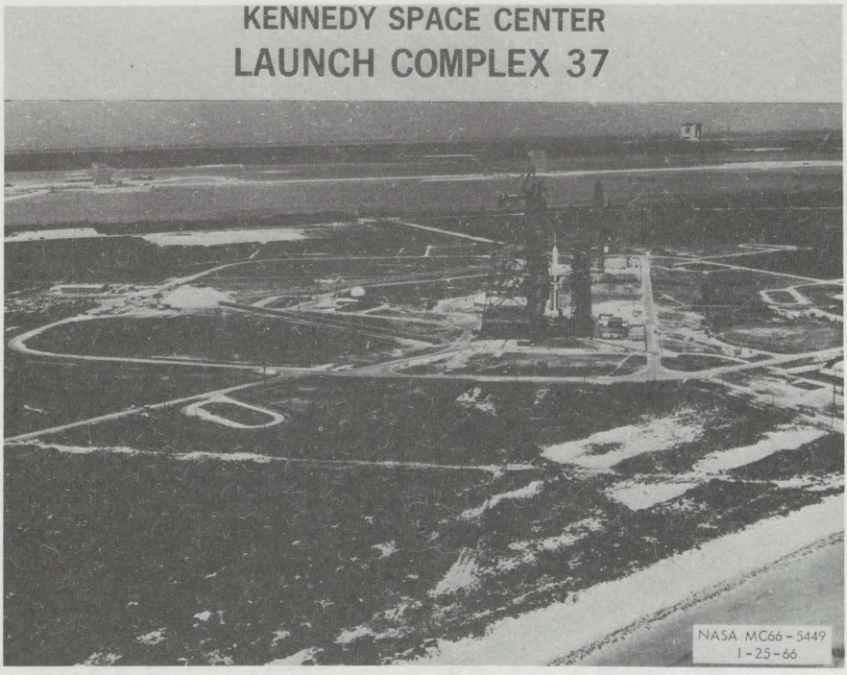


FIGURE 82

Future programs involving such operations as manned space stations, planetary exploration, and lunar bases can also be supported by these capabilities because of the flexibility which is inherent in the facilities we now have. For example, the Advanced Saturn Static Test Stand at MSFC, with modifications that would be nominal in cost compared to new construction, can be adapted to test launch vehicle stages with a thrust of 10 million pounds versus the current capability of 7.5 million pounds.

At the Mississippi Test Facility, the 2nd Stage (S–II) test stands as now configured will accept a LOX-hydrogen vehicle 33 feet in diameter, 81 feet long and with a rated thrust of one million pounds. With modification these stands could accept stages up to 36 feet in diameter, and 90 feet long, with a rated thrust of 1.5 million pounds. The 1st Stage (S–IC) stand has a comparable flexibility. The stand is being constructed to test a stage that is 33 feet in diameter, 138 feet long, with a rated thrust of 7.5 pounds. This stand can be modified for future program requirements to test stages up to 36 feet in diameter, and 170 feet long, with a rated thrust of 12 million pounds.

As I have pointed out, all of our fabrication facilities have a growth potential. The same is true of our unique facilities at the Manned Spacecraft Center where our space environment chamber, for example, can accommodate a spacecraft which is 35 feet in diameter and 80 feet in length as compared to the 21.6 and 54 foot dimensions of the Apollo. We have the capability at White Sands to test ascent, descent and reaction control propulsion systems having thrusts about double those we are now planning. At the Kennedy Space Center, we have the capability of launching more and larger vehicles than are now incorporated in the Saturn V system.

Finally, the facilities which we require for support of the present manned lunar landing program have been or are nearing completion. These complexes have the inherent capability of supporting space efforts beyond the Apollo program. Certainly the initial phases of a follow-on effort can be accomplished with relatively minor new construction. Apollo Applications is an example of a follow-on effort that capitalizes on the resources available to us through the Apollo program.

Apollo applications

In my earlier comments covering organizational changes in the Office of Manned Space Flight, I briefly described the new directorate established for Saturn Apollo Applications. At this time I would like to review in more detail the evolution, objectives and operations, plus the management aspects of Apollo Applications as well. I also will provide a report of current program status and our planned activities for the next fiscal year. In addition, I will discuss Post-Apollo Applications planning as a preliminary to my presentation of the Advanced Manned Missions portion of this statement.

Last year, I reported to you that the Apollo and Gemini programs are providing the nation with a broad base of technological, managerial and resource capability, which makes feasible a wide spectrum of Manned Space missions beyond the initial lunar landings. These Manned Space missions can be exploited in a wide range of operations in Earth orbit and lunar orbit, and operations on the lunar surface (fig. 83). The approved Gemini program has demonstrated extravehicular and rendezvous capability as well as the capability for flights of extended operational duration. Demonstration of the docking capability will occur this year. In the Apollo program we will develop capabilities for lunar orbit and landing, space maneuvers and super-orbital reentry. As I mentioned last year, utilizing these capabilities constitutes an important forward step in the logical development of the nation's Manned Space Flight program. At that time I pointed out that utilizing Apollo Saturn capabilities now under development will enable us to produce space hardware and fly it for future missions at a small fraction of the initial development cost. This was the basic concept embodied in what we proposed last year as the Apollo Extension Systems. We have since changed the name to Apollo Applications.

The Apollo Applications concept is to utilize to the fullest the capabilities inherent in the Apollo program. In my statement last year, I displayed this chart with the objectives considered for Apollo Applications (fig. 84). As shown on the chart, the manned lunar landing in this decade is a primary objective of Manned Space Flight. Only manned flights in earth orbit, lunar orbit

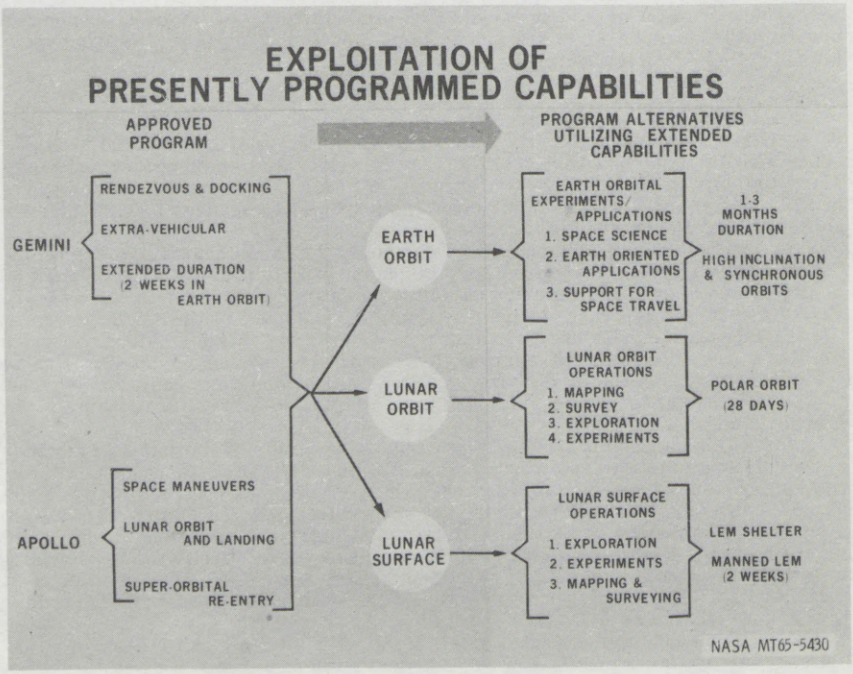


FIGURE 83

APOLLO CAPABILITY EXPLOITATION PROGRAM

CONSIDERATIONS

- LUNAR LANDING THIS DECADE -- PRIMARY OBJECTIVE OF MANNED SPACE FLIGHT
- PROGRAM EXTENSIONS
  - MANNED FLIGHTS
    - EARTH ORBIT OPERATIONS
    - LUNAR EXPLORATION OPERATIONS
  - UNMANNED FLIGHTS
    - SCIENCE AND TECHNOLOGY SATELLITES
    - PLANETARY EXPLORATION
- ONLY APOLLO HARDWARE--MODIFIED AS REQUIRED--WILL BE CONSIDERED FOR MANNED FLIGHT
- NO MODIFICATION TO LAUNCH VEHICLES
- COORDINATED DOD/NASA EFFORTS

NASA MA65-5433

FIGURE 84

and lunar surface exploration operations were considered. In addition, only Apollo hardware, modified as required, was considered for manned flights.

A basic consideration in planning for Apollo Applications as I pointed out last year, has been to use present Apollo hardware with as little modification as is consistent with the proposed mission under study. We have learned that, with the exception of added expendables and different payloads, a number of new missions can be accomplished with the presently designed Saturn Apollo launch vehicles and spacecraft.

Background

I would like to review for you some of the background of Apollo Applications. First, it is a product of the study and planning effort that has evolved since the Office of Manned Space Flight was established more than three years ago. Many industry studies and related internal NASA analyses have been performed in the three years since the lunar orbit rendezvous was selected as the mode for accomplishing the manned lunar mission.

A major factor in the selection of the lunar orbit rendezvous was that the Saturn Apollo systems required for this mode would provide a powerful and flexible manned space exploration capability as a product of the Apollo program. Performed in parallel with the definition and development of the Apollo program, the advanced system studies have identified a variety of mission objectives which could be accomplished with varying degrees of adaptation and modification of the basic lunar mission hardware. Apollo Applications has been planned from the narrowing down of the many possible adaptations to a limited number of specific missions.

Guiding this narrowing down process was the selection of those missions which appear most attractive from three points of view. The first such viewpoint was the ability to meet specified mission objectives as alternates to the lunar mission objective, as soon as the capabilities become available in the mainstream Apollo program. The second was the selective focusing on acquisition of data and manned space flight experience which can lead most effectively to the next generation of space exploration objectives. The third point of view was maximum utilization of the Saturn Apollo capabilities without extensive modifications to the basic hardware.

Apollo Applications evolved through joint efforts of all the NASA program offices. In my earlier reference to this new program I noted that the Office of Space Science and Applications, and the Office of Advanced Research and Technology will be major participants in the activity and users of the results,

and that the Office of Tracking and Data Acquisition will play a major role in accomplishing the proposed objectives.

Apollo applications operational capabilities

The current Gemini and Apollo programs are building on results from earlier successful Manned Space Flight programs. In turn, Gemini and Apollo will provide a new level of capability upon which to base Apollo Applications. Let me review some of the capability to be made available to Apollo Applications prior to 1970 by our two on-going programs.

We will have the capability to explore space out to 250,000 miles from Earth and to conduct manned operations and experiments on flights up to two weeks duration. The uprated Saturn I and Saturn V boosters will be able to inject 18 and 140 tons of payload, respectively, into near-Earth orbit. The Saturn V will be capable of sending 48 tons to the vicinity of the Moon.

The Apollo spacecraft will be able to sustain a three-man crew in a two-compartment, highly maneuverable, modular vehicle, capable of landing two men on the Moon and returning them, with samples of lunar material, to Earth. The U.S. astronauts will have logged in the Gemini and Apollo programs more than 500 man-days in space. They will have acquired data and experience from approximately 100 experiments in response to the specified needs of the scientific and technological communities.

All of the capabilities I have described build upon the basic Gemini and Apollo missions with the added capabilities of Apollo Applications, as shown here (fig. 85). The basic Apollo mission will develop the capability for three men to operate in Earth orbit for up to 14 days. Basic Apollo will also develop the capability to place three men in lunar orbit for 4 to 8 days if no landing is involved or two men on the lunar surface from 24 to 36 hours.

Added capabilities, as shown on the chart, include the ability to place two or three men in Earth orbit for six weeks on a single launch mission and up to three months through rendezvous resupply; to place three men in lunar orbit for periods up to 28 days; and to sustain two men on the lunar surface for periods of up to two weeks. Studies in the past three years indicate that the added capabilities are inherent in the system without major modifications.

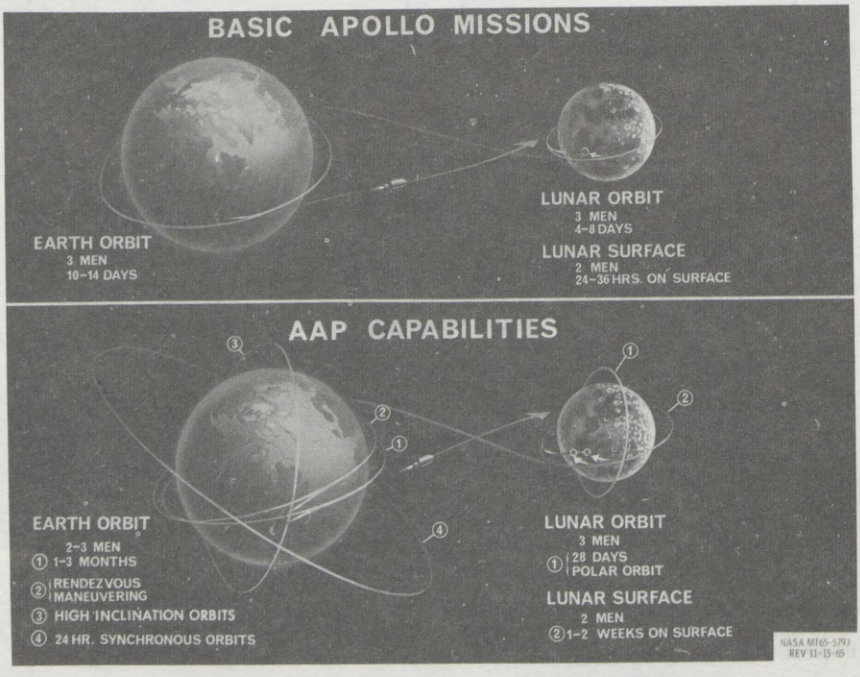


FIGURE 85

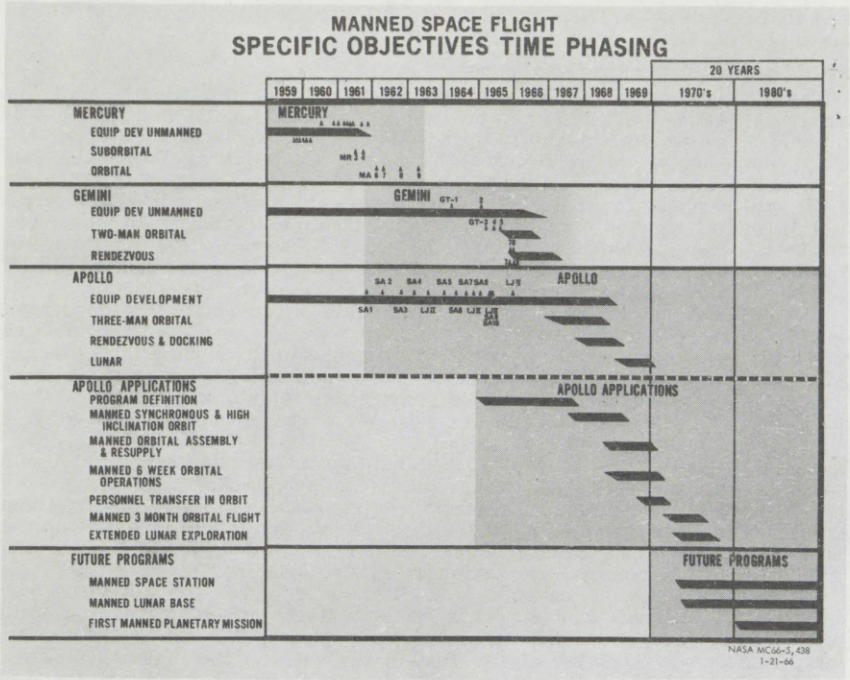


FIGURE 86

The next chart (fig. 86) shows the operational capability of the Apollo Applications in the context of the capabilities inherent in the Mercury, Gemini and Apollo programs. Apollo Applications logically follows Apollo and utilizes to the fullest support from our unmanned programs and the resources developed under Gemini and Apollo such as the Gemini and Apollo ground networks and tracking ships.

The chart shows that with present plans, manned synchronous and high inclination orbits could begin in 1968, orbital assembly and resupply operations in 1969, and long duration flight capabilities also may begin in 1969. Extended lunar exploration operations could begin in 1971. The chart additionally indicates that Apollo Applications will provide a firm operational and technological basis for future programs in the 1970's and 1980's.

Apollo applications objectives

Apollo applications objectives have been derived from the broader space goals shown here (fig. 87). The first of these broader goals is a national goal to achieve and maintain U.S. preeminence in space. The next of the descending goals is the NASA goal to explore and utilize the space environment for the advancement of human knowledge and for the benefit of mankind. Beneath this is a Manned Space Flight goal, to develop the capabilities for men to live and operate effectively in space for extended periods. It is followed by the Apollo goal to demonstrate the capability for three men to explore cislunar space by accomplishing a manned lunar landing in this decade.

From these goals are derived the general objectives of Apollo Applications, to provide a basis for the next major U.S. step in manned space flight, using the Apollo Saturn systems. These general objectives are to be provided by accomplishing (1) extended lunar exploration, including one-month orbital surveys and two-week lunar surface operations; and (2) manned operations in any Earth orbit of 90 days duration, using rendezvous resupply and orbital assembly techniques.

DERIVATION OF APOLLO APPLICATIONS OBJECTIVES

NATIONAL GOAL	• TO ACHIEVE AND MAINTAIN U. S. PRE-EMINENCE IN SPACE
NASA GOAL	• TO EXPLORE AND UTILIZE THE SPACE ENVIRONMENT FOR THE ADVANCEMENT OF HUMAN KNOWLEDGE AND FOR THE BENEFIT OF MANKIND
MANNED SPACE FLIGHT GOAL	• TO DEVELOP THE CAPABILITIES FOR MEN TO LIVE AND OPERATE EFFECTIVELY IN SPACE FOR EXTENDED PERIODS
APOLLO GOAL	• TO DEMONSTRATE THE CAPABILITY FOR THREE MEN TO EXPLORE CISLUNAR SPACE BY ACCOMPLISHING A MANNED LUNAR LANDING IN THIS DECADE
APOLLO APPLICATIONS GENERAL OBJECTIVES	• USING THE SATURN APOLLO SYSTEMS, TO DEFINE AREAS IN WHICH MANNED OPERATIONS IN SPACE CAN BENEFIT MANKIND AND TO PROVIDE A FOUNDATION FOR DEFINING AND UNDERSTANDING THE NEXT MAJOR UNITED STATES STEP IN SPACE BY ACCOMPLISHING: • EXTENDED LUNAR EXPLORATION, INCLUDING ONE-MONTH ORBITAL SURVEYS AND TWO WEEK LUNAR SURFACE OPERATIONS • MANNED OPERATIONS IN ANY EARTH ORBIT OF NINETY DAYS DURATION, USING RENDEZVOUS RESUPPLY AND ORBITAL ASSEMBLY TECHNIQUES

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FIGURE 87

Specific Objectives

Specific Apollo Applications objectives are shown in the next chart (fig. 88). The overall objective of Apollo Applications is to define areas in which manned operations in space can benefit mankind and to provide a foundation for defining and understanding the United States next major step in space. In Apollo Applications our prime motivation is to exploit currently available knowledge, experience, investment and capabilities. We are emphasizing manned operations in space to service all user requirements for operational, scientific and technological experiments.

In maintaining the leadership of the United States in space operations, NASA's contribution will be to acquire knowledge and remove barriers for further exploration of the universe. The Manned Space Flight contribution, utilizing Apollo Applications, will be the development of the capability for man to operate in space for indefinite periods of time. In addition, manned operational requirements for future Earth oribtal operations, lunar operations and planetary exploration operations will be defined.

Apollo Applications Operations

The major operational capabilities of Apollo Applications are (1) manned synchronous and high inclination orbit operations; (2) orbital assembly and resupply operations including personnel transfer; (3) long duration manned space flight operations; and (4) extended lunar exploration operations.

Manned Synchronous and High Inclination Orbit Operations

In Apollo Applications we may have the capability for manned synchronous and high inclination Earth orbital operations beginning in 1968. Emphasis could be placed on manned operations but some experiments may be directed toward ultimate unmanned or intermittently manned systems. In these cases, man would be ultilized to optimize measurement techniques and sensors, to evaluate, calibrate and check out equipment in space environments. By this means, highly reliable equipment ultimately could be placed in unmanned spacecraft for some applications.

It is probable that, as a result of manned space flight experiments, we will be able to accelerate the development of spacecraft systems which will enable us, for example, to forecast the weather more accurately for longer periods of time.

We are proposing to study a concept of an advanced meteorological research laboratory in synchronous orbit, enabling man to conduct experiments in a num-

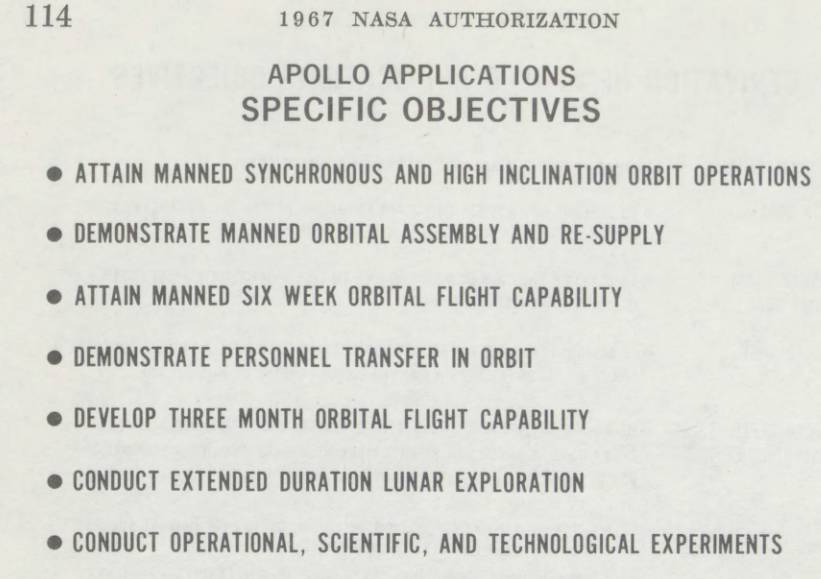

FIGURE 88

ber of fields. These include upper atmospheric composition and processes, the characteristics of severe local storms, the influence of extraterrestrial effects on weather phenomena, and atmosphere pollution analysis. Continuous one-third coverage of the Earth by synchronous orbit may enable man to gather synoptic weather data for long term forecasts and evaluate the effects of weather on Earth and space phenomena.

Another typical synchronous orbit operational area concerns manned orbital astronomical observations using optical telescopes (fig. 89). Astronomical observations may be made on all stellar objects including the Sun. Particular solar atsronomy effort could be concentrated in the 1968–70 period of peak solar activity, which will not recur for 11 years. The orbital vantage point would allow optical astronomy free of atmospheric distortion and filtering.

Thirty-eight inch telescopes developed for the Orbiting Astronomical Observatory program could be adopted for use with the Apollo spacecraft. After setting up the telescope in orbit, the astronaut would adjust, calibrate and operate it. The film and plates would be returned by the astronaut at the end of the first mission and the telescope would be left to operate unmanned until the astronaut returned to readjust the telescope on subsequent missions.

It is estimated that the results of these experiments would be an order of magnitude greater than what has been obtained previously. Man's ability to operate and maintain orbital telescopes could be tested, as well as systems and subsystems for future manned and unmanned optical astronomical missions.

Demonstrations of communications capabilities could also be made from manned spacecraft in Earth-synchronous orbits. These capabilities include direct broadcast of live FM radio and television on a worldwide basis, and navigation and traffic control.

Another benefit that may be gained from Earth orbit operations is synoptic data on the worldwide status of natural resources. Data may reveal new information as to mineral deposits, water resources, crops and forests, marine life, and other Earth phenomena.

Orbital Assembly and Resupply

Orbital assembly and resupply are prerequisite to man's continuing exploration and utilization of the space environment. Apollo Applications, using the Apollo Saturn systems, may remove further barriers to man's ability for accomplishing operations in space.

Operational techniques for cargo and personnel operations could be developed as shown here (fig. 90). Orbital maneuvering and docking techniques could be

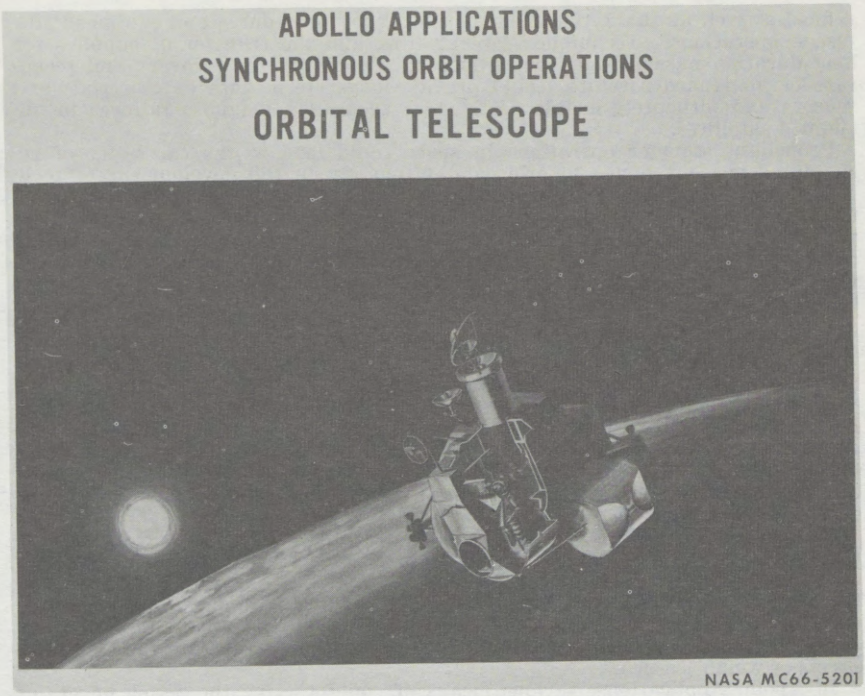

FIGURE 89

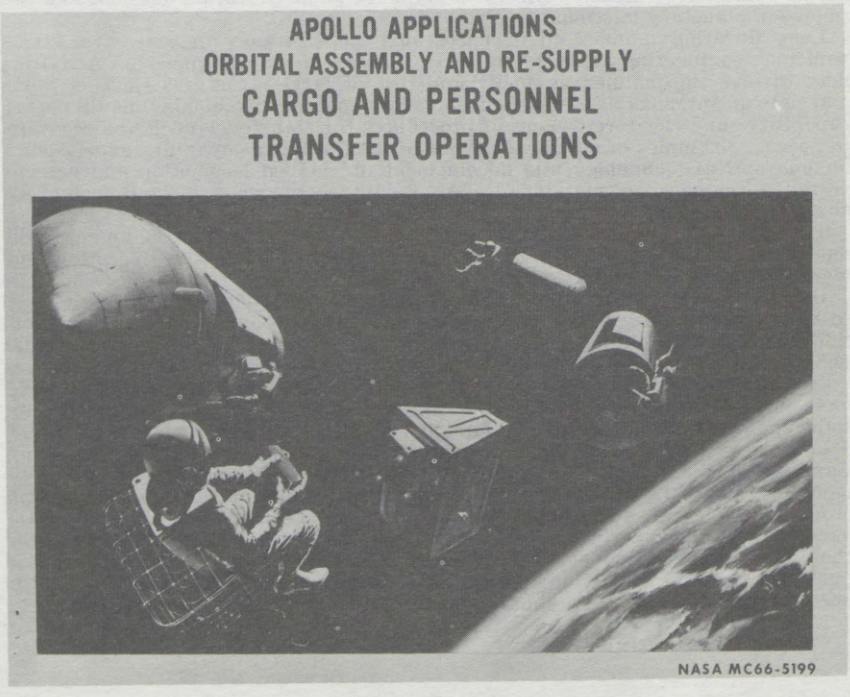

FIGURE 90

refined as well as the development of emergency procedures and equipment for rescue operations. Techniques for refueling and the transfer of supplies for long duration missions may be developed. Capability for recovery and recapture of unmanned satellites could provide longer term data on materials and sensors and ultimately enable us to more accurately diagnose failures in unmanned satellites.

Propellant transfer operations in space could lead to the capability of resupplying space vehicles in orbit and ultimately to the development of techniques for orbital launch operations. The testing of materials in space is aimed toward the improvement of spacecraft subsystems and materials. Fire and blast protection tests in the spacecraft atmosphere, long term space exposure effects on spacecraft materials and actual physical and chemical tests to stress materials both inside and outside the spacecraft may lead to improved materials for follow-on space systems.

Long Duration Manned Flight Operations

We may have the capability of placing astronauts in Earth orbit for approximately 4 weeks by 1969 and by 1971 we may extend this time to 3 months. The 4 week to 3 month orbital capacity should provide a capability to test man's behavior and his reactions to the spacecraft environment in long duration missions. Apollo Applications may not only permit extending man's time in space, but provide the capability for including trained medical observers on the mission and for investigating several means of therapy to counteract possible adverse effects of space flight.

Major areas of interest are the effects of weightlessness on the cardiovascular and musculoskeletal systems. Experience to date identifies no potential problems such as possible blood pooling in the legs, dizziness, and a loss of calcium from the system. However, such symptoms could result from longer time exposure; therefore a well-controlled series of experiments must be carried out. For these experiments, measurements would be made to monitor adequately the long term effects of weightlessness.

In Apollo Applications, various means of counteracting the zero-g effects of space could be investigated. Relatively simple means, such as conditioning exercise, may be used. In addition, the creation of an artificial gravity environment, such as a centrifuge or rotating spacecraft, may also be needed. These needs would have extensive effects on plans for longer duration missions and for follow-on planetary missions.

Long duration manned flight operations may develop an extensive extravehicular engineering activity (fig. 91). Extravehicular Engineering Activities may involve the manned assembly and test of large structures such as radio and optical antennas; the development of manned extravehicular manipulative capability; and the development of procedures for transfer, launch and recovery in space. Examples of the development of manipulative capability experiments include optical technology, the development of manned locomotion and maneuvering, development of maintenance and repair techniques, and the launch of an unmanned satellite.

The launch of unmanned satellites after they have been calibrated and checked out in orbit may provide for a higher probability of successful operation and more accurate insertion into orbit.

Design data is required for the development of reliable, long-duration (one to three years) subsystems for manned planetary missions and for long-duration Earth-orbital missions. Long-duration Earth-orbital operations may enable us to rotate crews in advanced Earth-orbital space stations with limited requirements for supplies inasmuch as the basic subsystems potentially would have one to three year lifetimes. This would improve cost effectiveness by reducing logistic launches and minimizing maintenance and replacement.

Long duration manned flight operations may provide a platform for many Earth Sciences and resources experiments. Earth Sciences and Resources experiments conducted in cooperation with other agencies may include global synoptic observations in the fields of agriculture, forestry, geology, geodesy and oceanography. In this experiment category, a great deal of interest has developed over the possible utilization of satellite-based observations in the management of agricultural resources. This application depends upon the employment of multispectral sensors to obtain a simultaneous recording of electromagnetic images in

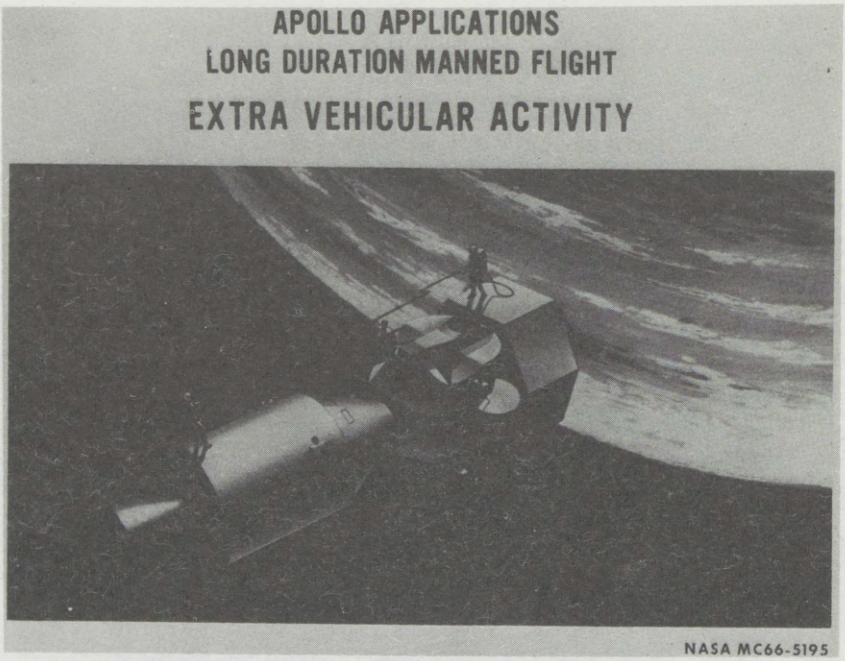

FIGURE 91

several different bands. Infrared, visible and ultraviolet multispectral sensing, for example, could lead to acquisition of useful data by operational Earth sciences and resources satellites. What we learn from measurements of the Earth from Earth-orbital satellites (which we can correlate with "ground truth") may improve our capability for analyzing planetary data from future planetary flyby or capture missions.

Additional long duration Manned Flight Operations could be aimed toward the evolution and improvement of spacecraft subsystems and materials. These include environmental control systems, fire and blast protection in the spacecraft atmosphere, long term exposure effects on spacecraft materials, and development testing of advanced subsystems.

Extended Lunar Exploration Operations

Because of the increased mission duration and extended area coverage potential of Apollo Applications, it may be possible to obtain definitive answers to a number of fundamental questions pertaining to the origin and history of the Moon by means of lunar surface exploration (fig. 92). Consistent with the basic objective of lunar exploration, various scientists have proposed experiments on investigations in such fields as geology, geochemistry, geodosy, biology and particles and fields.

Lunar surface processer and subsurface samples from drill holes at the landing sites and along the traverses could be studied. Seismic experiments may be conducted as well as studies of local gravity and magnetic anomalies. Galactic observations could be made utilizing radar and astronomical telescopes. The three major terrain types found on the Moon, e.g., Maria, highlands and thermally active lunar craters, will be studied in detail.

The 28-day lunar polar orbit capability should enable man by the use of cameras and other remote sensors to scientifically photograph and obtain multispectral data from the entire surface of the Moon. By the use of surface probes, man may obtain useful information concerning polar and far-side-of-the-Moon sites which may enable him to select areas for extended surface exploration.

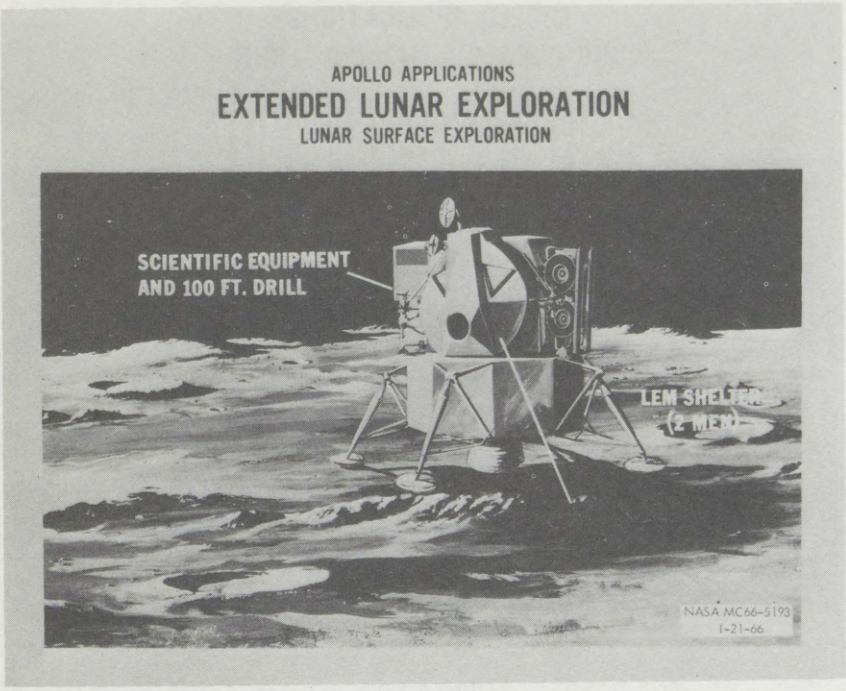

FIGURE 92

Manned lunar orbiters utilizing competent camera systems may collect data to compile a complete lunar topographic map series at various scales from 1:2,500,000 to 1:250,000 with selected areas at still large scales. Geodetic measurements may be performed to provide complementary results for analyzing in depth such phenomena as rotation, physical librations of the Moon and lunar tides.

Mission concepts

In the Apollo Applications program, the flight activity is classified into two categories, alternate missions and follow-on missions (fig. 93).

Alternate and Follow-on Missions

Alternate missions to the basic Apollo program in 1968–1970 could use those basic lunar mission space vehicles which may become available from the Apollo program, for alternate missions of a nominal two weeks duration.

Follow-on missions may use modified Apollo flight hardware with standard Saturn launch vehicles for long duration missions in Earth and lunar orbit and on the lunar surface.

All of the four Apollo Applications operations areas discussed are planned both for alternate and follow-on missions. The first series, flights in Earth orbit, including polar, synchronous and equatorial orbit, could be made to meet Earth-oriented applications, requirements, including meteorology, communications and Earth resources analysis. A second series may consist of flights in Earth orbit for astronomical observations and physical science experiments.

Another series of missions may consist of Earth-orbital flights for development, test and demonstration of space operations and technology.

Finally, we could have a series of lunar missions for both extensive orbital surveys and for lunar surface exploration.

APOLLO APPLICATIONS - MISSION CONCEPTS

ALTERNATE MISSIONS

USE OF BASIC LUNAR MISSION SPACE VEHICLES WHICH MAY BECOME AVAILABLE FROM THE APOLLO PROGRAM FOR APOLLO APPLICATIONS MISSIONS OF A NOMINAL TWO WEEKS DURATION

FOLLOW-ON MISSIONS

USE OF MODIFIED APOLLO SPACECRAFT WITH STANDARD SATURN LAUNCH VEHICLES FOR LONG DURATION MISSIONS IN EARTH AND LUNAR ORBIT AND ON THE LUNAR SURFACE

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FIGURE 93

Management considerations

Planning Schedules for Apollo Applications

Planning schedules for Apollo Applications have been prepared for the time period 1965 through 1971. These schedules are based on the technology being developed in the Apollo Saturn I and Apollo Saturn V programs.

The Apollo program schedules call for the first unmanned flight in 1966 on the uprated Saturn I (Saturn IB); the first manned Apollo flight on the uprated Saturn I in 1967; and on the Saturn V the first unmanned and manned flights in 1967 and 1968. Thus, beginning in 1968, the possibility of alternate missions to those in the mainstream Apollo program may be considered, using the unmodified spacecraft for nominal 14-day missions.

It appears from our studies that the technology would permit 4-week missions in Earth orbit with a single launch in about 1969 and up to 3 months by double rendezvous in 1971. This same spacecraft should be capable of 28-day missions in lunar orbit during 1970–1971. Similarly, utilizing the inherent capabilities in the basic Lunar Module, we could have a two-week lunar surface exploration capability a year or two after the initial manned landing.

The next chart (fig. 94) shows decision points for basic hardware procurement initiation to deliver hardware in time to meet follow-on flight schedules in 1969 and 1970. Initial hardware procurement for the Saturn I launch vehicle was initiated in December, 1965. Initial procurement for the spacecraft will take place in calendar year 1966.

Payload Integration

In Apollo Applications, one of the management tasks which we are now studying is the need for the assignment of experiments into compatible mission payloads. Compatibility involves power, volume, weight, shape, environmental control, spacecraft modifications, installation and accessibility requirements, crew time availability, and orbital deployments for the individual experiments.

The compatibility study effort is being conducted as a part of the Apollo Applications Payload Integration Project. Payload integration involves the hardware and software activity required to integrate and to qualify Apollo Applications space vehicles, individual experiments and integrated payloads. These must be

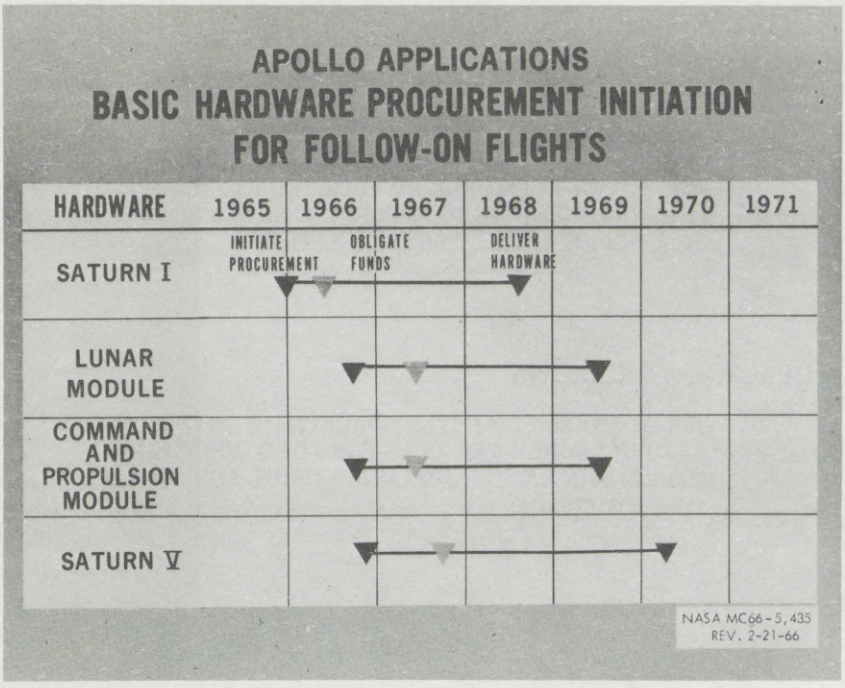

FIGURE 94

ready for delivery to the Kennedy Space Center for assembly, checkout and launch in accordance with Apollo Applications specified flight mission assignment plans and schedules.

The integration study encompasses all of the experiments under discussion in this presentation as well as potential future experiments. The analysis is currently being made on a flight-by-flight basis.

Major 1965 accomplishments

The Apollo Applications program office was established in 1965 and the Headquarters organization was approved in August (fig. 95). The roles and missions of the centers were determined in December.

The Manned Spacecraft Center, at Houston, has the responsibility of developing Apollo Applications spacecraft, training the flight crews, and conducting flight operations. In addition, the Center at Houston will be responsible for integrating experiment payloads on the command and service modules.

The Marshall Space Flight Center at Huntsville, Alabama, in addition to its responsibility for launch vehicle development, will be responsible for integrating payloads on the Lunar Module, the Saturn stages, and the instrument unit.

The Kennedy Space Center, Florida, will be responsible for Apollo Applications launch operations and will also be responsible for the installation of selected experiments into the space vehicle.

Preliminary flight mission assignments for Apollo Applications were completed in December, and a preliminary Program Development Plan was issued. We also completed preliminary definition of the extended duration spacecraft and payload integration activity. We identified 314 experiments and completed preliminary studies of the Manned Space Flight Network/NASA Communications (NASCOM) capabilities to support Apollo Applications missions. We also completed studies of launch operations and mission operations support.

APOLLO APPLICATIONS
MAJOR 1965 ACCOMPLISHMENTS

• APPROVED HEADQUARTERS ORGANIZATION	- AUGUST 1965
• ESTABLISHED ROLES AND MISSIONS OF CENTERS	- DECEMBER 1965
• ESTABLISHED PRELIMINARY FLIGHT MISSION ASSIGNMENTS FOR APOLLO APPLICATIONS PLANNING	- DECEMBER 1965
• ISSUED PRELIMINARY PROGRAM DEVELOPMENT PLAN	- NOVEMBER 1965
• COMPLETED PHASE B DEFINITION OF EXTENDED DURATION SPACECRAFT AND PAYLOAD INTEGRATION STUDIES	- FALL 1965
• COMPLETED B STUDIES OF MSF COMMUNICATIONS NETWORK CAPABILITIES TO SUPPORT APOLLO APPLICATIONS	- FALL 1965
• COMPLETED PHASE B STUDIES OF LAUNCH OPERATIONS AND MISSIONS OPERATIONS SUPPORT FOR APOLLO APPLICATION MISSIONS	- FALL 1965

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FIGURE 95

Major 1966 planned activities

In 1966, we expect to complete Apollo Applications flight mission assignments and spacecraft design (fig. 96). Payload Integration definition will be finished as well as the complete definition of experiments for the alternate missions. Preliminary definition of experiments for the follow-on missions will be done. In addition, we will complete the organization and staffing of the Apollo Applications Program Office at Headquarters and at the Centers. The Apollo Applicants Final Program Development Plan will be issued in 1966.

Summary

I have covered the total capabilities that exist in Manned Space Flight as the result of the Apollo program, and the results of our studies over the past few years which have indicated that it is both feasible and timely to start active effort to utilize the Apollo Saturn sysems for alternate and follow-on missions to those planned for the mainstream Apollo program.

I would like to summarize by examining some of the highlights of Apollo program progress (fig. 97).

Launch Vehicles

In the launch vehicle area, we have successfully flown the critical liquid hydrogen fueled upper stage. The instrument unit concept has surely been proven. A highly successful first phase of the Saturn I program has been completed. All stages of the uprated Saturn I (Saturn IB) and the Saturn V are in advanced stages of ground testing to prove the basic soundness of the design.

The common bulkhead features of both the 2d (S–II) and 3d (S–IVB) stages of the Saturn V and the 2d stage (S–IVB) of the follow-on Saturn I had been a matter of development concern, although we knew they could be built. The problems were those of fabrication, and of behavior of the stages under cryogenic conditions and structural loads. Our concern over fabrication of these large but finely-honed structures is largely behind us now.

Spacecraft

In spacecraft development, we have completed our boilerplate program in terms of deliveries, and in the main, the testing on these is well advanced. The Apollo spacecraft first flight article has been delivered, and this is always a major milestone. We have begun the fabrication on the flight Block II Command and Propulsion Module and Lunar Module.

APOLLO APPLICATIONS
MAJOR 1966 PLANNED ACTIVITIES

1. COMPLETE APOLLO APPLICATIONS FLIGHT MISSION ASSIGNMENTS
2. COMPLETE APOLLO APPLICATIONS SPACECRAFT DEFINITION
3. COMPLETE PAYLOAD INTEGRATION FINAL DEFINITION
4. COMPLETE DEFINITION OF EXPERIMENTS FOR ALTERNATE MISSIONS AND PRELIMINARY DEFINITION OF EXPERIMENTS FOR FOLLOW-ON MISSIONS
5. COMPLETE ORGANIZATION OF PROGRAM AT HEADQUARTERS AND AT THE CENTERS
6. COMPLETE APOLLO APPLICATIONS PROGRAM DEVELOPMENT PLAN

NASA MC66-5,168

FIGURE 96

APOLLO PROGRAM
PROGRESS INDICATORS

- LAUNCH VEHICLES
  - HYDROGEN UPPER STAGE SUCCESSFULLY FLOWN
  - INSTRUMENT UNIT CONCEPT PROVEN IN FLIGHT
  - SATURN I SUCCESSFULLY FLOWN - 10 FLIGHTS
  - ALL STAGES OF UPRATED SATURN I AND SATURN V SUCCESSFULLY GROUND TEST FIRED
  - COMMON BULKHEAD TEST PROGRAM SUCCESSFULLY COMPLETED
- SPACECRAFT
  - BOILERPLATE DELIVERIES COMPLETE
  - FIRST FLIGHT ARTICLE MANUFACTURED AND DELIVERED
  - FABRICATION BEGUN ON FIRST BLOCK II COMMAND AND PROPULSION MODULE AND LUNAR MODULE
- OPERATIONS
  - LC-34 ACTIVATED
  - MAJOR FACILITY CONSTRUCTION COMPLETED ON LC-39
  - STRUCTURAL MODIFICATIONS BEGUN ON LC-37B

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FIGURE 97

Launch Operations

In operations, Launch Complex 34 is in the final stages of activation. In this connection, a well deserved tribute to the Kennedy Space Center is in order. They have overcome considerable adversity, in terms of late deliveries of ground equipment and spacecraft, and yet have been able to reshape the activities necessary at the Cape to keep the program moving. By readjusting events without compromising program safety or technical objectives, we have been able to maintain the schedule which has been on the books now for some two years. Structural modifications to the second Saturn I stand at Launch Complex 37 are now well underway.

The major large-scale construction on Launch Complex 39 for Saturn V launches is now behind us, certainly a significant achievement.

Planned Activities

To summarize the job ahead (fig. 98) in terms of some of the high points in the technical area, the qualification of the spacecraft heat shield in flight at lunar return velocities is a major program event. The demonstration of the ability to restart the third stage in Earth orbit is vital to the translunar injection of the Saturn V. Gemini is leading the way in rendezvous and docking, and we are looking to Surveyor for verification of the lunar landing site conditions.

Some very significant decision points are ahead of us, including a decision on follow-on procurement. Our contracts are rolling at high momentum, and some of them are starting to see the end of the line. All of the articles currently planned for procurement are now in some stage of fabrication. The major planned activities of Apollo for 1966 are listed in this series of charts (figs. 99, 100, 101, 102, and 103).

Resources Capability

In pointing out the management, personnel, and facilities capabilities that exist in Manned Space Flight as a baseline for the lunar landing capability, I reviewed the development capability at the three MSF Centers and the NASA facilities under their cognizance, and at contractor facilities. Included were the launch vehicles, development, manufacturing and test capability at Marshall Space Flight Center, Mississippi Test Facility and at engine and stage contractor facilities; space development, manufacturing and test capability at Manned Spacecraft Center, Michoud Assembly Facility, Sacramento Test Facility, and at contractor facilities; space operations capability at MSC; and launch operations capability at Kennedy Space Center.

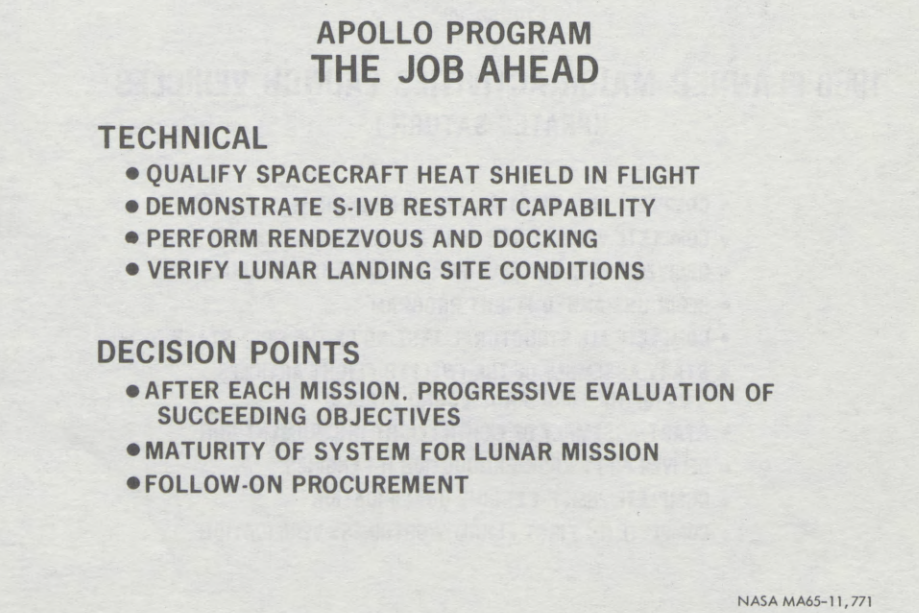

FIGURE 98

1966 PLANNED MAJOR ACTIVITIES SPACECRAFT

COMMAND & PROPULSION MODULE

- INITIATE FLIGHT TEST OF BLOCK I AIRFRAME
- ACTIVATE THE HOUSTON THERMAL VACUUM CHAMBER
- COMPLETE 008 TESTS IN SUPPORT OF 012 SPACECRAFT
- COMPLETE BLOCK I SUBSYSTEM QUALIFICATION TEST PROGRAM
- COMPLETE DELIVERY OF ALL BLOCK I SPACECRAFT
- COMPLETE PROPULSION MODULE-001 SUBSYSTEM TESTS IN SUPPORT OF 011, 012
- COMPLETE COMMAND/PROPULSION MODULE STRUCTURAL & THERMAL TESTS
- BEGIN INITIAL TESTING OF BLOCK II SPACECRAFT
- CONDUCT DYNAMIC TESTING OF FUEL CELLS

NASA MC66-5274
1-21-66

FIGURE 99

1966 PLANNED MAJOR ACTIVITIES LAUNCH VEHICLES

UPRATED SATURN I

- COMPLETE QUALIFICATION TESTING PROGRAM
- COMPLETE VEHICLE GSE FOR LAUNCH COMPLEX 37B
- DELIVER PROGRAM TAPES FOR AUTOMATIC CHECKOUT
- BEGIN UNMANNED FLIGHT PROGRAM
- COMPLETE ALL STRUCTURAL TESTING OF THE FIRST STAGE
- START ASSEMBLY OF THE TWELFTH FLIGHT ARTICLES OF THE FIRST AND SECOND STAGES
- START ASSEMBLY OF EIGHTH FLIGHT INSTRUMENT UNIT
- DELIVER FIFTY 205K PRODUCTION H-1 ENGINES
- COMPLETE 205K H-1 ENGINE QUALIFICATION
- COMPLETE H-1 FIRST FLIGHT WORTHINESS VERIFICATION

NASA MC66-5275
1-21-66

FIGURE 100

1966 PLANNED MAJOR ACTIVITIES SPACECRAFT

LUNAR MODULE

- COMPLETE THERMAL VACUUM TESTING, SUBSYSTEM INTEGRATION TESTS, VIBRATION TESTS AND STRUCTURAL TESTS
- CONTINUE PROPULSION TESTS
- COMPLETE QUALIFICATION TESTS ON PROTOTYPE FLIGHT HARDWARE
- DELIVER FIRST FLIGHT VEHICLE TO KSC

NASA MC66-5302
1-21-66

FIGURE 101

1966 PLANNED MAJOR ACTIVITIES SPACECRAFT

CHECKOUT

- COMPLETE CHECKOUT OF ALL BLOCK I SPACECRAFT
- ACTIVATE FIRST TEST STAND FOR INITIATION OF FIRST BLOCK II SPACECRAFT CHECKOUT
- COMPLETE GSE QUALIFICATION PROGRAM FOR BLOCK II SPACECRAFT
- SPACE ENVIRONMENT SIMULATION LABORATORY AT MSC OPERATIONAL
- COMPLETE CHECKOUT OF THE FIRST MANNED SPACECRAFT (CSM012) AT KSC

NASA MC66-5303
1-21-66

FIGURE 102

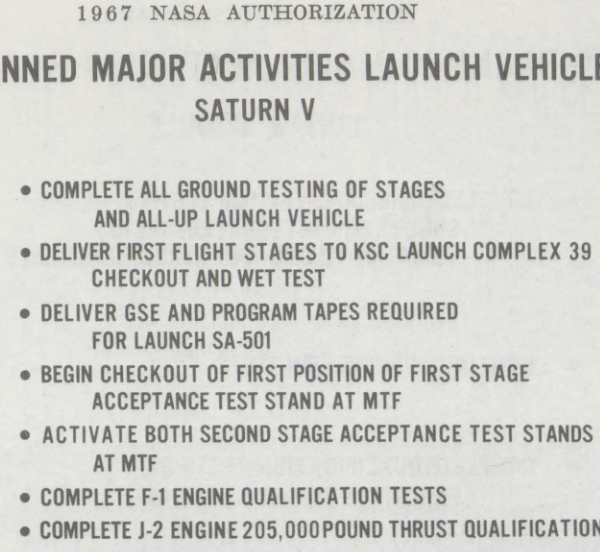

FIGURE 103

Apollo Applications

In the Apollo program, we are developing a broad and powerful national operational capability which can now be directed in a number of different ways. These Apollo Applications will provide particular focus as well as broad emphasis for the accomplishment of economic benefits, lunar and planetary exploration and scientific advancement.

Confidence in the Future

Let me conclude by giving you some basis for confidence in the future (fig. 104). The organization has been built and staffed. It is a capable organization and staffed with competent people who are dedicated and determined to get the job done.

The program has been essentially defined and we have essentially achieved stability. These are two very important statements in relation to the future of the program.

Our progress has been steady. We have tight control over the requirements of the program, over its schedules, costs, and the performance that we are developing and demonstrating.

We have good management visibility, and it continues to improve. Finally, our program organization and the Apollo contractors are working effectively in the solution of problems and in other management action.

Mission Operations

I would like to turn now to the operational side of the Manned Space Flight program, specifically the mission operations for Gemini Apollo.

Manned Space Flight Network

As the spacecraft develop the missions become more complex, and the Manned Space Flight Network is evolving to support it. We will not achieve complete configuration of the network in support of Apollo until late 1967. The evolution of the network to support our first four Apollo Saturn missions can be seen in the next series of charts I will show.

Unmanned Missions

The first mission, AS–201, will be launched on a 105° azimuth with a rather short ballistic trajectory from Cape Kennedy to the vicinity of Ascension Island, approximately 4,650 miles downrange (fig. 105). The next chart (fig. 106)

BASIS FOR CONFIDENCE

- ORGANIZATION BUILT AND STAFFED
- PROGRAM DEFINED AND STABILITY ACHIEVED
- STEADY PROGRESS TOWARD OBJECTIVES
- TIGHT CONTROL OVER REQUIREMENTS
  - SCHEDULE
  - COST
  - PERFORMANCE
- INCREASED MANAGEMENT VISIBILITY
- MANAGEMENT ACTIONS
  - NASA
  - CONTRACTORS

NASA MA65-11,748

FIGURE 104

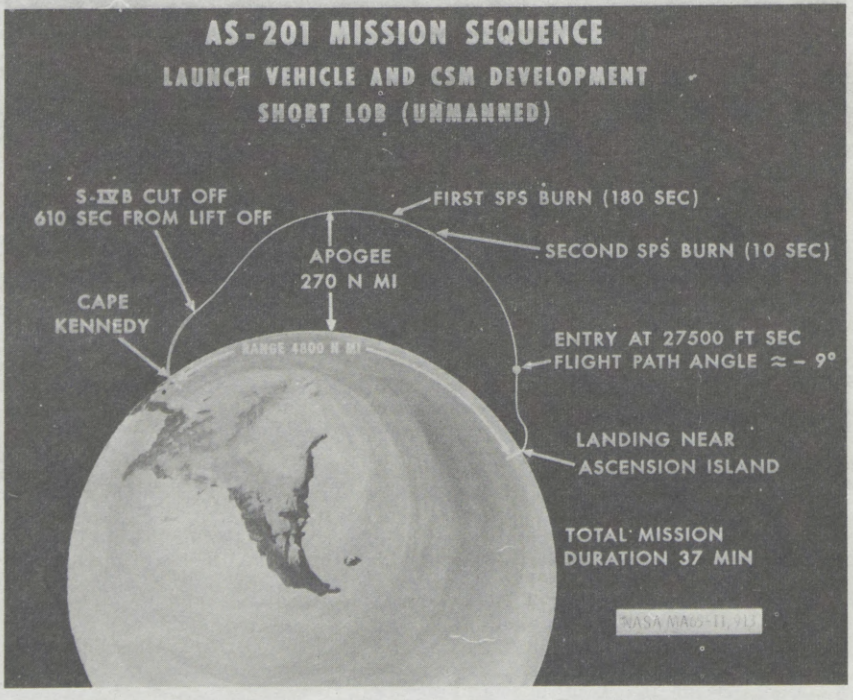

FIGURE 105



FIGURE 106

shows the instrumentation network which will support this mission. The network consists primarily of the downrange stations of the Eastern Test Range, supplemented by the instrumentation ship Rose Knot Victor and three instrumentation aircraft. These are basic Gemini stations with console modified to support Apollo.

This chart (fig. 107) indicates the Apollo-peculiar equipment introduced into the network for this mission. These include the Apollo launch data system, which ties the Center instrumentation facility and launch complex at Cape Kennedy to the Mission Control Center at Houston, and additional pulse code modulated decommutators at Antiqua and Grand Bahama Island.

The second mission, AS–202, has a longer ballistic trajectory, terminating in the vicinity of Wake Island (fig. 108). From the next chart (fig. 109), it is evident that additional stations must be called up in support of this mission. This also represents minor modification of existing Gemini instrumentation with one exception. At Carnarvon, for the first time, we will have an opportunity to confirm the operation of unified S-band communications between the spacecraft and the ground station.

The third mission, AS–203, as sown here (fig. 110), is of somewhat different character. Its primary objective is to determine the behavior of liquid hydrogen in a zero-g enviroment. The boilerplate spacecraft is ejected by use of the launch escape system shortly after launch and the primary objective of the mission will be accomplished during three orbits of the 2nd stage (C–IVB). Through special efforts by the Goddard Space Flight Center, early capability of the unified S-band antennas will be provided at Carnarvon, Hawaii, Texas, and Cape Kennedy (fig. 111). Special television equipment will be connected to these antennas to record the behavior of the liquid hydrogen during this period. Another first on AS–203 will be the initial use of the first Apollo instrumentation ship in the vicinity of Bermuda to confirm orbital insertion.

MSFN ACQUISITION RESOURCES
MISSIONS AS-201-204

MISSION	APOLLO PECULIAR EQUIPMENT
AS-201	APOLLO LAUNCH DATA SYSTEM AND CENTRAL INSTRUMENTATION FACILITY ONE ADDITIONAL PULSE CODE MODULATED DECOMMUTATOR AT ANTIGUA AND GRAND BAHAMAS ISLAND
AS-202	MINOR UNIFIED S-BAND SUPPORT AT CARNARVON
AS-203	SPECIAL TV EQUIPMENT AT TEXAS, CARNARVON, CAPE KENNEDY AND BERMUDA APOLLO INSTRUMENTATION SHIP (INSERTION)
AS-204	START OF UNIFIED S-BAND EVALUATION MSFN USB SUPPORT AT MERRITT ISLAND, BERMUDA, GUAYMAS, CARNARVON, GUAM, HAWAII, TEXAS, INSERTION SHIP, INJECTION SHIP ONE APOLLO INSTRUMENTATION AIRCRAFT (ENGINEERING EVALUATION)

NASA MA65-11,469

FIGURE 107

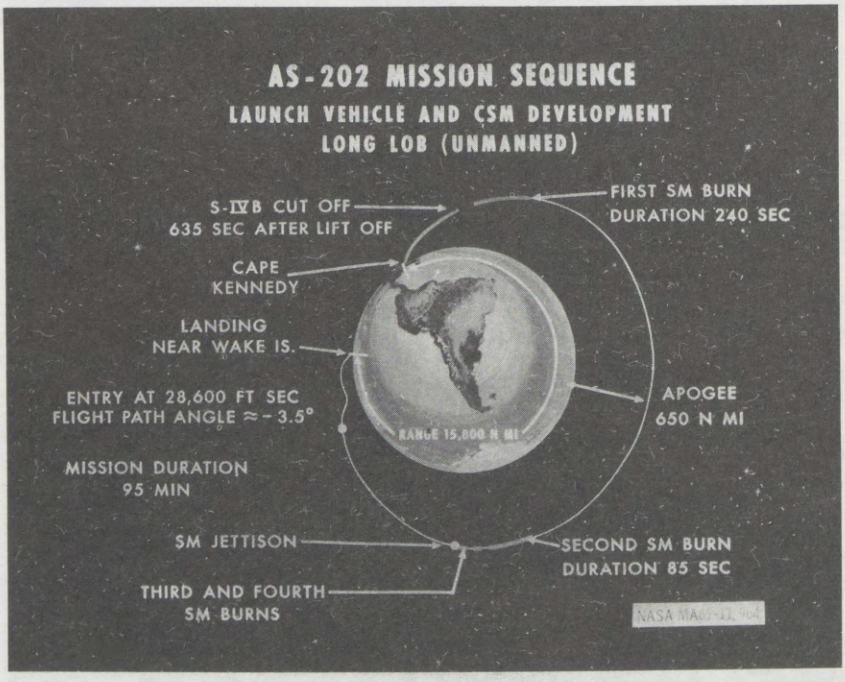

FIGURE 108

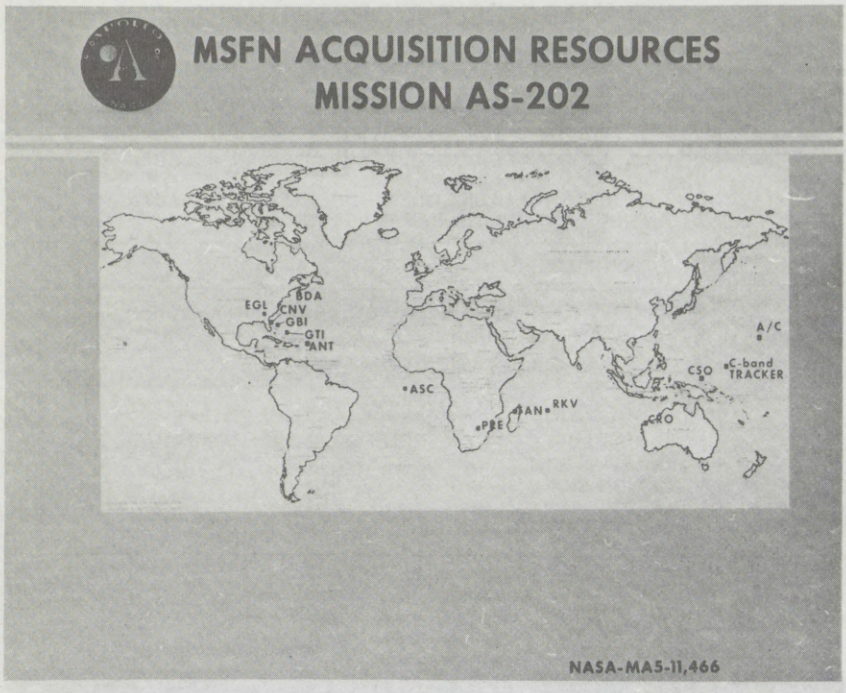

FIGURE 109

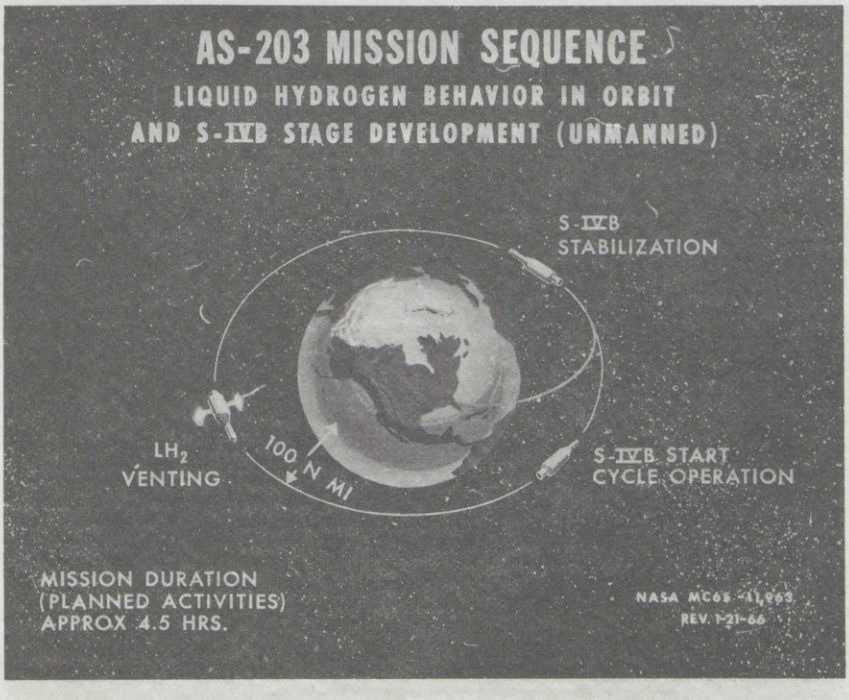

FIGURE 110



FIGURE 111

Manned Missions

Scheduled for 1967, the first Apollo Saturn I manned mission, (fig. 112), with a duration of up to 14 days, requires major augmentation of the network (fig. 113). On this mission, first evaluation and verification of the operation of the Unified S-band system will be conducted. This will be accomplished at Kennedy Space Center, Bermuda, Carnarvon, Guam, Hawaii, Guaymas and Texas. Two of the Apollo instrumentation ships will be available for support of this mission as well as the first Apollo instrumentation aircraft.

Here (fig. 114) is an artist's concept of an Apollo instrumentation ship. The next view (fig. 115) shows the status of completion of the first of these vessels in mid-November. This chart (fig. 116) illustrates the planned modification schedule for the first three Apollo instrumentation ships. Because of tight schedules, the recent decision to install communications satellite equipment will require close cooperation between the personnel responsible for the modification and those responsible for operational support.

Crew training

Crew training includes the training of Launch and Flight Controller Crews as well as astronaut Flight Crews. Launch crew training involves formal training for both Kennedy Space Center personnel and for support contract personnel in spacecraft, launch vehicle, and ground support equipment systems (fig. 117). Launch crew training includes individual study involved in blockhouse console training and many simulations, both in-house at Kennedy Space Center and in conjunction with the Manned Spacecraft Center.

Launch Crew Training

A good indication of what is involved in launch crew training is the amount of technical material with which launch crews must become familiar (fig. 118). The training is generally oriented toward general support with which launch crews must become familiar for specific missions.

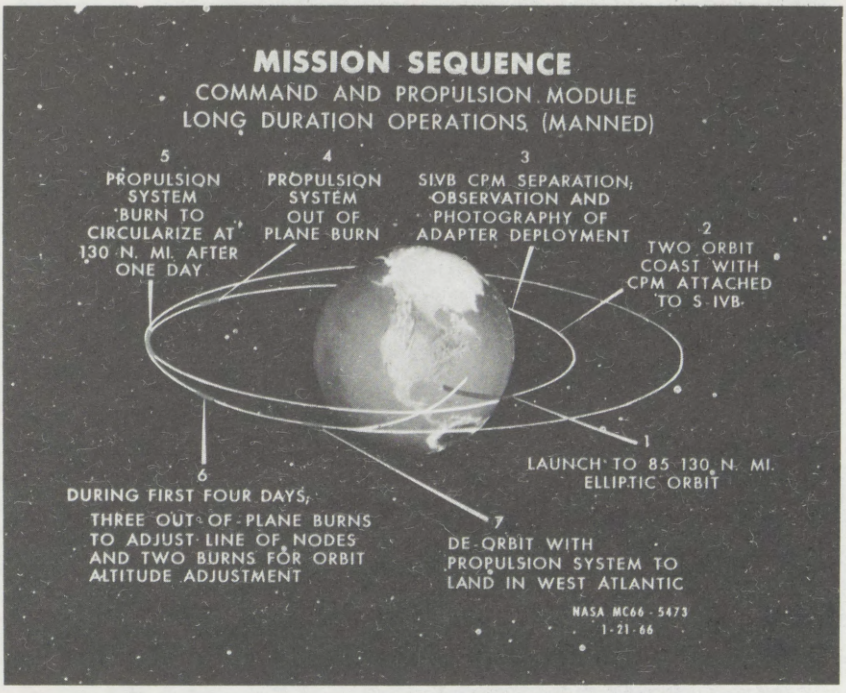

FIGURE 112



FIGURE 113

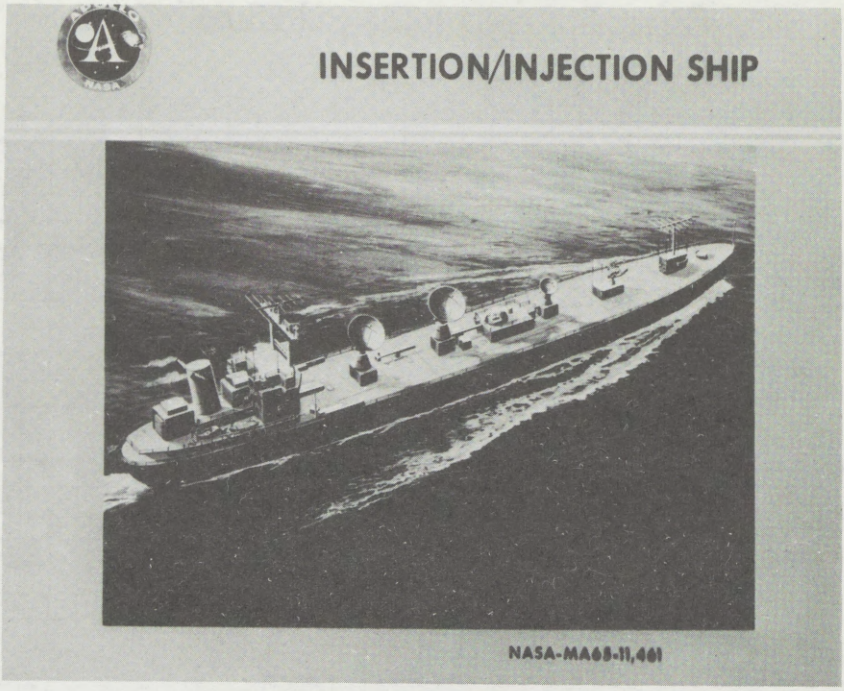

FIGURE 114

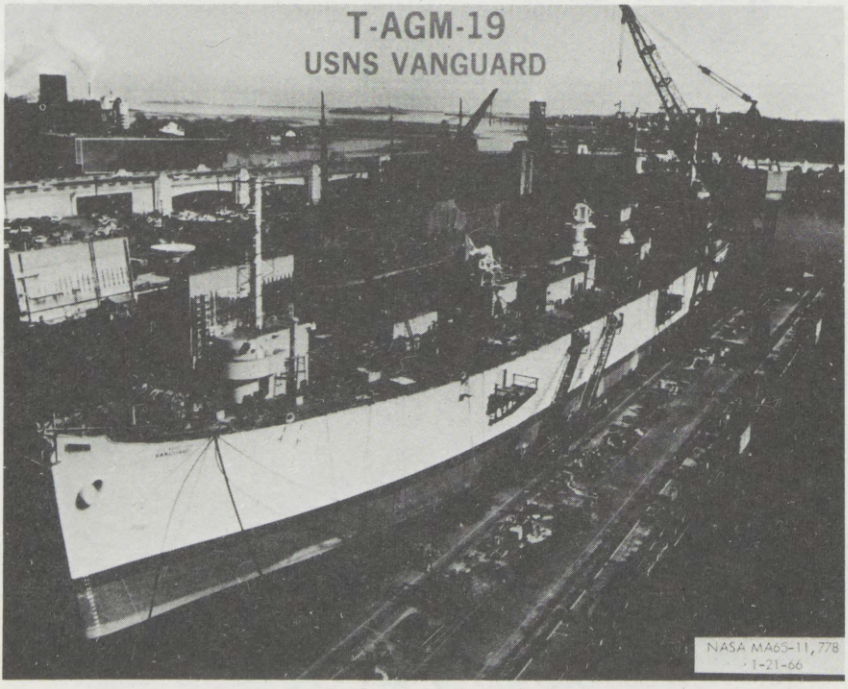

FIGURE 115

SHIP PLANNING SCHEDULE

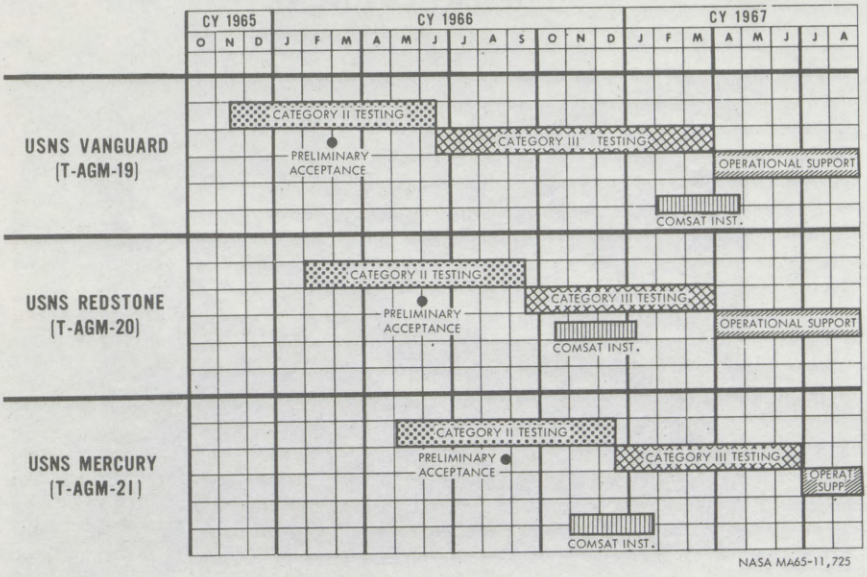

FIGURE 116

LAUNCH CREW TRAINING

- FORMAL TRAINING-FOR KSC AND SUPPORT CONTRACTOR PERSONNEL IN SPACECRAFT, LAUNCH VEHICLE AND GSE SYSTEMS
- INDIVIDUAL STUDY
- BLOCKHOUSE CONSOLE TRAINING
- SIMULATIONS

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FIGURE 117

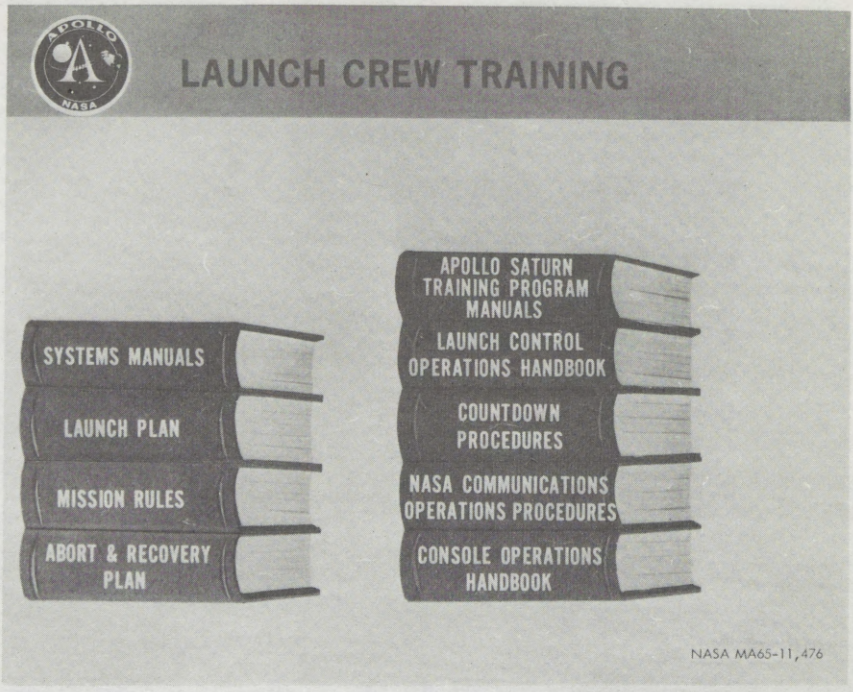

FIGURE 118

Recent launch schedule adjustments cause an overlap between preparations for AS–202 and AS203. By design, we had planned that the launch of AS–201, 202 and 204 would take place on Launch Complex 34 and that AS–203, which has a boilerplate spacecraft, would be launched from Launch Complex 37B. This essentially decouples these operations, and by having an overlap in checkout, permits us to get back on schedule with AS–204; however, this does require one and one-half launch crews to be able to carry out this simultaneous checkout. Therefore, we have a problem at Kennedy Space Center in the implementation of additional launch crew personnel.

Flight Controller Training

Flight Controller training follows a pattern similar to launch crew training with five principal training areas (fig. 119). These consist of systems knowledge, individual study, console training, confidence testing with the Simulated Checkout and Training System (SCATS), and finally, network simulations with all hands involved. Again we have technical information with which all of the Flight Controllers must be familiar, and specific documentation and support of specific missions as depicted here (fig. 120).

Flight Crew Training

Flight Crew training is a complicated and long duration program, as this chart shows (fig. 121). The average preselection requirement for astronauts who will probably be involved in our early Apollo program missions would be about 15 years. This includes their college training, their flight experience, their test pilot training, and their experience as test pilots.

After selection as astronauts, the flight crew go through a general training program which includes special academic training in astronautics and related technical subjects. They receive survival training on land and sea in various climates; environmental training in zero g and altitude chambers; and then a series of training in specific mission-oriented trainers.

FLIGHT CONTROLLER TRAINING

- SYSTEMS KNOWLEDGE
- INDIVIDUAL STUDY
- CONSOLE TRAINING – MCC-H
- CONFIDENCE TESTING
- SIMULATIONS

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FIGURE 119

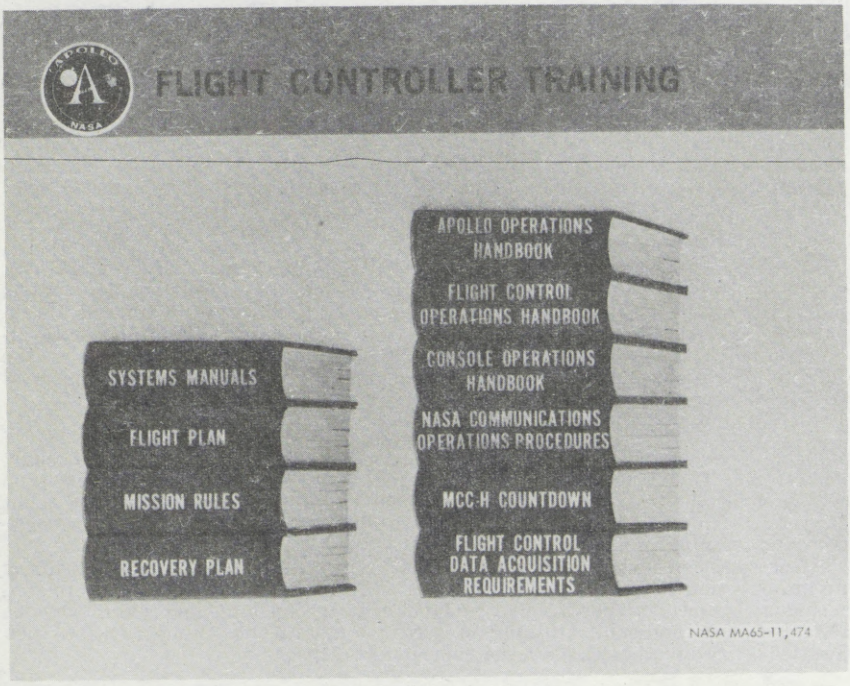

FIGURE 120

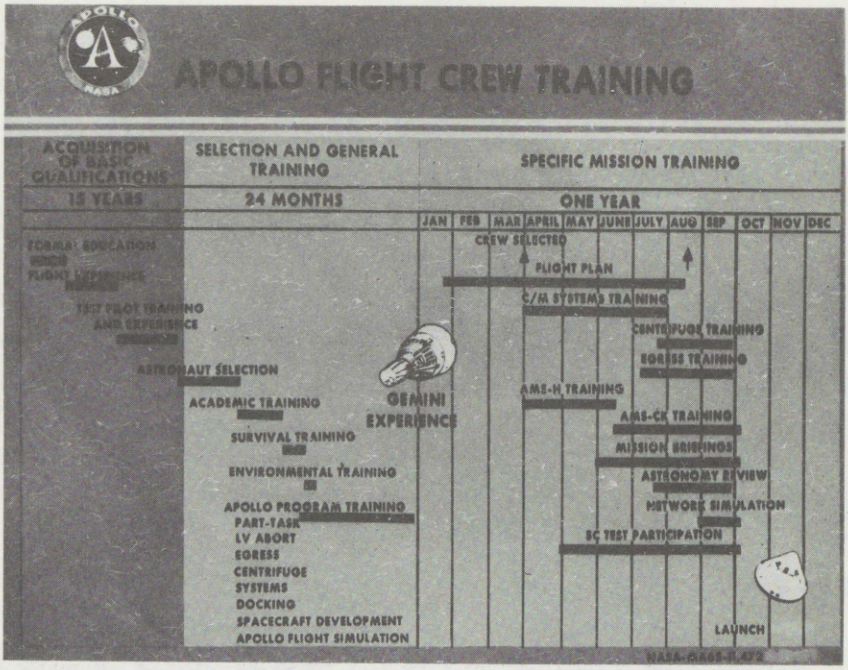

FIGURE 121

Summary

I can summarize Mission Operations by noting that our mission operations team has a solid year of experience and achievement behind them in carrying out the exacting tasks of the successful Gemini missions. These unique human resources will be brought to bear in the remaining Gemini flights and in the Apollo missions which follow. These comments also apply to our other mission operations resources such as the world-wide Manned Spaceflight Network, the Mission Control Center-Houston, the Apollo instrumentation ships and aircraft; and, finally, the recovery forces of the DOD. As we look ahead to the even more taxing demands of the Apollo missions, we can do so with confidence that our mission operations resources will be equal to the task.

ADVANCED MANNED MISSIONS STUDIES

Background

Over the past year, no area of the space program has received as much interest, study, and speculation as that of NASA's plans for future programs—or more specifically, "What will be the next major manned project after Apollo?" Referring to this impending answer, the Associate Administrator, Dr. Seamans, recently remarked that, "There is no dearth of imagination. What we must have is the courage and wisdom to judge selectivity among the many options we have before us."

Before going into these advanced manned programs, it might be of value to review briefly a few of the events of the past two years as background to highlight the interest that has been expressed in this area of NASA's space program.

In January 1964, the President sent a letter to Mr. Webb requesting that NASA review its future space exploration plans with the object of relating hardware and development to prospective missions and make a preliminary progress report. A letter from Mr. Webb to the President reported on NASA's planning for and evaluation of future space exploration up to that time.

This interim reply was followed on by another letter from Mr. Webb to the President, which forwarded a comprehensive document titled, "Summary Report, Future Programs Task Group." This report presented the results of

studies made during 1964 to answer the inquiries made by the President in his letter of January 30, 1964. Alternative programs were presented in much detail. However, no criteria were given as to how a selection would be made nor was it practicable to provide meaningful cost information to relate to the various projects presented. In this regard, the last paragraph of Mr. Webb's letter stated: "More than in most areas, major decisions on space require a broad concensus. During the next several years it is likely that the selection of major new space missions will be the subject of serious study and debate by many individuals and agencies in public and private walks of life."

Last summer, the interest and concern of the Congress were evidenced in the matter of exploring the reaons for the absence of a decision regarding the next major manned program. Hearings which have since been published were held in August by the Senate Committee on Aeronautical and Space Sciences on the subject of national space goals for the post-Apollo period. In September, a presentation on this same subject was made by NASA to the staff of your Subcommittee on NASA Oversight. The resulting staff study is one with which I am sure you are familiar.

Now we have made decisions for the immediate future in Apollo Applications as I have already mentioned. We are also continuing on a daily basis to develop the vast amount of information which will be needed to make that important decision to which Mr. Webb and Dr. Seamans referred, the selection of major new space missions. The information which NASA is developing as a basis for such decisions is the subject I would like to discuss with you now.

Evolution of Future Program Planning

Program Evolution Alternatives

In our quest for the best possible recommendation for the next major manned program, we have examined five major program alternatives. While they do not exhaust all possibilities, these program alternatives do cover the major candidate approaches which might be considered within the context of the NASA charter. The next chart (fig. 122) shows the tabulation of these alternatives according to the primary objective of each, and the program emphasis which would be required to achieve the primary objective.

MSF PROGRAM ALTERNATIVES

PROGRAM ALTERNATIVE	PRIMARY OBJECTIVE	PROGRAM EMPHASIS
1	DIRECT ECONOMIC BENEFITS	EXTENSIVE EARTH ORBITAL ACTIVITIES
2	LUNAR EXPLORATION & SCIENCE	EXTENSIVE LUNAR OPERATIONS
3	PLANETARY EXPLORATION & SCIENCE	EARLY PLANETARY LANDINGS
4	MAXIMUM EFFORT	PREEMINENCE IN EARTH ORBITAL, LUNAR, AND PLANETARY ACTIVITIES
5	* BALANCED PROGRAM	BEST BALANCED PROGRAM BASED ON NATIONAL CAPABILITY

NASA MT 5-9591

* COST-EFFECTIVE COMBINATION OF ECONOMIC BENEFITS, LUNAR & PLANETARY EXPLORATION, AND SCIENCE.

FIGURE 122

Let us now look at the likely evolutions of these alternative programs. We have displayed a large selection of Manned Space Flight program alternative on this chart (fig. 123). The basic figure is divided into three broad horizontal strips. The upper one represents lunar activities aimed ultimately at lunar exploration; the center part represents Earth-orbital activities aimed largely at Earth-oriented applications; and the lower area shows planetary program activities aimed at planetary and solar system exploration. As can be seen; we are starting with Apollo, followed by Apollo Applications. Both programs cover both lunar and Earth-orbital areas. This is a major but short range thrust for the next few years and represents our bridge to the more advanced space systems.

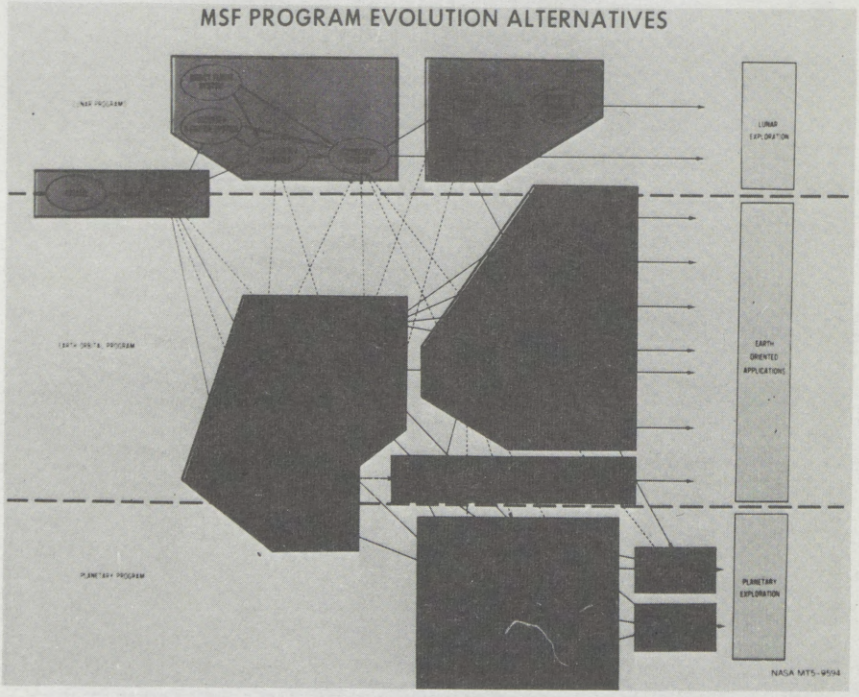

FIGURE 123

Direct Economic Benefits

Shown here (fig. 124) are the development steps which would be taken for the first program alternative, in which emphasis is placed on direct benefits to mankind. In this alternative, large emphasis is given to the Earth-orbital activities. These activities start with the Apollo and Apollo Applications, leading to development of an orbital station with suitable logistics capability as well as longer duration communications power and life support systems. An applications center and research facility are next, leading to a resources inventory station, a communications station, and a capability for enhancing national security. In addition, ultimately an improved point-to-point Earth transportation system would also be developed.

Lunar Exploration and Science

The second alternative (fig. 125) emphasizes lunar exploration and science. Because of the specific area of program emphasis in this alternative, the program consists of almost the complete lunar program evolution.

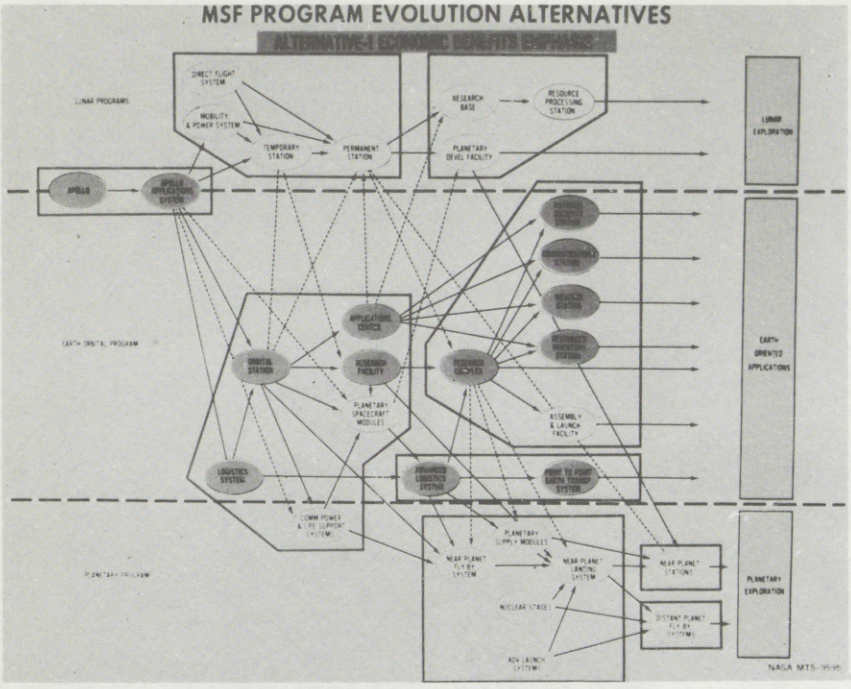

FIGURE 124

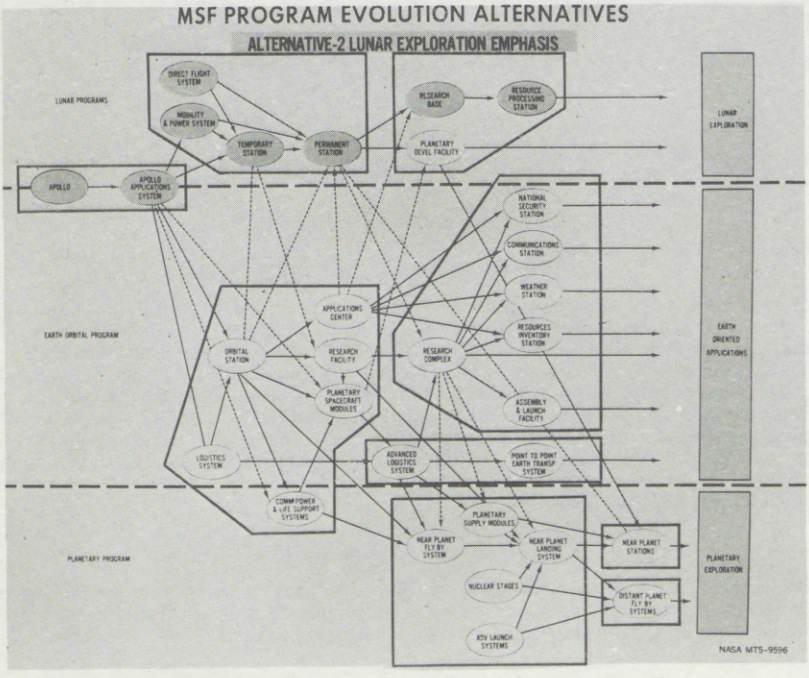

FIGURE 125

Planetary Exploration

The third alternative (fig. 126) is based on planetary exploration emphasis. Here again, Apollo Applications lead us to the planetary activity. However, you will note that it is essential to utilize the orbital station and a suitable logistic system in order to be able to have the communications, power, and life support subsystems necessary for the eventual development of suitable planetary spacecraft modules.

Independent of the planetary program, early support from the Earth-orbital program is required. In this particular early planetary emphasis program, we have considered flybys past the planet Venus in 1975 and past the planet Mars in 1978. Later manned landings on Mars are seen in the early 1980s.

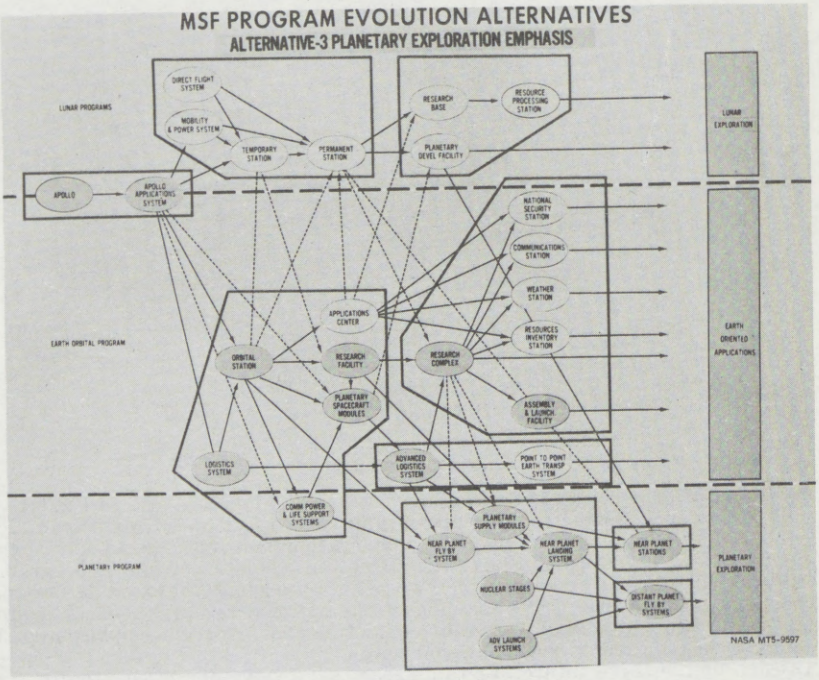

FIGURE 126

Maximum Effort Program

Finally, we have the approach to the fourth and fifth alternatives (fig. 127). The principal differences between these last two and the previously discussed program evolution alternatives will be timing and program emphasis.

In the case of the maximum effort program, timing is critical; being able to perform certain activities early and, in particular, earlier than other nations, becomes an important factor. In fact, it might be inferred that because of these timing pressures, a maximum effort program would not be the most efficient program nor would it lay the strongest base for achieving ultimate national objectives.

In this program the orbital station is assumed to be operational in 1972, the lunar station in 1974, flybys of the planets Venus and Mars are accomplished in early 1970's and an Earth-orbital research facility and applications center would be operational in the late 1970's. The ultimate goal of the program is a Mars manned landing which would occur about 1980.

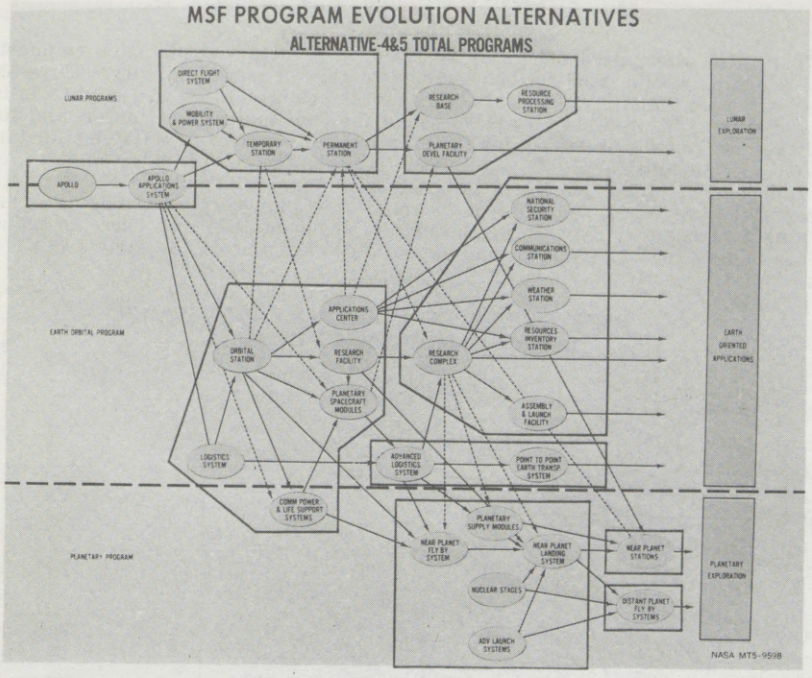

FIGURE 127

Balanced Program

In the case of the balanced program, we are seeking the best cost-effective combination for achieving the benefits of alternatives 1, 2, and 3; namely, direct benefits to mankind lunar and planetary exploration, and scientific advancement. Here we would be supporting activities over the whole spectrum of programs as illustrated. It is a program which we believe bears careful examination and scrutiny in terms of the best allocation of our national resources. Such a program would require a high degree of control so that program emphasis could be shifted as required to meet national needs.

In each of the three future program areas that I have discussed—the Lunar, Earth-Orbital, and Planetary areas—we have been conducting numerous studies. We have shown progress in these studies, and plan further accomplishment in the next fiscal year. I will now mention briefly the status of each area of study.

Earth orbital program studies

Study Categories

The first major area of studies is that devoted to Earth-orbital missions, as shown by this chart (fig. 128). The three fundamental study categories in this area are those related to mission identification and experiment support, those directed toward specific space station configurations, and those directed at definition of the ferry and logistic systems which would resupply Earth-orbital space stations.

Studies Completed to Date

This chart (fig. 129) which I showed before illustrates the broad spectrum of Earth-orbital systems which have been under study for some time. The early Apollo orbital research laboratory concept was the forerunner of the present Apollo Applications laboratory-configured LEM. The manned orbiting research laboratory (MORL) concept envisages a spacecraft which would be launched on the improved Saturn I, unmanned, and would be manned and resupplied by Apollo spacecraft launched on separate vehicles. The large rotating orbiting

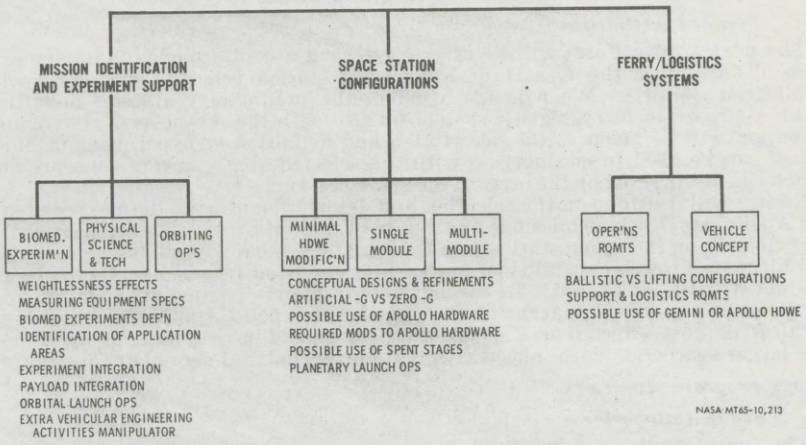

FIGURE 128

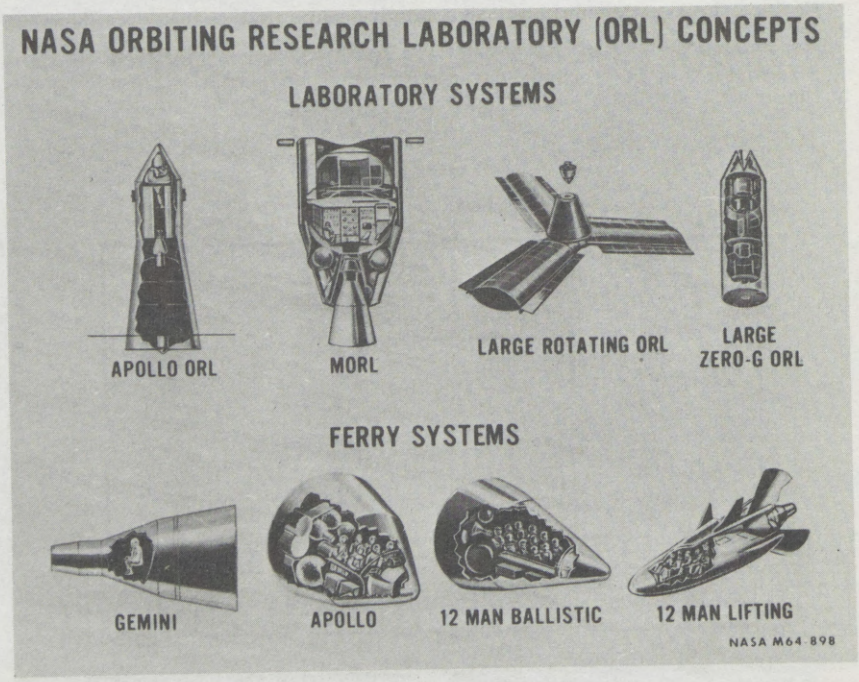

FIGURE 129

laboratory providing a simulated gravity environment, or the large zero gravity laboratory, would require a Saturn V launch vehicle to provide adequate payload capability. Related to these laboratory systems are a number of ferry and logistic systems based on the Gemini or Apollo command modules or increased sized Apollo spacecraft larger ballistic systems, and lifting-body systems.

Planned Activities

The next study efforts will be directed toward a continuing preliminary systems definition of the most promising space station concepts for post-Apollo applications efforts. We will also conduct the preliminary systems definition of an appropriate ferry/logistic system for use with these concepts. Particular attention will be given to the description and definition of experiment modules which can be used in conjunction with the selected space station concepts and which can be operated by the crew of the space station.

Efforts will continue on the selection and description of candidate experiments for Apollo Applications missions and for advanced missions. The ampact of the experiments on the space station and the logistic system will be assessed. Also, the ultimate growth capability of such a space station into a planetary mission module will be considered. In the next study efforts particular attention will be given to the determination of the time when Apollo Applications missions, because of cost effectiveness considerations, should be supplanted by a new and larger spacecraft with inherently greater experimental man-hour capabilities.

Lunar program studies

Study Categories

The lunar studies can be divided into four basic categories, as shown here (fig. 130). The categories of studies are those to derive mission requirements, those directed toward lunar exploration systems, those related to transportation systems, and those to evaluate the supporting operations.

Studies completed to Date

We have broken down the mission requirements studies into specific study areas.

The studies in a given fiscal year are based on the results from previous studies and result in recommendations for follow-on activities. For example, in the area of simulation of surface explorations, we are now undertaking the

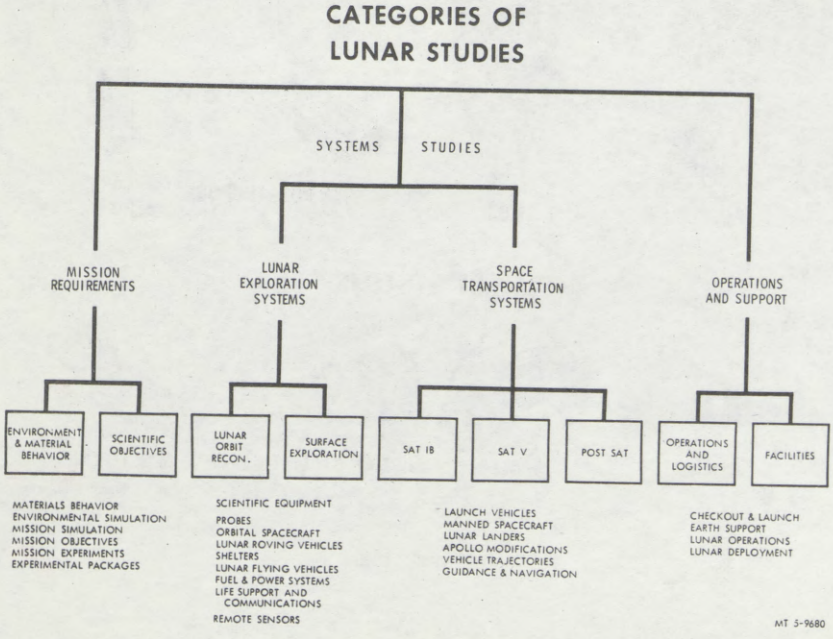

FIGURE 130

third year of activity by the U.S. Geological Survey at Flagstaff, Ariz. to understand the many complex implications of operating in the Moon's environment.

Each year's activity increases in operational complexity and extends the operational capability of the systems being utilized. Similar study efforts have defined various scientific instruments and have examined the degree to which the various advanced systems support the specified scientific objectives.

Planned Activities

The next study efforts will emphasize the definition of an extended lunar exploration program plan and the accompanying conceptual designs. Our comparative evaluation of shelter concepts, mobility concepts, and various modes of payload delivery to the lunar surface will be combined with the recommendations of the scientific community, e.g., the Falmouth Conference in July 1965, to formulate a comprehensive lunar exploration program. We will also obtain the preliminary definition of the necessary systems concepts. In addition, this work will provide the essential basis for future decisions concerning the intiation of program definition for an advanced lunar exploration system. This advanced system can be used to conduct effective exploration of the Moon after the scientific exploration requirements exceed the capabilities of the Apollo Applications system.

Planetary program studies

Study Categories

The third area of advanced manned mission studies is concerned with possible manned missions to planets of our solar system. This chart (fig. 131) indicates the breakdown of planetary mission studies into the three areas of mission requirements, systems studies, and operations and support. Mission requirements studies are focused on two general types of missions. The types are capture missions, in which the spacecraft could orbit the target planet and perhaps send a landing vehicle down to the surface; and flyby missions, in which a landing is not attempted. The chart also shows the breakdown of systems studies into concepts for these respective types of missions.

Studies Completed to date

Manned missions to the near planets are summarized on this chart (fig. 132) which we have shown you previously also, but which is basic to analyzing some aspects of the planetary exploration problem. The top circles indicate the opportunities for Mars missions and the lower circles indicate the opportunities for Venus missions. These missions are based on optimum location of the target planet with respect to the Earth to minimize the performance requirements and mission duration.

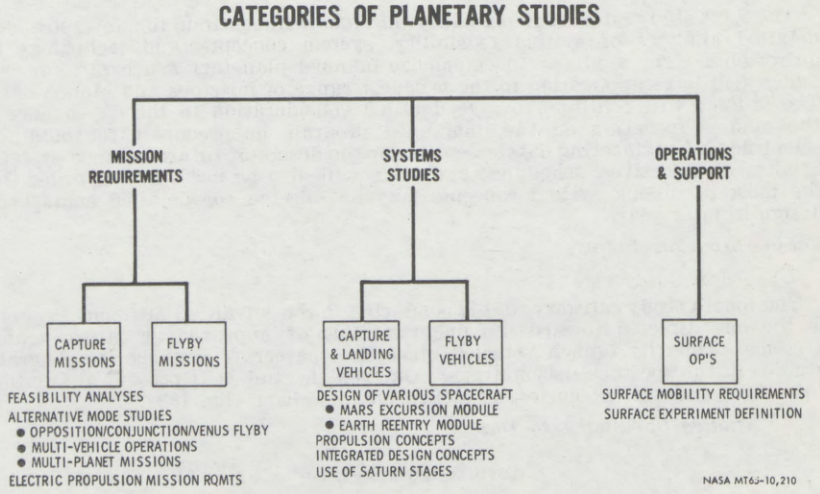

FIGURE 131

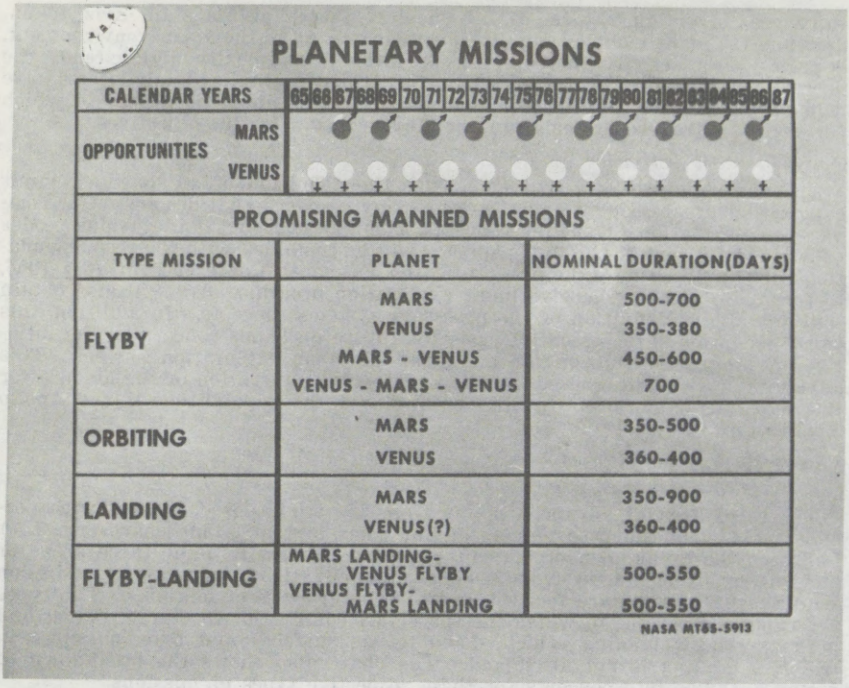

FIGURE 132

A summary of promising manned missions which have been investigated is shown at the bottom of the chart. It is apparent that the shortest missions, whether we are considering flyby, orbital or landing missions, require on the order of one year, and the longer missions may require as long as two or three years. These flight times are longer than our proposed Apollo Applications Earth-orbital mission capability by a factor of ten.

Planned Activities

The next study efforts for planetary missions will continue to emphasize more detailed analysis of system feasibility, system concepts, and technology requirements. The studies will emphasize manned planetary spacecraft concepts which will have application to the broadest range of missions and launch dates. The studies will continue to give detailed consideration to the dependence of the manned program on the unmanned program as precursor for obtaining scientific nad engineering data essential for the design of future manned systems. Studies of objectives, schedules, and costs will also be necessary in order that the most promising system concepts may be selected for detailed engineering design in later years.

Vehicle program studies

Study Categories

The fourth study category that is conducted in the Advanced Missions Program is the one directed toward the understanding of improved or future vehicle systems, primarily launch vehicles, since the spacecraft systems are generally studies in the specific misison areas. Our vehicle studies at present are divided into three general categories, as shown on this chart (fig. 133).

Studies Completed to Date

Saturn V System Studies

The tabular listing shown on this chart (fig. 134) outlines the principal techniques for major performance gains being considered in Saturn improvement studies.

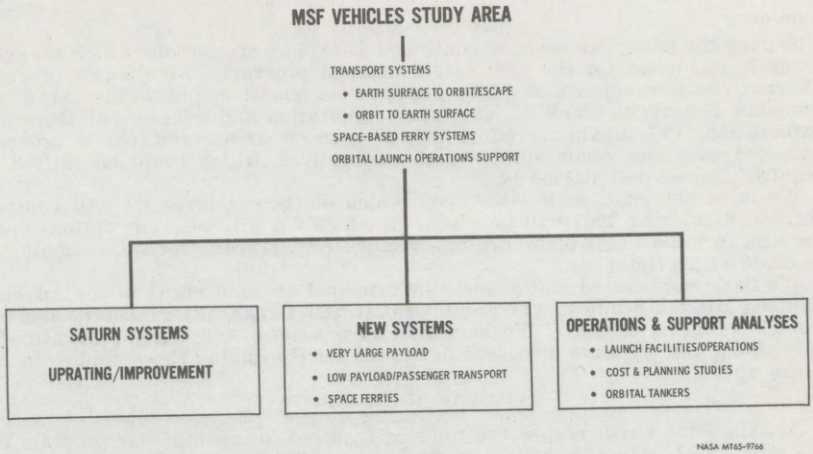

FIGURE 133

SATURN VEHICLES UPRATING/IMPROVEMENT TECHNIQUES

GENERAL CATEGORIES — INCREASED SIZE; INCREASED EFFICIENCY

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	FIRST STAGE	SECOND STAGE	THIRD STAGE
PROPULSION SYSTEM & PROPELLANTS	• UPRATED, F-1 • TOROIDAL F-1 • ADDITIONAL ENGINES • FLOX	• UPRATED J-2 • TOROIDAL J-2 • ADDITIONAL ENGINES • ADVANCED ENGINE • FLOX	• UPRATED J-2 • TOROIDAL J-2 • ADVANCED ENGINE • FLOX
VEHICLE STAGE	• INCREASED LENGTH (PROPELLANT LOADING) • BOOST - ASSIST UNITS (SOLID OR LIQUID) • ZERO STAGE • NEW SOLID STAGE • REDUCED INERT WEIGHTS	• INCREASED LENGTH (PROPELLANT LOADING) • REDUCED INERT WEIGHTS	• INCREASED LENGTH (PROPELLANT LOADING) • REDUCED INERT WEIGHTS

MT5-9673

FIGURE 134

Reusable Systems Studies

A prime objective of the Reusable Transport studies has been the evolution of a second generation aerospace transportation system that could provide routine earth surface to orbit and return transportation for passengers and cargo.

Planned Activities

Studies of potential launch vehicles to support Earth-orbital, lunar, and planetary manned missions will be conducted. These vehicle systems studies will emphasize preparation for system definition of improved Saturn vehicles as well as study reusable airplane-type transport concepts. Studies of the operational and support facilities for these potential improved and new vehicles will also be conducted.

Summary

During the past year we have continued to explore the options which are open to us in our quest for the next major manned program. Five major program alternatives were discussed. The alternatives placed emphasis on (1) direct economic benefits to mankind, (2) lunar exploration and science, (3) planetary exploration, (4) maximum effort in all program areas, and (5) a program balanced over the whole spectrum of alternatives, which could be shifted as required to meet national needs.

We have not made a decision upon which of these courses we will embark. Rather, fiscal year 1967 will be a year in which we will keep our options open, keeping in mind our Administrator's remark that "future decisions should not be made with a timid hand."

We have enumerated and defined the principal areas of effort in our Advance Manned Mission Studies: (1) Earth Orbital, (2) Lunar, (3) Planetary and (4) Vehicle program studies. We have described some of our accomplishments in this effort, and we have discussed our plans for continuing these studies in the years ahead.

FUNDING REQUIREMENTS

At this point I will review the funding required to continue our program for the next fiscal year (fig. 135). In fiscal year 1967 Manned Space Flight will require a total of $3,405.4 million for Research and Development, Construction of Facilities and Administrative Operations.

Research and development

Research and Development requirements are identified in the three Manned Space Flight Programs—Gemini, Apollo and Advanced Manned Missions—for a total of $3,022.8 million.

Gemini

In Gemini, requirements decline again for the third year, from a peak requirement of $418.9 million in fiscal year 1964 down to $308.4 million in fiscal year 1965, to $226.6 million for fiscal year 1966, to our current request of $40.6 million

NASA
MANNED SPACE FLIGHT
FY 1967 BUDGET ESTIMATE
(MILLIONS OF DOLLARS)

	FY 1965	FY 1966	FY 1967
RESEARCH AND DEVELOPMENT	$2,949.0	$3,204.0	$3,022.8
GEMINI	308.4	226.6	40.6
APOLLO	2,614.6	2,967.4	2,974.2
ADVANCED MISSIONS	26.0	10.0	8.0
CONSTRUCTION OF FACILITIES	199.8	21.4	54.4
ADMINISTRATIVE OPERATIONS	281.2	295.5	328.2
TOTAL	$3,430.0	$3,520.9	$3,405.4

MP66-5157
1/14/66

FIGURE 135

for fiscal year 1967. These funds will provide for the final hardware deliveries and support the last Gemini flights.

I think you will agree that our investment in Gemini has successfully validated the operational concepts and developed the skills and techniques such as long-duration flights, extravehicular maneuvers, rendezvous, and controlled reentry that are the prerequisities to even more complex space activities.

Apollo

As I indicated last year, fiscal year 1966 Apollo funding is supporting an intensive ground development test program at the subsystem level. The current budget request continues ground development testing of the Apollo spacecraft modules and Saturn launch vehicle stages and also provides for an intensification of ground and flight qualification testing in preparation for manned missions. Our total Apollo program requirements for fiscal year 1967 are $2,974.2 million.

Spacecraft

The Apollo spacecraft modules are currently undergoing a critical period of development and qualification testing on the ground in preparation for flights of the uprated Saturn I (Saturn IB) and the Saturn V. The first unmanned flights on the uprated Saturn I will begin in calendar year 1966 and will be followed by manned missions in Earth orbit during calendar year 1967. Unmanned flights on the Saturn V launch vehicle will also begin during 1967 and manned flights are planned for 1968. Funding of $1,200.6 million is requested in fiscal year 1967 to support this effort.

Saturn I

Moving on the the Saturn-class launch vehicles, $216.4 million are required for the uprated Saturn I for the fiscal year 1967. Unmanned missions will be conducted this year, leading to manned missions in Earth orbit during calendar year 1967. The fiscal year 1967 funds will support a heavy production, test, and checkout effort to bring the uprated Saturn I launch vehicles to flight readiness.

Saturn V

We are requesting $1191.0 million in fiscal year 1967 for the Saturn V. These funds support a critical period of continued ground testing, both development and qualification, and the first Saturn V launches from Launch Complex 39 at Kennedy Space Center. Dynamic testing of the entire Apollo Saturn V space vehicle, including the three stages, the instrument unit, and the spacecraft, will be conducted at Marshall Space Flight Center. Static testing of 1st and 2nd stages will be conducted at the Mississippi Test Facility and 3rd stage testing will be continued at the Sacramento Test Facility site in preparation for shipment to Kennedy Space Center. These funds will also provide for a vigorous qualification test program on the 2nd stage of the Saturn V. Fiscal year 1967 will be the peak year to date for production and delivery of Saturn V vehicles.

In fiscal year 1967, funds provide for completion of the structural, dynamic, and Launch Complex 39 checkout ground test programs. In addition, the first flight stages will be readied for launch at Kennedy Space Center.

Engine Development

Funds in this project, for which we are requesting $111.0 million in fiscal year 1967, provide for the development of engines to be used for Saturn vehicles. Procurement of the engines is funded under the appropriate launch vehicle project. In addition to H–1 engine field support, the fiscal year 1967 estimates provide for F–1 component qualification and related engineering support, and qualification of an uprated J–2 engine. Extensive ground testing of both the F–1 and J–2 will also be conducted during fiscal year 1967.

Mission Support

Mission support requirements in fiscal year 1967 are $255.2 million. These funds cover the overall launch, flight, crew, and recovery operation; program-wide systems engineering; supporting development necessary for the successful accomplishment of manned space flights; and Apollo Applications.

Operations include the activation and operation of preflight and launching facilities, mission control, flight crew training and actual flight operations,

including recovery. The fiscal year 1967 funding provides for the extension and expansion of the operational activities provided in fiscal year 1966 and is inconsistent with the completion and activation of Apollo Saturn V and increasing frequency of flight missions.

Advanced Missions

The objective of the Advanced Missions program is to examine advanced manned space flight mission concepts. Our fiscal year 1967 request for this program is $8.0 million. Specific areas of investigation include manned Earth-orbital, lunar, and planetary missions, as well as lunar vehicles studies.

Administrative Operations

The total Manned Space Flight Administrative Operations requirement for fiscal year 1967 is $328.2 million. These funds will provide for the operation of the three Manned Space Flight Centers: the George C. Marshall Space Flight Center at Huntsville, Alabama; the Manned Spacecraft Center at Houston, Texas; and the John K. Kennedy Space Center, Kennedy Space Center, Florida.

The John F. Kennedy Space Center requires $98.1 million for fiscal year 1967. These funds will provide for 2,796 civil service employees and other operational costs.

The Manned Spacecraft Center at Houston, Texas, requires $98.2 million for fiscal year 1967. The funds will be utilized for the personnel cost of 4,866 civil service employees and other operational costs.

The Marshall Space Flight Center will employ 7,390 civil service personnel at Huntsville and the other three MSFC locations. To operate the Center and provide for the compensation of the staff, $131.9 million will be required in fiscal year 1967.

The need for greater administrative support at the Manned Space Flight Centers in fiscal year 1967 is related principally to the increased number of manned flights scheduled and the resultant increase in activity at MSC and KSC. This change in pace is most pronounced at KSC where we are providing common support, supplies and materials to the many NASA contractors at that location. The activities of these hardware contractors are being accelerated as additional facilities become operational and more of the Apollo program effort is carried on at KSC. A portion of the common support provided to stage contractors at KSC, as well as the institutional support at the other two Centers, is provided through contracts with commercial firms.

Also associated with the increased activity at KSC and MSC are the additional man years of effort required in the launch and flight operations areas at these two Centers. These are the requirements which I previously covered in my discussion of manpower. The additional man years required, plus the cost of the civil service pay raise for a full year account for increased personnel costs.

Construction of facilities

The total funding requirement for Manned Space Flight Construction of Facilities for fiscal year 1967 is $54.4 million.

During the past five years, we have accomplished an orderly buildup of facilities to achieve our space objectives. Significant accomplishments have been made in the construction of facilities for the development, fabrication, test, checkout and launch of manned space vehicles.

At Cape Kennedy where checkout and launch of our space vehicles is conducted, this year's progress assures that the facilities will be ready for the Saturn V launch program.

At the Manned Spacecraft Center at Houston, most major facilities are completed. Spacecraft development and astronaut training will continue in line with program schedules. Facilities at MSC progressed satisfactorily. The Lunar Module engine test facilities at White Sands Test Facility are complete and operational.

At the Marshall Space Flight Center, the Michoud Assembly Facility in New Orleans and the various plants and facilities for vehicle and engine development, manufacture and test, we are in a fully operational status. Significant progress has also been made at the Mississippi Test Facility during the past year so that the facility will move from the construction and activation stage to actual operation during the current year.

Kennedy Space Center

Accomplishments in construction during the past year at Kennedy Space Center peaked with the completion of more than 25 significant facilities projects. During this period, the Launch Complex 39 Vehicle Assembly Building was structurally topped out; all three Launch Umbilical Towers were erected and structurally completed; the Launch Control Center was completed with two firing rooms occupied; and the furnishing and outfitting of two low bays in the Vehicle Assembly Building was accomplished (fig. 80, see p. 107). PAD A and the Crawlerway were completed (fig. 78, see p. 106); the ordnance storage building and an instrumentation building were also completed.

Major facilities not associated with Launch Complex 39 which were completed include Launch Complex 34 for the uprated Saturn I (Saturn IB), Range Instrumentation Sites, and the Apollo Static Test Facility for spacecraft engine checkout (fig. 136). Hypergolic Building No. 2, Cryogenic Building No. 2, the Central Instrumentation Facility and the Flight Crew Training Building, the Launch Equipment Shop, Vehicle Maintenance and Service Facility and Extension to Central Supply Facility also were completed. Other completions include the Base Operations Building, the 3rd floor addition to the Operations and Checkout Facility, KSC Headquarters Building and significant sections of railroads, roads and other major utilities.

Through the remainder of this calendar year, we have scheduled the activation of Launch Complex 37 for the uprated Saturn I, the first and second High Bay in the Vehicle Assembly Building, and the Mobile Service Structure (fig. 137). Other activations include the Cryogenic Test Building No. 2, Hypergolic Test Building 2, the propellant systems for both PAD A and PAD B, and both Crawler-Transporters.

In summary, major facilities will be complete by the end of the year, and a launch capability will be available on Launch Complex 39.



FIGURE 136

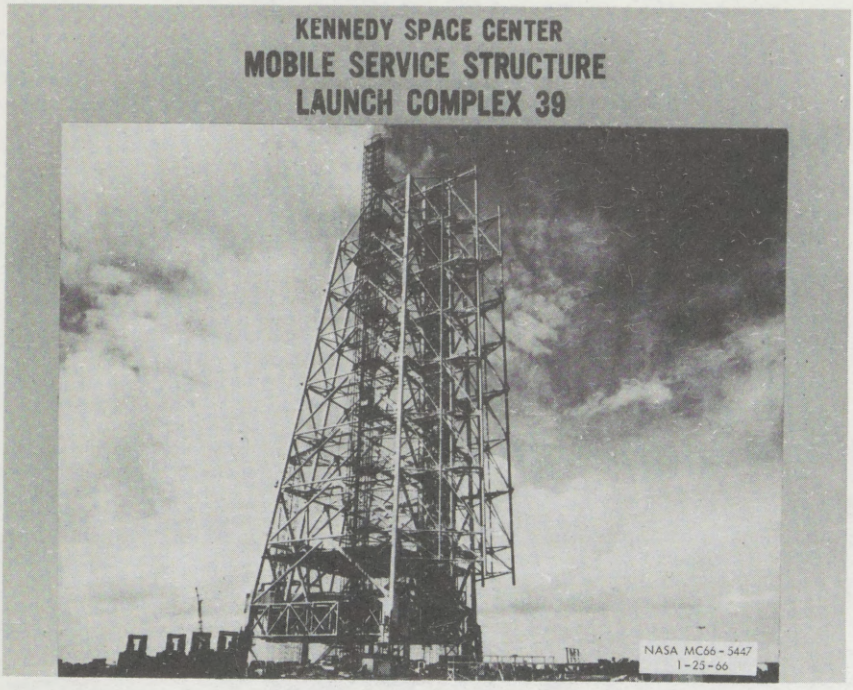

FIGURE 137

For fiscal year 1967 at Cape Kennedy we are requesting funds to continue outfitting of all elements of Launch Complex 39 which are required to perform assembly, checkout and launch of the Apollo Saturn V mission; a project for an extension to the Central Supply Complex to provide necessary storage facilities; and an addition to the KSC Headquarters Building which will provide urgently required space for personnel. Finally, we are requesting funds for the continued development and completion of the Merritt Island Launch Area utility system by additions to the electrical distribution and communications systems.

Manned Spacecraft Center

The orderly buildup of construction at the Clear Lake Site near Houston continued to a point where most major facilities were completed (fig. 70, see p. 100).

The Mission Control Center Houston was used as backup to the Mission Control center at Cape Kennedy during the Gemini III flight in March, and became completely operational commencing with the Gemini IV flight in June 1965. Other facilities that became operational during 1965 included the Thermochemical Test Complex, the Mission Simulation and Training Facility, the Anechoic Test Chamber Building and Antenna Test Range, the Acoustic Test Laboratory, and the Contractor Support Facility.

Additional major milestones occurring during 1965 were award of contracts for the Project Engineering Facility, the addition to Central Heating and Cooling Plant, the Electronic Systems Compatibility Facility, the Ultra-High Vacuum Space Chamber Facility, the Technical Services Facility, and the Lunar Mission and Space Exploration Facility. These facilities are all scheduled to be completed during 1966. The Crew Systems Facility, currently under construction

also will be completed. The Flight Acceleration Facility and the Environmental Testing Laboratory are scheduled to become operational during the first half of the current year.

For the fiscal year 1967 program at the Manned Spacecraft Center we are requesting a Lunar Sample Receiving Laboratory which will house all activities and functions pertinent to receipt, processing, and distribution of samples of lunar materials, as well as the quarantine of lunar exploration teams and spacecraft. Also in our fiscal year 1967 request is a facility to provide space and supporting facilities for an additional Command Module simulator, and a Lunar Module simulator. We are also requesting a new Engineering Building in order to improve a critical shortage of engineering and administrative space. Finally, our fiscal year 1967 request includes a project for additions to the existing heating, air conditioning and electrical system which are consistent with the development of the Center.

White Sands Test Facility

During 1965, construction of the Lunar Module Test Facilities was carried to completion at White Sands Test Facility (fig. 76, see p. 104). Facilities are thus available for testing the ascent and descent engines, with an environmental simulation capability available on two of three test stands. The White Sands Test Facility now has the capability for developmental testing of all spacecraft propulsion elements (fig. 77, see p. 105).

There are no fiscal year 1967 requests for this location.

Marshall Space Flight Center

At the Marshall Space Flight Center, several major milestones were achieved which provide a permanent base for continued development in support of Manned Space Flight Programs. Facilities completed and placed in operation during the year included the Saturn Static Test Facility for the first stage of Saturn V (fig. 66, see p. 97); the Liquid Hydrogen Facility; modification of West Side of Static Test Stand for F–1 Engine developmental testing and the Acoustic Model Test Facility. Other facilities in this category were the Hazardous Operations Laboratory; Hanger for Vehicle Components and Assembly Station; addition to the Test Support Shop; Project Engineer Office; addition to the Computation Division Building; and a significant portion of Utility Installations, including the completion of the Saturn V Road to the Barge Dock.

Also completed and placed in operation were the Component Test Facility, Advanced Saturn GSE Test Facility, and that portion of the Saturn Support Test Area which includes the addition to the Components Support Building and the Acoustic Control and Communications Center. In addition, the F–1 Engine test stand which was completed in 1964 was placed in operation.

Work now under contract and to be completed by June of this year includes such major facilities as the Acceleration Test and Calibration Facility; additions to the Components Test Facility and the Saturn V Ground Support Equipment Test Facility; expansion and modernization of High Pressure Gas and Propellant Systems, modernization of Instrumentation and Control Systems in the East Area, extension to the Propulsion and Vehicle Engineering Laboratory, and utility installations for these facilities.

For fiscal year 1967 the only Marshall Space Flight Center project in our program is the Hazardous Operations Laboratory, which will provide additional capability for the development and evaluation of accurate and reliable in-flight instrumentation.

Michoud Assembly Facility

During 1965 at Michoud Assembly Facility in New Orleans, where the Saturn I and Saturn V first stages are manufactured we completed the construction necessary for a fully operational plant (fig. 69, see p. 99). Facilities completed during the year were Road and Airstrip Rehabilitation, and Parking and Security Improvements. In addition, the Hydrostatic Test and Cleaning Facility and the Vertical Assembly Facility became operational. Soon to be completed are the Vehicle Component Supply Building, the Contractor Service Building, Extension to the Marine Dock and improvements to the Storm Drainage System.

For our fiscal year 1967 program, we are requesting approval of a project to expand and modify the chemical waste disposal system. This will be accomplished through the rehabilitation of an existing injection well and the construction of a second one.

Mississippi Test Facility

Significant progress was made in the construction and activation of the Mississippi Test Facility during calendar year 1965. The first Saturn V second stage test stand and all its supporting facilities achieved operational readiness (fig. 68, see p. 98). Other major facilities that became operational include the Laboratory and Engineering Building, the Central Control Facility, the Electronics, Instrumentation and Materials Laboratory, the High Pressure Water Facility, The Test Maintenance Building and the Inflammable Materials and Compressed Gases Storage Facility. During this period the Navigation Lock, Bascule Bridge and the Canal System to the S–II complex and cryogenic docks also achieved operational capability (fig. 138). The major road and railroad networks were also completed.

By the end of calendar year 1966, all authorized work, with the exception of the bridge for U.S. Interstate Highway No. 10 and the 2nd position of the dual Saturn V first stage stand will be completed (fig. 139). Thus, the Mississippi Test Facility will move from the construction and activation stage to a fully operational status. Saturn V second stage testing will be in full swing and the first stage firing on the B–2 position will take place by the end of the year.

Our fiscal year 1967 request includes modifications to the Saturn V first stage dual stand flame deflectors and additions to the high pressure water and high pressure gas systems. Also included are the procurement and installation of additional data acquisition equipment in the first stage stand, the second stage stand, the Test Control Centers, and the Data Acquisition Facility.

Various Locations

The facilities for manufacture, assembly and checkout of the Saturn V 2d stage (S–II) and 3d stage (S–IVB), as well as the F–1 and J–2 engines, are now fully operational. In 1965 our efforts were directed toward the completion of the 2d stage Vertical Checkout Facility at Seal Beach, and the 3d stage Vertical Checkout Facility at the Sacramento Test Facility. Also at the Sacramento Facility the conversion of Beta 1 from a battleship to an acceptance test stand was accomplished.

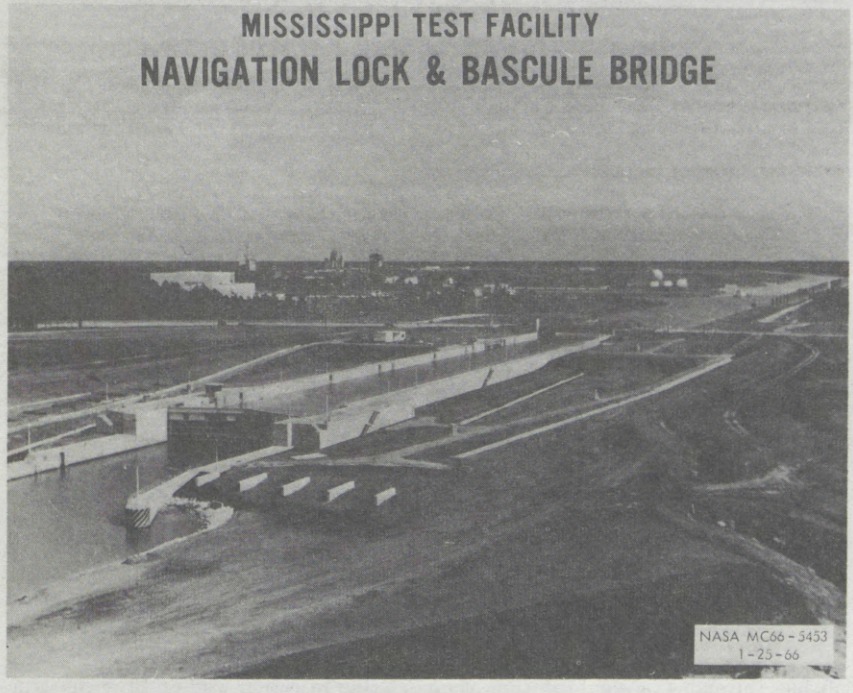

FIGURE 138

MISSISSIPPI TEST FACILITY
SATURN V 1st STAGE DUAL POSITION
TEST STAND

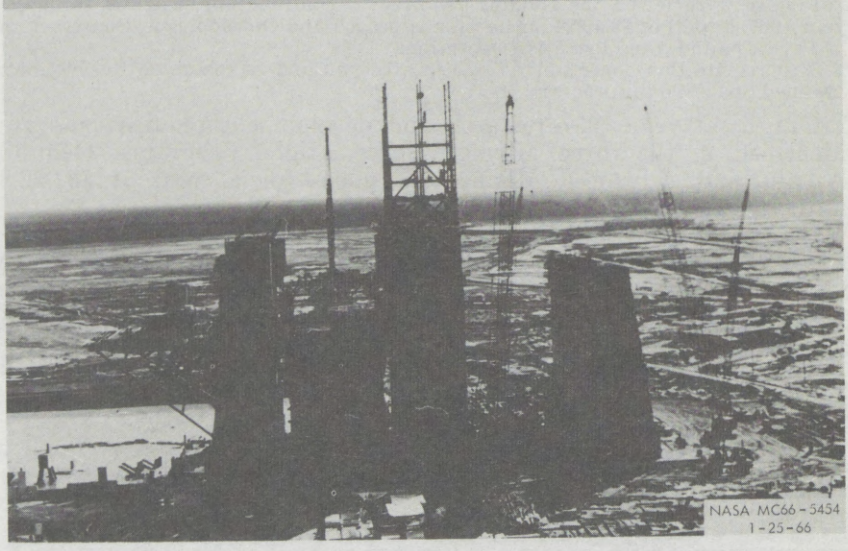

FIGURE 139

For fiscal year 1967, under the Various Locations budget category, we are requesting only one project to provide additional Saturn upper stage components test facilities at the Sacramento Test Facility. These facilities will be used for testing complete subassemblies and major components of the Saturn upper stage.

Summary

In my presentation today I have reported on the excellent progress and the major problems of the past year in meeting program objectives, and have discussed our plans for the coming fiscal year.

I have reported on the status of our management of the Manned Space Flight programs, discussing personnel and organizational changes, incentive contracting, and program planning and management techniques. I have reviewed our productive relationships with the Department of Defense and with other government agencies, and with industry.

My review of the Gemini program highlighted the progress made toward operational capability and other program objectives with each of the five manned flights following the unmanned qualification flight early in 1965. Key accomplishments of these missions were long duration flight, extravehicular activity, and orbital rendezvous of four astronauts in two Gemini spacecraft only inches apart.

In reviewing the Apollo program, I described our objectives, and the Apollo Saturn I and Apollo Saturn V space vehicle flight schedule. I discussed the management processes used on the Apollo program to overcome technical and administrative problems and to reach cost, schedule and performance milestones. I have discussed the resources capability generated by the Apollo program in terms of funds, management, people, and facilities, both government and industry. I also reviewed the evolution, objectives and operations of Apollo Applications as an outgrowth of the Apollo program, using Apollo-developed capabilities for other missions. I noted the evolution of Apollo Applications planning, the Apollo capabilities available for Apollo Applications and the operational potential of such applications in Earth orbit, lunar orbit, and on the Moon's surface.

I described the operational side of the current Manned Space Flight programs, specifically the Mission Operations for Apollo and Gemini.

The planning for future programs conducted by Advanced Manned Missions was my next review topic. I discussed the alternative considerations which can be applied to selection of future program alternatives, and reviewed our present and planned studies for Earth orbital and lunar missions.

Finally, I reviewed the funding required to continue our program for fiscal year 1967, a total of $3,405.4 million for Research and Development, Construction of Facilities and Administrative Operations.

I appreciate this opportunity to meet with you and to report on the Nation's Manned Space Flight program.

Our fiscal year 1967 research and development requirements are identified in the three Manned Space Flight Programs—Gemini, Apollo, and Advanced Manned Missions—for a total of $3,022.8 million.

Construction of Facilities funding requested for fiscal year 1967 totals $54.4 million. The total Manned Space Flight Administrative Operations requirements for fiscal year 1967 is $328.2 million. These funds will provide for the operation of the three Manned Space Flight Centers.

This concludes my summary of the prepared statement submitted for the record.

The CHAIRMAN. Next is Dr. Newell.

Mr. DADDARIO. Mr. Chairman——

The CHAIRMAN. I asked that we forgo questions until we receive all of the statements.

STATEMENT OF DR. HOMER E. NEWELL, ASSOCIATE ADMINISTRATOR FOR SPACE SCIENCE AND APPLICATIONS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. NEWELL. Thank you, Mr. Chairman. Mr. Chairman and members of the committee, it is a pleasure and a privilege to appear before you at this time to report on progress in our national space Science and Applications Program, and to seek your continuing support for this very exciting and highly productive effort.

This program is the handiwork of over 60,000 workers in government, industry, and universities, with substantial participation from other countries. I think we can take considerable pride in their accomplishments of last year, which have done much to strengthen our position of leadership in the scientific exploration of space and the useful application of space knowledge and technology.

If I may, Mr. Chairman, at this point I would like to interpolate a remark on reporting on our program. We have in publication a report of significant achievements in the Space Science and Applications area from 1958 to 1964. The first four volumes of a total of ten volumes in the Space Science and Applications disciplines are out. I have made these volumes available to Mr. Hammill for distribution to the committee and other volumes are available if the Committee wishes.

Accomplishments in 1965: Sixteen successful space missions were flown in 1965 for an 84% success rate. These included five additional Explorer satellites, bringing the total to 31. These Explorers are providing important new observations of the geodetic properties of the earth, the earth's magnetosphere, its ionosphere, the sun, and solar terrestrial relationships. These observations are supplemented by

those of two new satellites built by Canada and France, and launched by the United States.

Our second Orbiting Geophysical Observatory was launched into a nearly polar orbit as part of a massive assault on understanding the complex interactions among the various phenomena observed in space. The second Orbiting Solar Observatory was successfully orbited to study the driving force behind most of these phenomena, namely the sun.

In the area of practical applications, two additional TIROS spacecraft were launched, ending the NASA series at nine straight successes, and providing the Department of Commerce series with a good start. The subsequent successful launch of ESSA I and II for the Department of Commerce early this year inaugurated a national operational weather satellite system under the management of the Environmental Science Services Administration, with NASA providing TIROS-type spacecraft and the launch services on a reimbursable basis. This surely is a milestone in a series of solid practical returns to the supporters of this program.

Another such milestone was the initiation of regular commercial transatlantic communications service with the Communications Satellite Corporation's Early Bird I, located in a 24-hour equatorial orbit over the Atlantic Ocean. NASA provided the launch services on a reimbursable basis. The series of live television international town meetings illustrates some of the potential for improved communications and understanding among nations via this medium. The Early Bird was patterned after NASA's successful synchronous satellites, Syncoms II and III. These satellites, which have been turned over to the Department of Defense, have been located over the western Pacific and Indian Oceans where the services are experimenting with their operational use.

Our explorations of the moon, planets, and interplanetary space achieved 100 percent success during the past year. Rangers VIII and IX culminated the Ranger series of flights designed to provide photo reconnaissance of the lunar surface in advance of Surveyor and Apollo landings. The total of 17,000 high-quality photographs taken of two maria and the crater Alphonsus yielded surface resolutions approaching one foot in the last frames and showed the topography of all three areas to be very similar and to be adequately level for landings. Photographs from the recent successful landing of Luna 9 by the Soviets at a different location generally confirm these topographic observations, and in addition, indicate that the surface is firm enough to support a landed spacecraft.

The Mariner IV successfully completed its 8-month, 326-million-mile journey to Mars and yielded a wealth of information about this neighboring planet. Unlike the Earth, Mars has no appreciable magnetic field or trapped radiation. It has an ionosphere, however. The Martian atmosphere is very thin, with a surface pressure less than 1 percent of Earth's. Most spectacular were the photographs showing its previously unknown surface to be cratered like that of the Moon.

The first in a new series of Pioneer spacecraft was launched to measure radiations and fields in interplanetary space to distances beyond 50 million miles.

Our launch vehicle activities were highlighted by the successful completion of the Centaur development for the first Surveyor flights.

In addition, a greatly uprated version of the Delta was successfully introduced, and the Scout achieved 100 percent reliability with a string of successes now totaling 15.

Nearly 250 successful sounding rockets were launched in support of the Physics and Astronomy and the Meteorology Programs.

Importantly, man in space began to realize some of his potential as a scientific investigator. Photographs of both the earth and sky taken on the Gemini flights illustrate the potential of such flights to make important contributions to astronomy and to geography, the latter subject embracing geology, water resources, glaciers, oceanography, forestry, and agriculture.

The Sustaining University Program continued its successful and orderly development was over 3,000 doctoral candidates now enrolled, over 50 universities developing their potential to support the space program under NASA grants, and with 33 facility grants to make this expansion of activity possible.

All in all, Mr. Chairman, in 1965 this program achieved both the momentum and the successes for which we have been striving so hard. Only two of the many original projects undertaken early in the Space Science and Applications Program have yet to achieve their first flights. These are Surveyor and the Orbiting Astronomical Observatory, and these will fly within the next few months. It is significant that these are the most difficult of the projects undertaken in the early space science program.

The Current Program: The composition and funding requirements of the Space Science and Applications Program for fiscal year 1967 are shown in figure 140. Although some of the early projects will

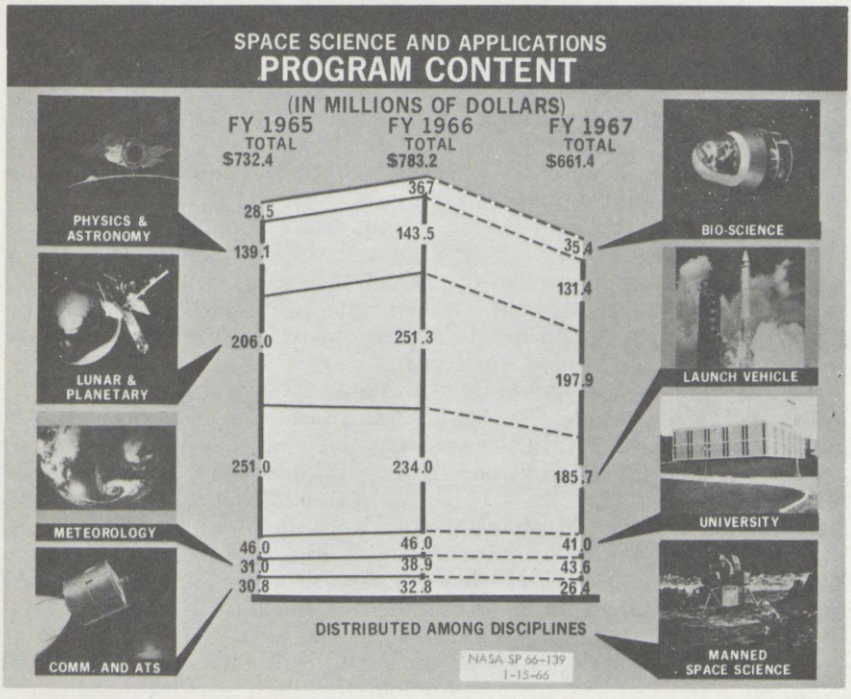

FIGURE 140

continue, many of them, like Echo, Relay, Syncom, Tiros, and Ranger have successfully completed their missions, and have been phased out. The pace of flights in 1966 and 1967 will continue to be high. During these years, in addition to Surveyor and the Orbiting Astronomical Observatory, the second generation of missions are all scheduled to achieve first flights, including the Lunar Orbiter, Biosatellite, and the Applications Technology Satellite.

The funding level for research and development drops markedly in fiscal year 1967 to a budget request of $661.4 million, as compared with the fiscal year 1966 and fiscal year 1965 levels of $783.2 million and $732.4 million. This budget reduction has been necessary because of pressing national needs in other areas, including the demands of the conflict in Vietnam. We believe that the program for which we are asking your support is well balanced and sound, and is one in which the country can continue to take pride. Nevertheless, it must be clear that the considerable cutback in funding level must be reflected in a corresponding reduction in program level. We have had to cancel or postpone important program activities as I shall point out in discussing the budget details.

The funding requirements for Physics and Astronomy are shown in figure 141. The funds provide for a continuation of a strong effort in Supporting Research and Technology, Sounding Rockets, Explorers, Orbiting Solar Observatories, Geophysical Observatories, and Astronomical Observatories. It has been necessary, however, to cut back drastically in solar research by cancelling the Advanced Orbiting Solar Observatory (AOSO).

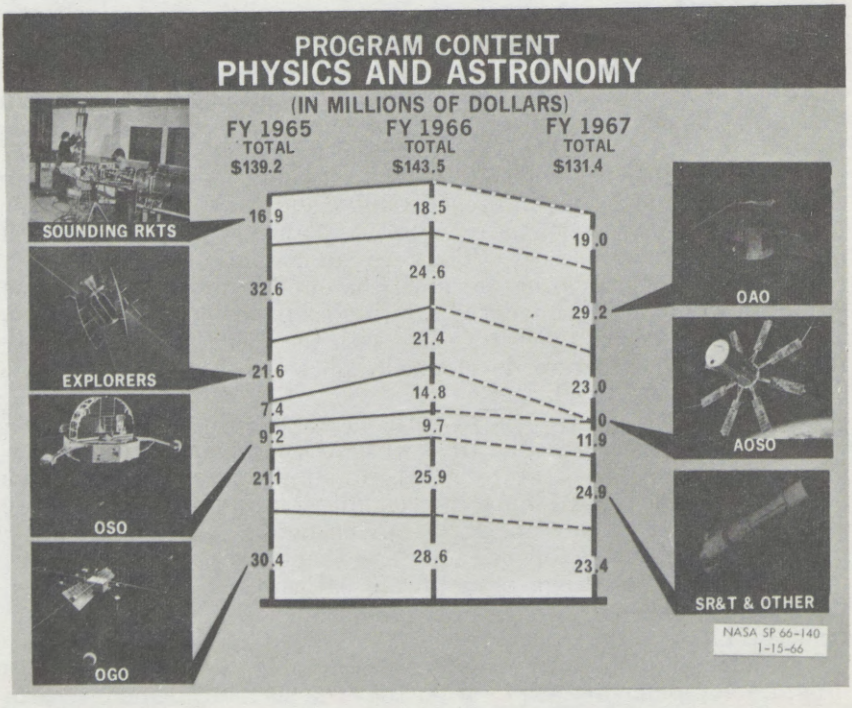

FIGURE 141

In view of the importance of AOSO to the solar physics program in providing long life, increased payload capacity, and high pointing accuracy, thereby permitting observations of high spatial, spectral, and time resolution, the decision to cancel AOSO was an extremely difficult one to take. In view of the strong support given to the AOSO project by both the full committee and the Subcommittee on Space Science and Applications, it is well to review here the rationale behind the AOSO action.

The AOSO cancellation was not taken in isolation from the rest of the Space Science Program, nor was it the only action required to accommodate to the established budget level for the program. For example, adjustments were also made in the planetary program, as will be discussed a little later, and in several areas the procurement of follow-on spacecraft was postponed to a later year. Our effort was to continue to profit by the substantial investments already made in the various elements of the program, and to maintain a reasonable balance among the various disciplines of space science.

In the area of solar physics, in addition to supporting research in universities and in our Centers, we had work underway on the Orbiting Solar Observatory, on AOSO, and on studies of a solar telescope mount for use on earth orbital Apollo missions.

The last mentioned—the Apollo Telescope Mount—is of importance for two reasons. First, it will provide early design and operational experience with man-operated telescopes in orbit, which will contribute to the design of a man-operated, large-aperture, optical, orbiting telescope. The National Academy of Sciences Space Science Board has stated that such an instrument orbiting above the obscuring atmosphere would be of major importance to the science of astronomy.

Secondly, the Apollo Telescope Mount will permit the use of photographic film in investigating the sun, affording even higher resolutions than would be obtainable from AOSO, although one must hasten to add that this advantage over AOSO is more than offset by the relatively very short duration of Apollo missions.

We can improve the pointing and scan capabilities of OSO to some extent. Thus, by using improved OSO's and the Apollo Telescope Mount, we can do some of the experiments planned for AOSO, though not the more advanced ones. Thus, we can maintain a sound, though reduced solar physics program until the opportunity returns in the future to reactivate an advanced orbiting solar observatory program. These considerations, taken together with the fact that we had only just begun the hardware development phase of AOSO, led to the decision to cancel AOSO.

I know the committee shares with me the disappointment in not being able to proceed at this time with AOSO; I am sure the committee appreciates the careful weighing of alternatives required before taking a decision; and I hope the committee agrees that the step we did take was reasonable under the circumstances.

Our funding request for the Lunar and Planetary Program is shown in figure 142. Here again significant adjustments were required. The major change in plans was to defer the first Voyager mission from 1971 to 1973.

The deferral of Voyager to 1973 left such a gap in the United States program for planetary exploration that the successful Mariner pro-

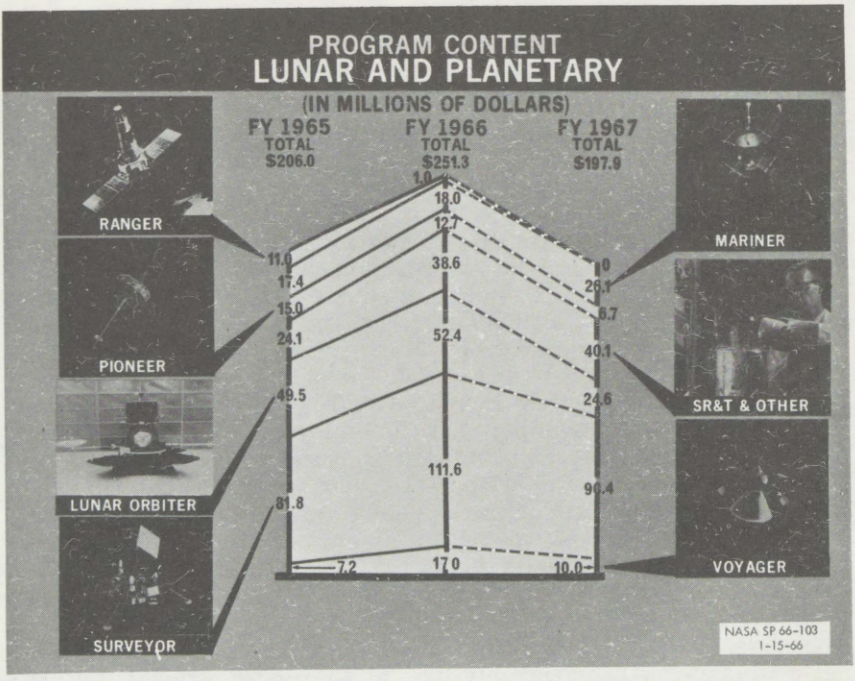

FIGURE 142

gram was reinstated. The reason this country has led the world in planetary exploration is not the lack of Soviet effort. Their program is apparently several times the size of ours, with multiple flights to Mars and Venus at each opportunity, using heavier spacecraft. Whereas Mariner II and Mariner IV were the first planetary craft to complete their missions, there is little doubt that Soviet successes will soon press us hard in this important area of advanced research.

Nevertheless, we can hope that our single Mariner flight to Venus in 1967, using a modified spare Mariner on hand, and the two Mariners to Mars in 1969, with uprated versions of this craft, will maintain us near the forefront of this exciting area of space exploration until the Voyager becomes operational in 1973. Starting with Mars, we may then begin a comprehensive examination of the near planets from orbit about them, and the study of surface properties and the search for extraterrestrial life from landed capsules.

The Space Science Board of the National Academy of Sciences has recommended the planets as the major goal for United States space exploration in the 1970's. We stand ready and eager to undertake this challenge.

In making its recommendation, the Space Science Board strongly emphasized the importance of investigating not only Mars, but the other planets as well. Both Mars and Venus are important because of their similarity in many respects to earth. A comparative study of these planets and Earth should greatly illuminate the understanding of Earth. Mars has especial interest because of the possibility of finding life there. Mars has additional interest, because it is inter-

mediate between the Moon and the Earth in size, and perhaps in internal structure and amount of differentiation that has occurred since its origin.

The atmosphere of Venus is a puzzle. No one has put forth a good explanation of why Venus should have so much atmosphere, amounting to possibly 100 Earth atmospheres at the surface. Being almost a twin to Earth in size and mass, Venus might be expected to have slightly less of an atmosphere than Earth because of its closeness to the Sun and the greater atmospheric heating to be expected. Also it is indeed puzzling that Earth's twin should not have a magnetic field comparable to Earth's. Moreover, the matter of how hot the surface of Venus is, is still not settled. Further studies of the available data, including thoses obtained from Mariner II, raise some question. While it is still generally agreed that the most likely explanation of the data is that the surface lies between 600° F. and 800° F., nevertheless there is the possibility that the high temperatures exist somewhere up in the atmosphere, and that the surface is cooler. The possibility then raises the further question as to whether there still might be life to be found on the surface of Venus.

It is to try to resolve some of these questions about Venus that we plan to fly a Mariner by the planet in 1967.

It is to further our understanding of Mars, and to lay additional groundwork for the later Voyager missions, that we plan to fly missions by Mars in 1969. More pictures, including some with wider fields of view, will extend our look at the planet beyond the mere 1 percent that we have seen so far. Better atmospheric measurements will improve our understanding of the Mars atmosphere, and, being taken at a different time of the Mars year will give some information on seasonal variations. These, combined with continuing observations of Mars from Earth, will give added data to use in both the design of Voyager and in the planning of the Voyager scientific experiments.

Thus, in reactivating the Mariner program to counteract the delay in the Voyager effort, we have good scientific missions for Mariner to do. Although NASA feels that the earlier plan to send Voyager spacecraft to Mars in 1971 was better, nevertheless the present plan is a good one. In fact, the Space Science Board has stated, and NASA concurs, that the best planetary program would involve small exploratory missions to complement the larger missions.

The delay of Voyager does ease some problems. The delay of two years permits much lower funding in both fiscal year 1966 and fiscal year 1967. Also there is more time to take care of long leadtime items. On the other hand, the schedule does not permit complacency. Experience has shown that large projects like OAO, Surveyor, and now Voyager, take 4 or 5 years to reach first flight. Backing off from the 1973 first Voyager flight, we find that hardware development must begin at the start of 1968 in order to be ready for flight in 1973. Conceptual and preliminary design work on the Voyager capsule will take the rest of 1966. That will leave only 1967 to do detailed design, including the experimental and design studies required for sterilization of the capsule for landing on the Mars surface. We must, therefore, have the Sterilization Assembly and Development Laboratory (SADL) ready at the Jet Propulsion Laboratory by the beginning of 1967 in order to do this important work. Failure to do this research

in timely fashion could lead to costly reworking of the capsule at a later time. For this reason we had to program funds from the fiscal year 1966 budget to complete SADL in time.

Surveyor continues to be our top priority project in the Space Science Program. The test models have now passed several descent tests, and the very severe vibration and environmental tests at the Hughes plant. The first flight spacecraft passed its flight acceptance tests, and is now at San Diego for combined systems test with Centaur. Following completion of these tests, operations will move to Cape Kennedy in preparation for a launch of the first Surveyor in the second quarter of this year.

The landing of Luna 9 is encouraging to us both for Surveyor and for Apollo. The question naturally arises as to the need for Surveyor in the light of Luna 9's success. The answer is that Surveyor continues to be needed for two purposes: (1) to make preliminary measurements in support of the Apollo landing mission; and (2) to form, with Lunar Orbiter and Apollo, a flexible capability to explore and investigate the moon.

The Luna 9 success shows that objects can be softly landed on the Moon. But to date the information that we have from Luna 9 on lunar bearing strengths is largely qualitative. Quantitative estimates range all the way down to one-tenth of a pound per square inch. We must get the better, quantitative measurements that Surveyor will give us.

Also, it is not sufficient to have data on only one spot on the Moon, a spot, moreover, that does not even lie within the range of admissible Apollo landing sites. The country assumes a grave responsibility when it sends men to the hostile lunar surface. We feel that a minimum of 10 Surveyor missions is required to meet this responsibility to minimize the dangers from lack of knowledge. Moreover, the increased instrumentation planned for the last three Surveyors will add importantly to our understanding of the lunar surface.

Surveyor has the additional value that the landing operation with Surveyor is similar to that to be used with the Lunar Excursion Module. Thus, operational experience with Surveyor will be applicable to LEM. The data from the radar altimeter will be useful, both in checking out the operation of a system of this kind, and in determining the radar reflectivity properties of the lunar terrain.

Our budget request for the Meteorology Program is shown in figure 143. We will continue to support ESSA (the Environmental Science Services Administration) in launching their operational weather satellites, and in research and development for more advanced operational systems.

Figure 144 shows the budget request for the Communications and Applications Technology Satellities Program. The program for fiscal year 1967 is largely one of advancing technology in space applications to such areas as navigation, direct radio and television broadcast, meteorology, and data collection and distribution.

The Bioscience Program budget is set forth in figure 145. Biosatellite continues to be the major project during fiscal year 1967, although work will be building up in preparation for developing an

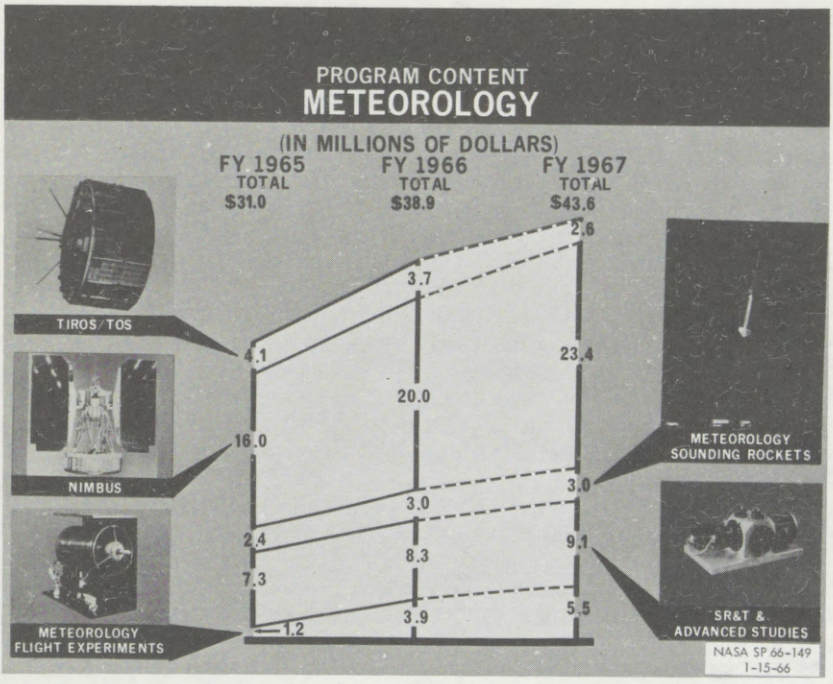

FIGURE 143

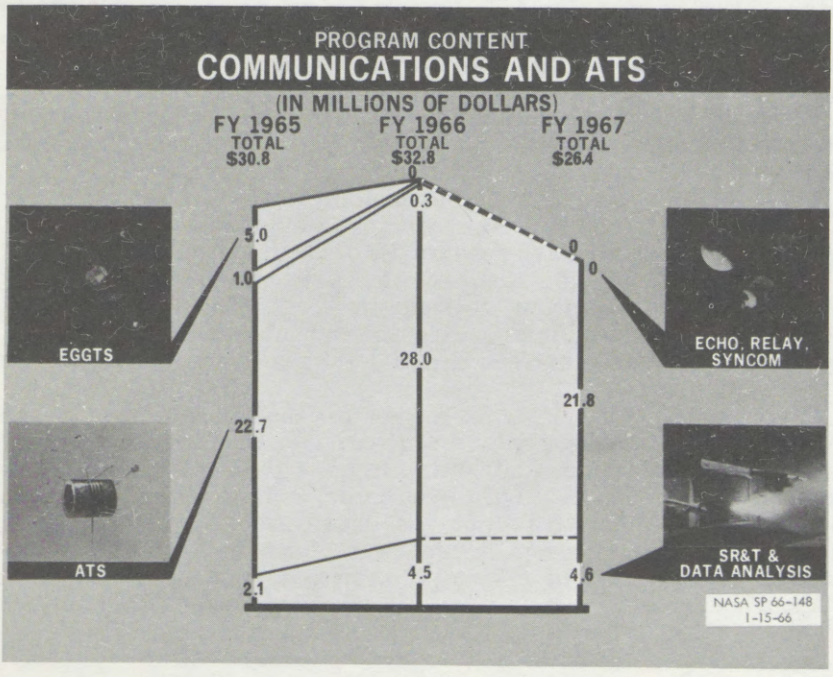

FIGURE 144

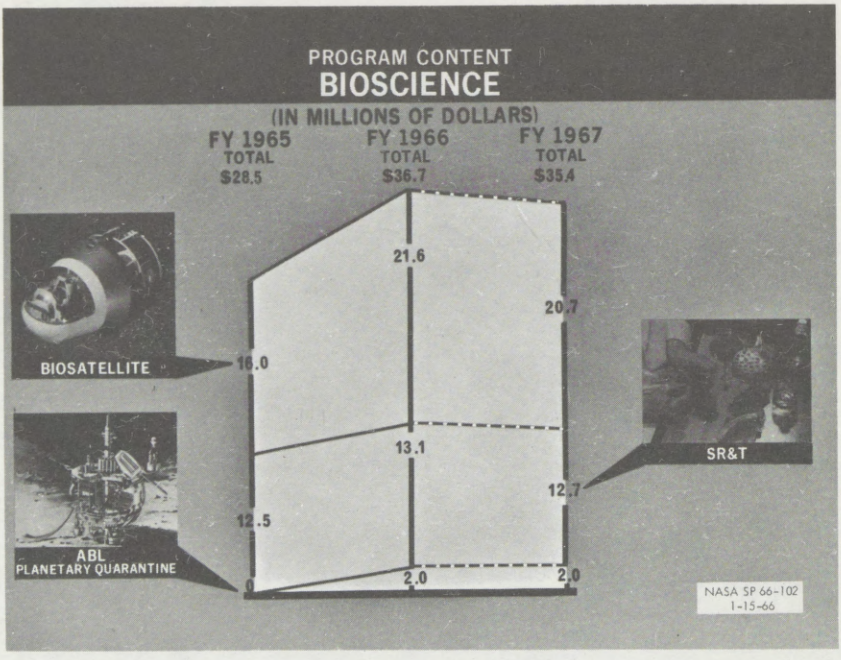

FIGURE 145

Automated Biological Laboratory for flight on Voyager missions to Mars.

The Manned Space Science budget, shown in figure 146, is distributed among the disciplines that will be making use of manned space flight for the conduct of research in their respective areas. Experiments are being flown on Gemini missions, others are being prepared for Apollo earth orbital and lunar missions, and others are under study for Apollo Applications flights.

The Sustaining University Program budget is given in figure 147. The objectives and composition of the program are as described last year, but with a slight falloff in funding.

The Launch Vehicle Development Program funding request is given in figure 148. In addition to supporting research and technology work, these funds will provide for two launchings of Centaur to develop the dual burn capability needed for some of the planned Surveyor missions.

The Launch Vehicle Procurement requirements are shown in figure 149.

The Administrative Operations budget is given in figure 150. The increase is due to the increase in personnel requested for the Goddard Space Flight Center to support increased demands on the Apollo tracking net, to the pay raise, and to increases in computer rentals and services.

Finally, we have a modest request for Construction of Facilities, shown in figure 151, to support the program described above.

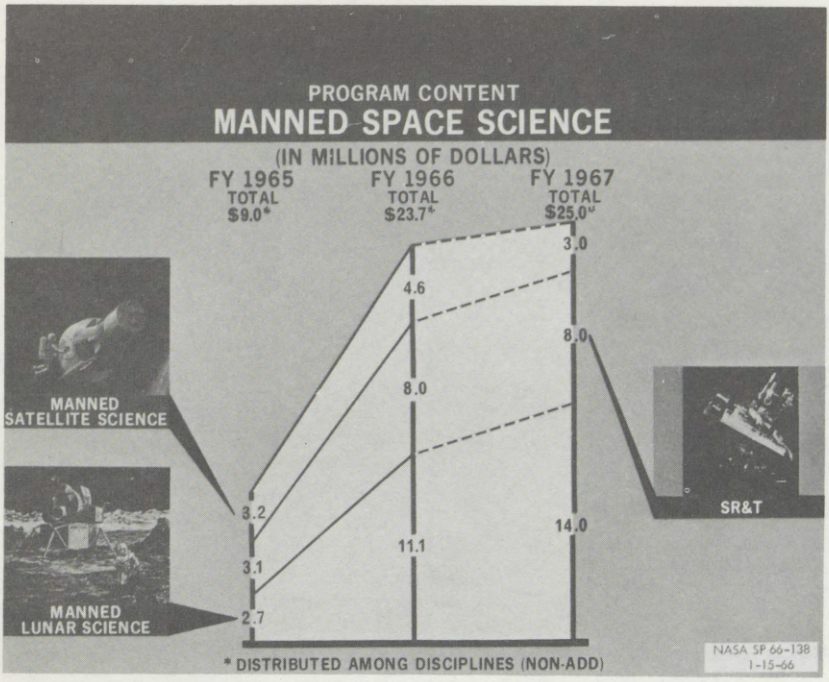

FIGURE 146

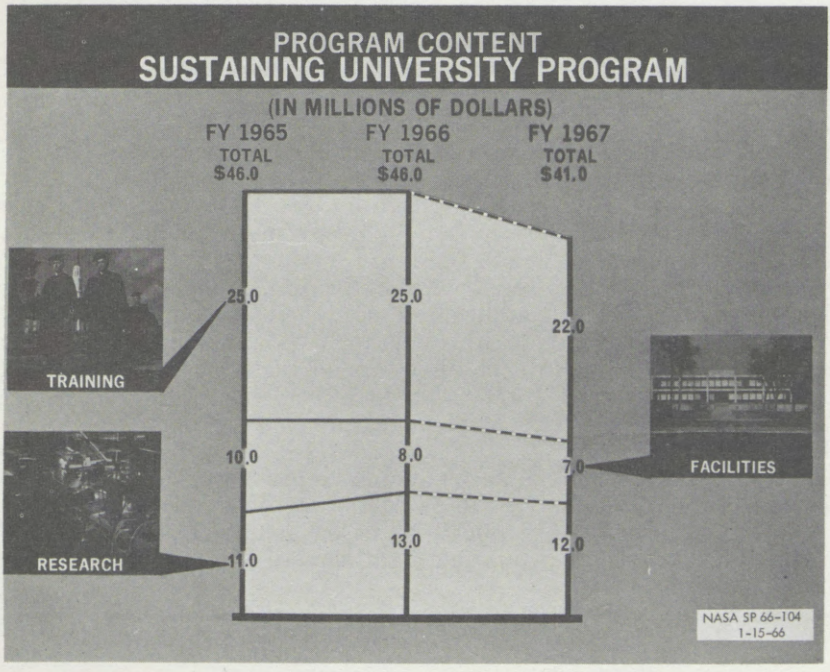

FIGURE 147

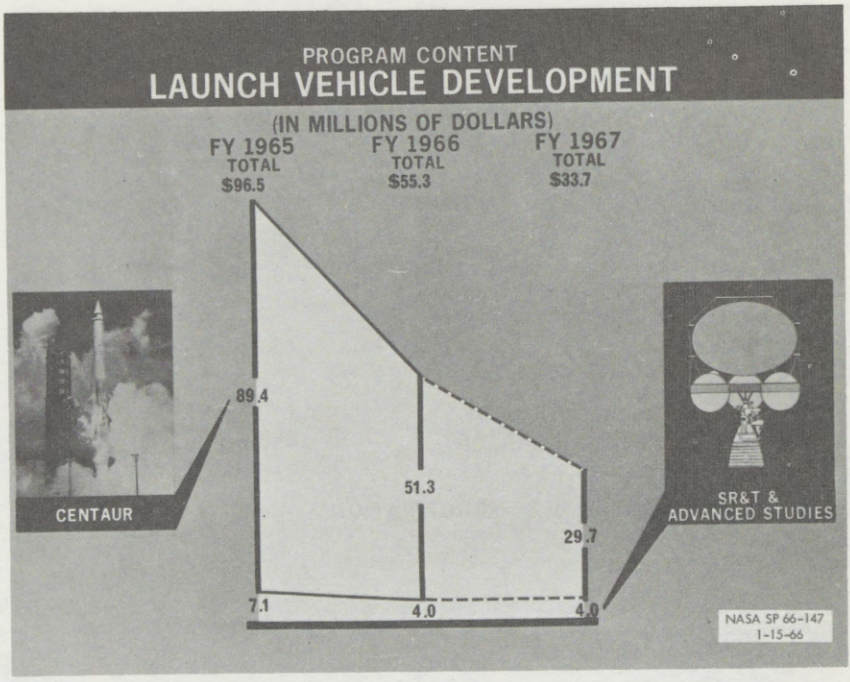

FIGURE 148

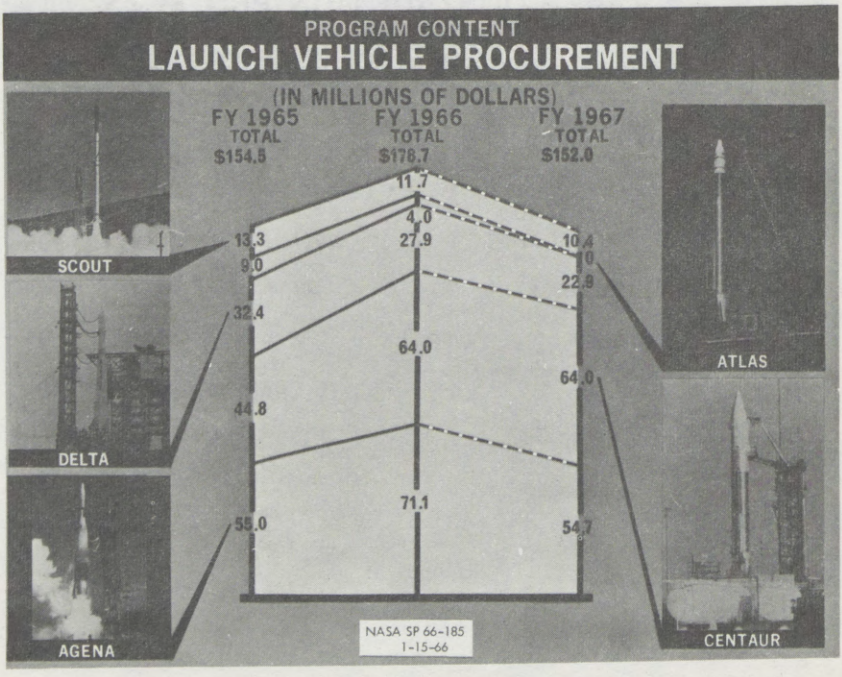

FIGURE 149

OFFICE OF SPACE SCIENCE AND APPLICATIONS

ADMINISTRATIVE OPERATIONS BUDGET

(IN THOUSANDS OF DOLLARS)

	FY 1966	FY 1967
• GODDARD SPACE FLIGHT CENTER	$64,040	$71,687
• WALLOPS STATION	9,446	10,166
TOTAL	$73,486	$81,853
(JET PROPULSION LABORATORY)*	(65,699)	(71,218)

*FUNDED FROM THE R&D APPROPRIATION

NASA SP 66-137
1-15-66

FIGURE 150

FY 1967 CONSTRUCTION PROJECTS

SUPPORTING SPACE SCIENCE AND APPLICATIONS PROGRAMS

(IN THOUSANDS OF DOLLARS)

PROJECT	LOCATION	COST
• MODIFICATIONS TO LAUNCH COMPLEX 17	KENNEDY SPACE CENTER	$740
• MODIFICATIONS TO LAUNCH COMPLEX 12		639
• ROCKET STORAGE MAGAZINE	WALLOPS STATION	205
• AEROBEE 350 LAUNCH FACILITY	WHITE SANDS	1,200
• LAUNCH VEHICLE SERVICE TOWER	WESTERN TEST RANGE	2,443
• SPIN TEST FACILITY		745
• UTILITIES INSTALLATION	JET PROPULSION LABORATORY	350
	TOTAL	$6,322

NASA SP 66-136
1-15-66

FIGURE 151

Concluding Remarks:

Mr. Chairman and Members of the Committee, I have endeavored in this summary to give you some feeling for the forward-moving dynamic character of our program in Space Science and Applications, both in moving from past to present, and in planning from the present into the future. This country may be justly proud of last year's achievements in our explorations of the Earth and the solar system, especially of the Ranger, Mariner, and Gemini programs. Yet, the opportunities that lie ahead of us are even more challenging than those that lie behind. There is no occasion for complacency. On the contrary, there is need for vision, determination and dedication. These we pledge to you and to the Nation. We ask your support that we may continue to move forward in this great venture of mankind.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much, Doctor.

The next witness is Dr. Mac C. Adams, Associate Administrator, Advanced Research and Technology.

Dr. Adams.

STATEMENT OF DR. MAC C. ADAMS, ASSOCIATE ADMINISTRATOR FOR ADVANCED RESEARCH AND TECHNOLOGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. ADAMS. Mr. Chairman and members of the committee, I am glad to have this opportunity to summarize the NASA Advanced Research and Technology portion of the FY67 budget request. My associates and I have appeared before your Subcommittee, chaired by Mr. Hechler, and have described our program in detail. Comprehensive statements have been submitted on the eight line items (fig. 152) that make up our total program. The eight programs are grouped

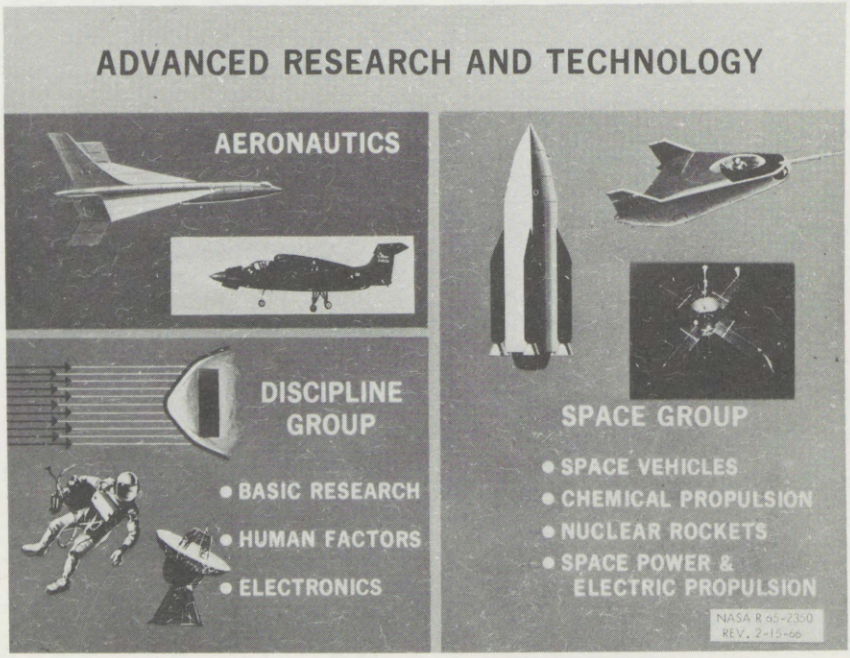

FIGURE 152

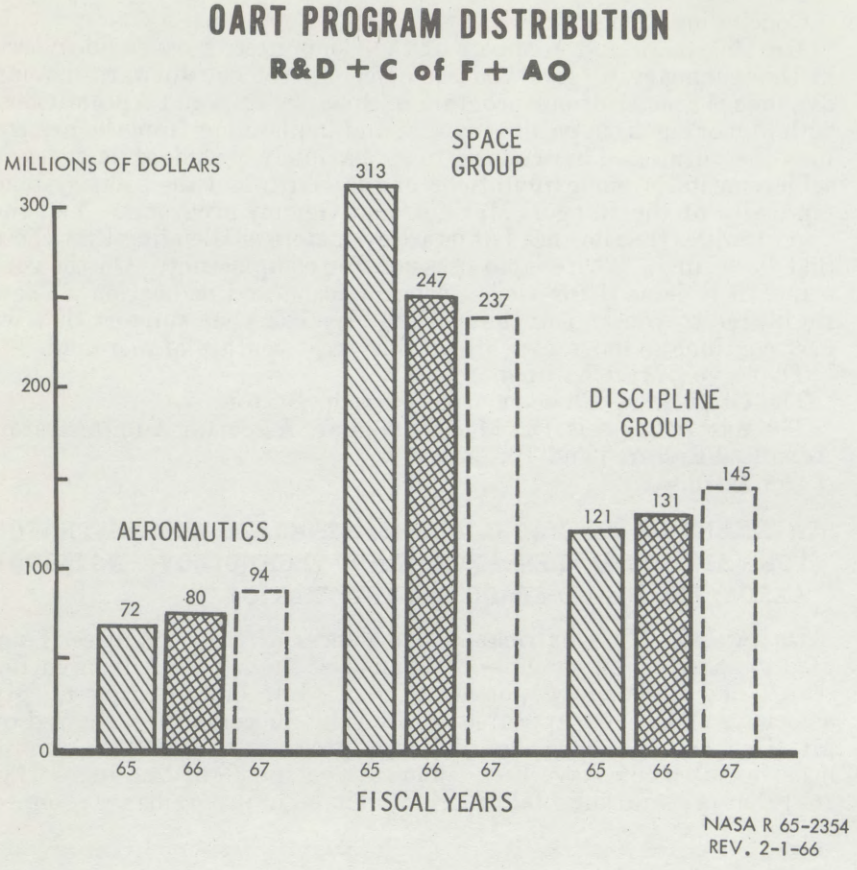

FIGURE 153

under the headings of Aeronautics, Space, and Discipline. The *Aeronautics* program is devoted to research and technology for all types of aircraft that span the speed and distances spectrum. The *Space* effort consists of Space Vehicle Systems, Chemical Propulsion, Nuclear Rockets, and Space Power & Electric Propulsion. In the *Discipline* group are Basic Research, Human Factors, and Electronics Systems.

The sum of R&D, CofF, and AO, for each of the three major groups, is compared for three fiscal years (fig. 153). The increases in the Aeronautics and Discipline groups are accompanied by a decrease in the Space group.[1] We are proposing a net increase in the OART budget of 16.1 million dollars, giving a total budget request of 499.4 million dollars.

It should be pointed out that the delineation of our work by the three groups does not reveal the applicability of technology from one group to another. For example, we estimate conservatively that 30

[1] The sum of the numbers on the figure is from $23 million to $25 million less than the totals for the three fiscal years. This difference is the Administrative Operations portion of the budget of the five Research Centers that is spent to manage work of NASA program offices other than OART and hence, is not applicable to the OART R&D programs. We receive similar benefits from these other offices for OART R&D work managed for us by other Centers.

million dollars in the Discipline and Space groups is also applicable to the Aeronautics program. This raises the total aeronautics effort, in effect, from 94 to 124 million dollars. More generally, I would note that the increase in the aeronautics budget reflects a concerted effort to strengthen our facilities position in support of air breathing propulsion and V/STOL research. The increase in the research disciplines will give added strength in these important program areas which underlie both the aeronautics and space groups.

I will not briefly discuss the major programs, describe some highlights, and mention significant program changes between fiscal year 1966 and fiscal year 1967.

In Aeronautics, V/STOL will receive increased emphasis, particularly in propulsion and zero visibility landing problems. A new facility, V/STOL Transition Research Wind Tunnel (fig. 154), is requested for study of the critical transition between vertical and forward flight. A feature of the tunnel is an endless belt to provide realistic ground effect, and flight speed simulation of 0 to 200 knots.

Research in support of supersonic transports will be emphasized in fiscal year 1967 by explansion of the Propulsion Systems Laboratory (fig. 155) to enable full-scale research on advanced engine components and complete engine systems at speeds up to Mach 3. Three test cells, a heater, and coolers will be constructed. Existing air supply and exhaust equipment will be used.

Research in operational problems, particularly noise, will increase in fiscal year 1967. Work will be continued on investigation of engine components in the search for a quieter engine and this will lead to

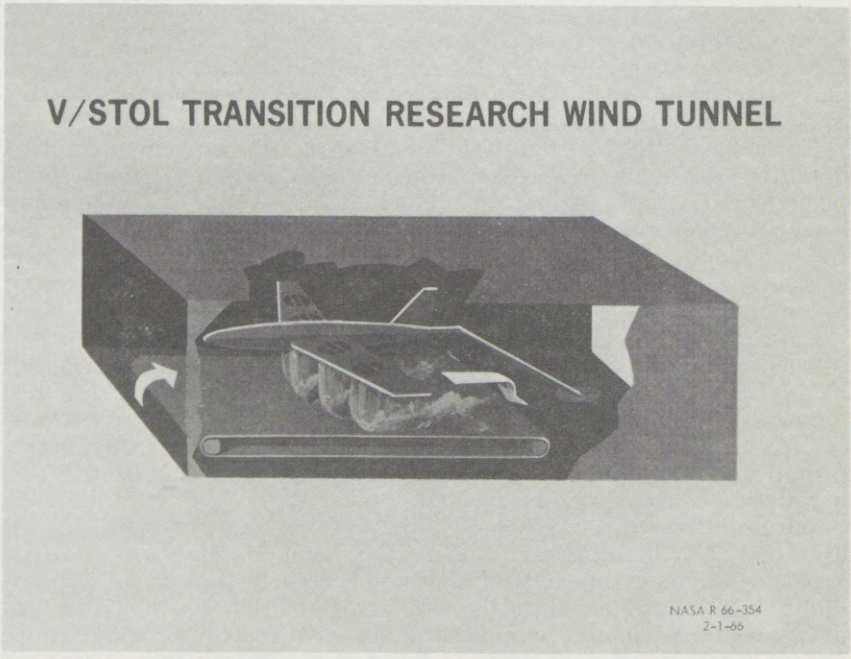

FIGURE 154

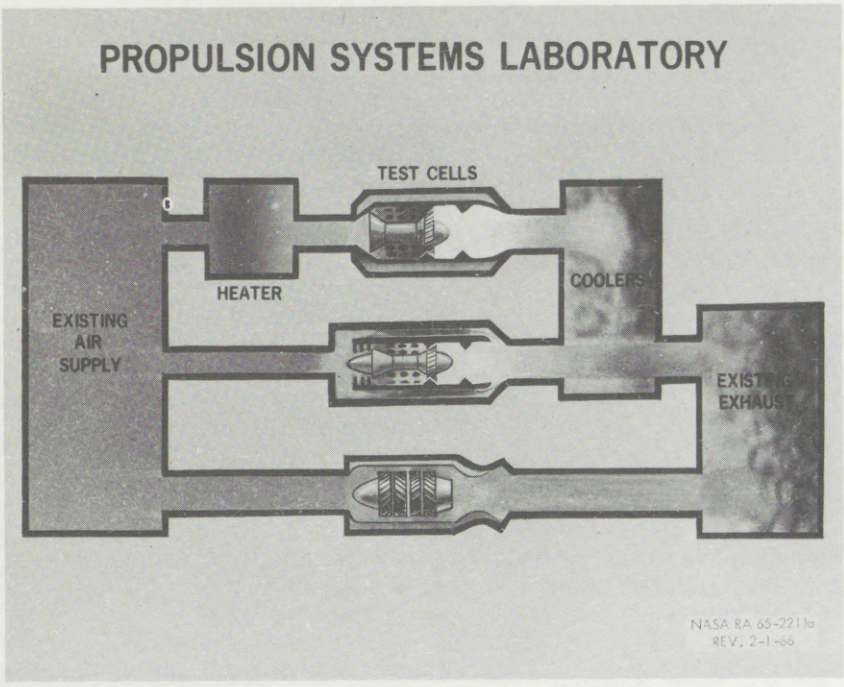

FIGURE 155

future flight tests of promising noise suppressors. We will continue to work very closely with the FAA on noise and sonic boom problems and will participate in the National Sonic Boom Program of the Office of Science and Technology.

Hypersonic flight in the range of Mach 6 appears very attractive, but there are many research problems to be solved, particularly in propulsion. We are requesting funds in fiscal year 1967 to build a new type of hypersonic tunnel for testing ramjet engines (fig. 156). The facility would use an existing heater to raise nitrogen to a high temperature, mix it with gaseous oxygen, and expand this synthetic air to hypersonic velocities.

Last year the Aeronautics program made significant contributions to such national programs as the Supersonic Transport and the Air Force C5A large transport, and continued support will be provided these and other developments. Flight research, utilizing several aircraft, will continue. Key problems will be treated in aerodynamics, propulsion, structures, flight dynamics, and operations from which new design concepts will be evolved.

Turning now to the Space Group; progress last year (fig. 157) is highlighted by landing studies of reentry lifting bodies, a second Fire experiment to measure heat transfer at high velocities, three Pegasus flights to measure meteoroid hazards, two successful firings of a 260-inch solid rocket motor, by a series of successful nuclear rocket firings, a 2600 hours endurance test of an ion engine, and by endurance tests of the major components of the SNAP–8 nuclear electric power generator.

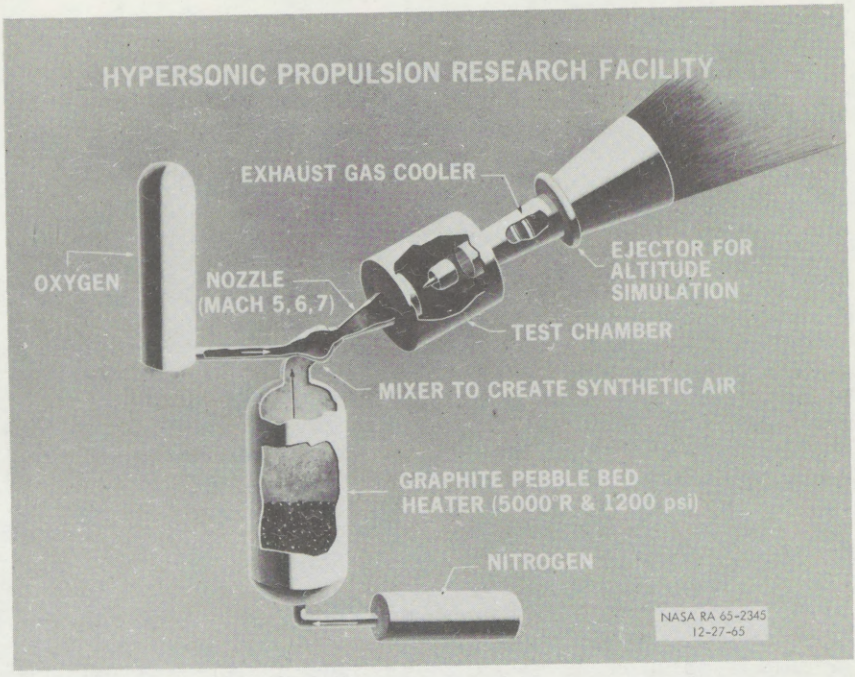

FIGURE 156

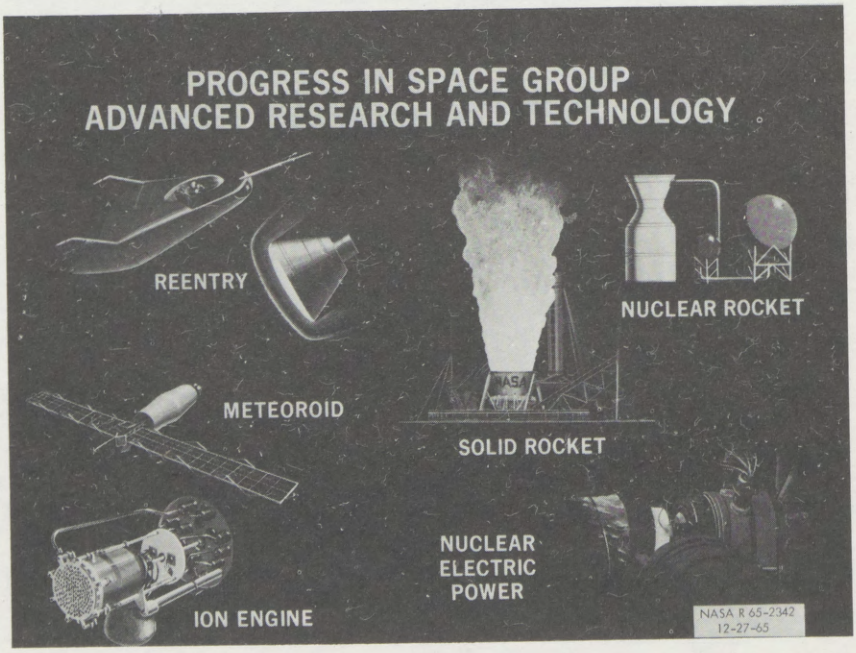

FIGURE 157

In *Space Vehicles*, we have made program changes in fiscal year 1967 to increase work on space radiation as it affects spacecraft materials, devices, and components. This increased emphasis is made possible by the new Space Radiation Effects Laboratory operated for NASA by the three universities comprising the Virginia Associated Research Center.

In *Chemical Propulsion*, work on the M–1 engine will be terminated on completion of component testing now under way. Demonstration of the oxidizer and fuel turbopump performance has been completed. Remaining work, to provide scaling and design information, involves testing of an uncooled thrust chamber to investigate injector and combustion characteristics. In fiscal year 1967, emphasis will be placed on advanced high performance engine concepts. In one approach, higher operating pressures will be used and in a second approach, a toroidal combustion chamber will be employed.

Of the 5.5 million dollars allocated in fiscal year 1966 to the M–1 engine, 2 million dollars has been apportioned to complete the M–1 component test program. In order to initiate new work in fiscal year 1966 on the high performance engine concepts, we request your endorsement of our plan to utilize 3.5 million dollars of fiscal year 1966 M–1 funds.

In the large solid motor program, we successfully fired the free world's largest single rocket motor on September 25, 1965 (fig. 158). The maximum thrust was 3.5 million pounds and the test was over two minutes in duration. A second 260-inch motor firing was conducted February 23, 1966, to verify the design and previous results. In both

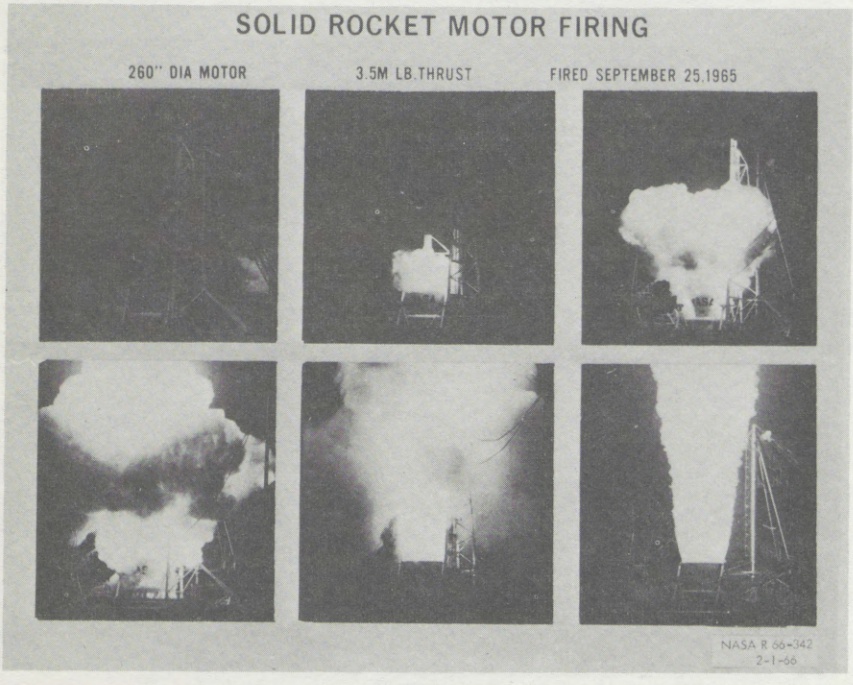

FIGURE 158

tests, performance was in close agreement with predictions. The funds requested for fiscal year 1967, combined with funds from previous years, will cover the cost of an additional firing. The new test will employ a reentrant nozzle, configured similar to a nozzle for thrust vector control. The thrust will be approximately 5 million pounds and the duration 80 seconds. This thrust level will be obtained with a larger nozzle diameter and modification of the propellant to give a higher burning rate. It will also incorporate a failure warning system.

In *Nuclear Rockets*, there were a number of successful tests (fig. 159). Reactor safety and performance tests were conducted during 1965. Starting this February, a complete breadboard system has been in operation. Total operation time from 1965 to date is 153 minutes, half of which has been on the breadboard system. These tests demonstrated altitude specific impulse of over 750 lb-sec/lb—almost twice chemical rocket values—and a thrust of over 50,000 pounds. They also demonstrated start and restart capability and stability over a wide range of operating conditions. In fiscal year 1967, the engine test series will continue as well as other nuclear rocket technology. In addition, we plan to initiate development of a 5,000-megawatt nuclear rocket engine, NERVA, with application to attractive future missions.

In *Space Power and Electric Propulsion*, we plan to continue the SNAP–8 program since power systems in the range of 35 kilowatts are very attractive for several future applications. All the major components of SNAP–8 have successfully operated at full power con-

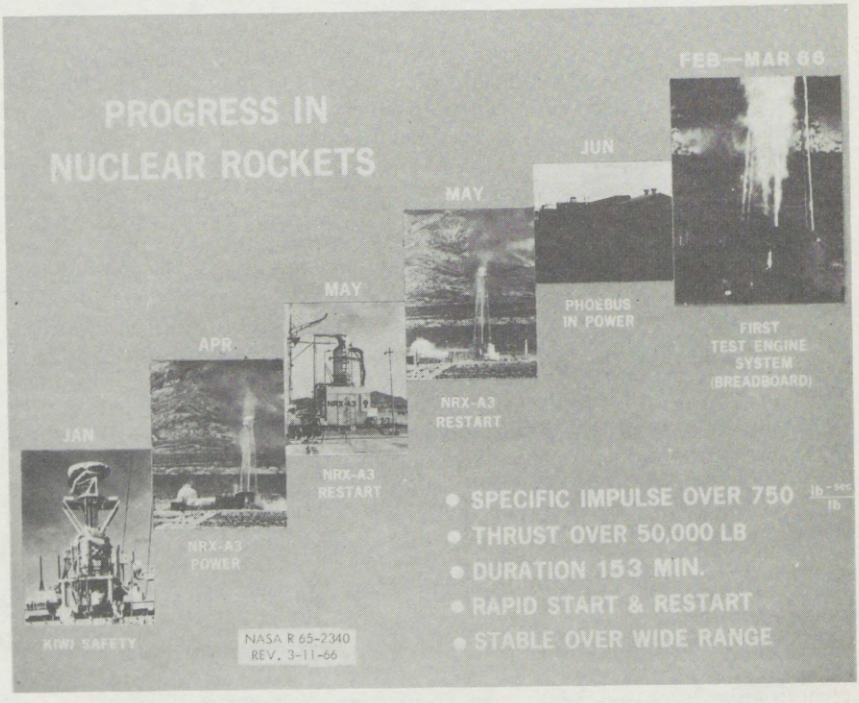

FIGURE 159

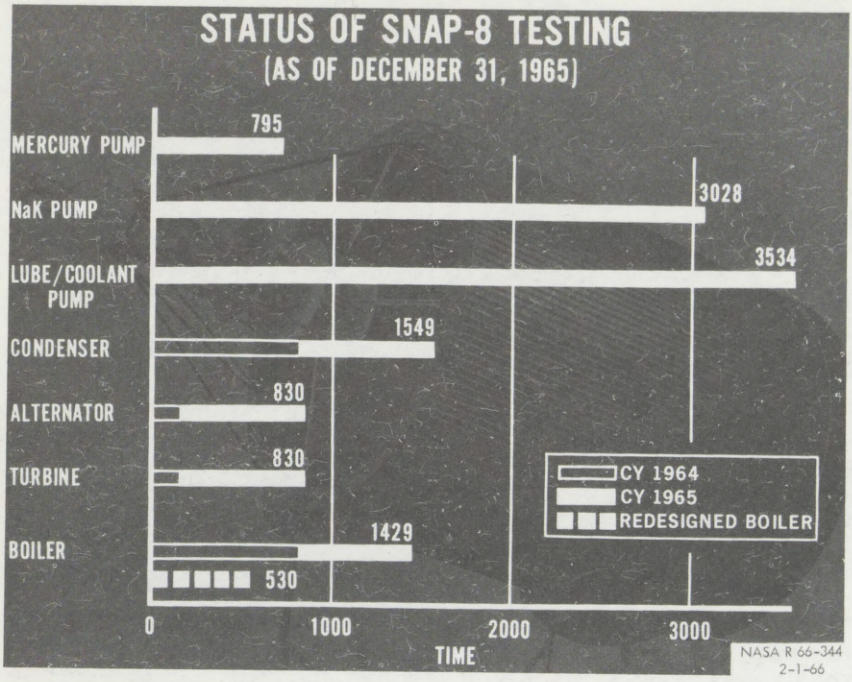

FIGURE 160

ditions and are now undergoing endurance testing (fig. 160). The cumulative test time of the major components ranges from 800 to 3,500 hours. In fiscal year 1967, we plan to continue endurance testing of components.

In *Basic Research*, we plan to continue our level of effort in fluid physics, electrophysics, mathematics, and materials. This work supports both the Aeronautics and Space programs. An example of materials research is an investigation of stress-corrosion of titanium, a desirable material for supersonic transports, compressor parts for jet engines, and tanks for space vehicles (fig. 161).

Titanium alloys are known to crack under low loads and moderately high temperatures when exposed to corrosive substances such as salt. In the upper left is shown the effect of hot salt on cracking. You can observe the region of loads and times where cracks and fractures occur. On the upper right, the plot shows that salt water can greatly reduce the strength of some titanium alloys in a few hours. We have also found that titanium tanks for nitrogen tetroxide can fail from stress-corrosion as illustrated in the lower left. This tank exhibits a break around its entire periphery. Also shown are the many variables under study.

In *Human Factors*, we wish to increase life support and protection systems, bioinstrumentation, and stress physiology. Life support is a key technology for long duration flights, for example, a large weight savings can be realized if oxygen, water, and other supplies can be reclaimed in a closed cycle. In fiscal year 1967, we will continue our research in this area, using newly delivered equipment for manned tests of closed systems.

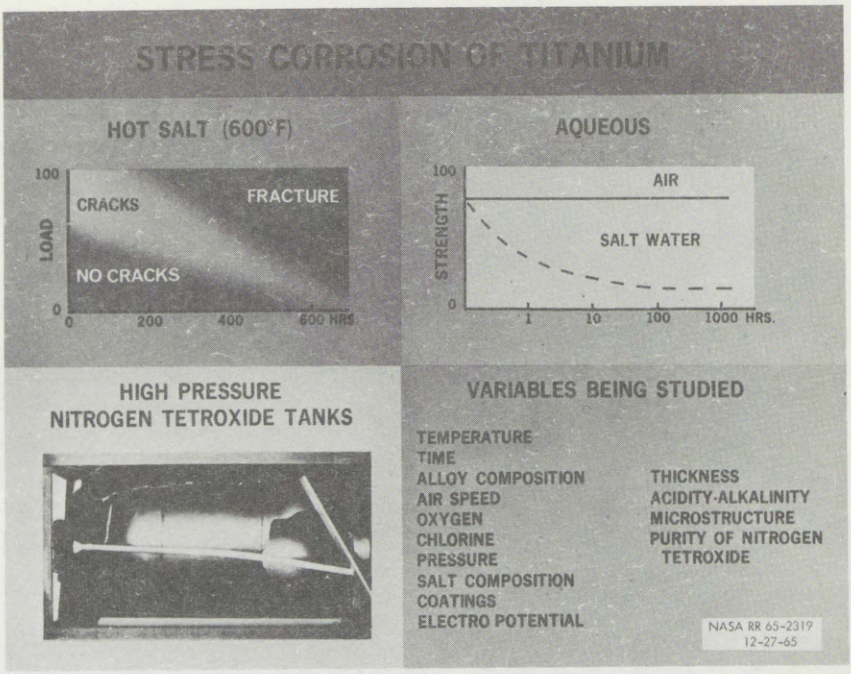

FIGURE 161

Work on bioinstrumentation will be continued to investigate human performance. In stress physiology work, for example, a portable instrument was developed to measure a pilot's or astronaut's heartbeat without interfering with his performance of duties. In cooperation with the Navy, we obtained data from aircraft carrier pilots during actual combat operation (fig. 162). The curves show heart rate and aircraft acceleration measurements during the time the pilot enters the cockpit, takes off and flies a bombing mission, and lands back on the carrier. A significant finding was that heart rates were higher during take-off and landing than during the combat period. These data will be correlated with other measurements of human stress in different environments.

In the *Electronics Systems* program, increased emphasis will be given communications, data handling and processing, and electronic components and techniques. The increased effort will be carried out at the Electronics Research Center for which we are requesting fiscal year 1967 funds for facilities to support qualifications and standards, electrical components, and space guidance laboratories. ERC now leases office and laboratory space in Cambridge. Land acquisition is moving forward so that the first construction contract could be as early as May 1966.

Regarding the requested fiscal year 1967 facilities, present schedules indicate that the Corps of Engineers could use authorized and appropriated funds as early as August 1966.

As an illustration of advances in the Electronics Systems program, I would like to show you some significant results obtained in process-

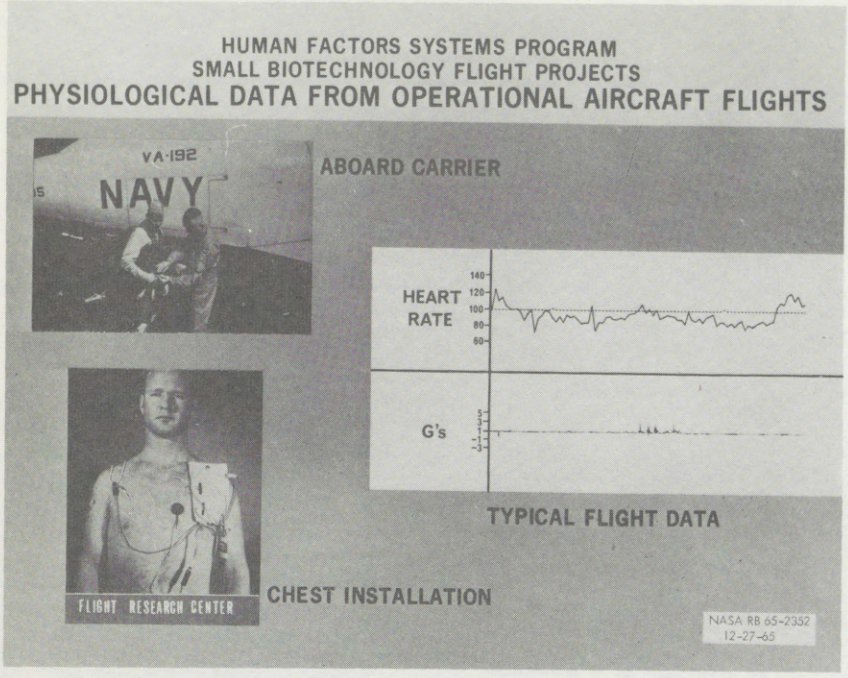

FIGURE 162

ing photographs transmitted from a distant spacecraft. New computer techniques make possible the extraction of significant data from photographs of marginal quality. These techniques were applied by JPL to the pictures of Mars taken by Mariner IV (fig. 163). The picture on the left is as received; the picture on the right shows the same photograph after computer processing. The method of processing corrects for geometrical and camera distortions, improves the picture contrast, removes electrical transmission noise, and restores detail degraded in the transmission process.

I have only briefly highlighted the Advanced Research and Technology program. The past year has been most successful as indicated by the accomplishments cited in detail in the Subcommittee hearings and only touched upon this morning. Our fiscal year 1967 request is shaped to further the advancement of technology which will be required for future missions. Your continued support is essential to preserve the role of the United States as a leader in aeronautical and space technology.

Dr. ADAS. Thank you very much.

The CHAIRMAN. We will next hear from Mr. Edmond Buckley, Associate Administrator of Tracking and Data Acquisition.

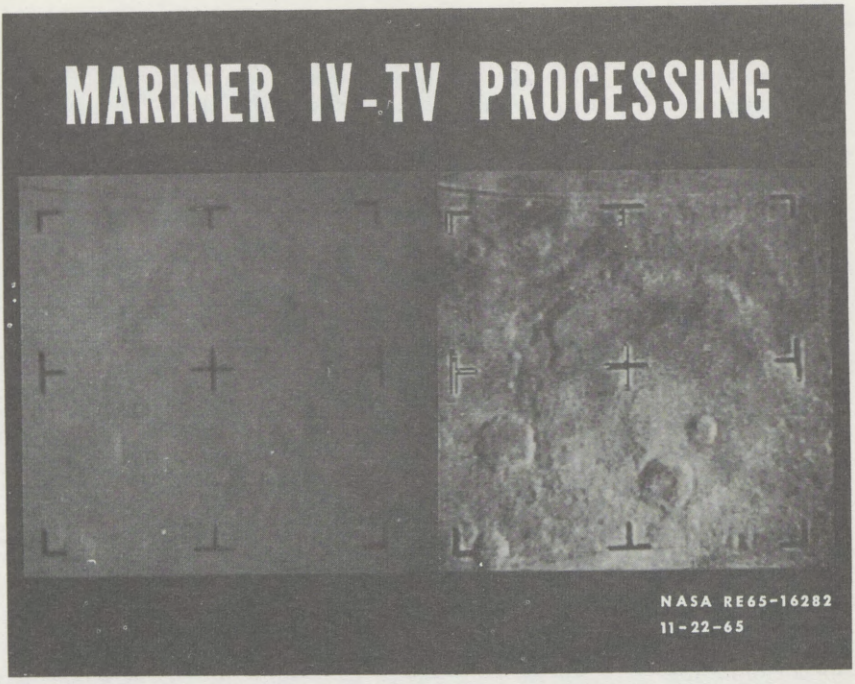

FIGURE 163

STATEMENT OF EDMOND C. BUCKLEY, ASSOCIATE ADMINISTRATOR FOR TRACKING AND DATA ACQUISITION, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. BUCKLEY. Mr. Chairman and members of the committee, it is a pleasure to appear before the committee today to report on the progress we have made in the Tracking and Data Acquisition Program during the past year and to outline our plans for the future. There is a prepared statement available for the record (see p. 195). However, I will be talking today from a very much shorter paper.

During the past year, NASA's program achievements have been very significant. The tracking and data acquisition support provided the flight programs during this period met all established NASA program requirements. In addition, much progress was made in the augmentation of facilities to meet future support requirements. These activities will continue in the coming year with somewhat greater emphasis on operational support of current missions.

During the past year, ten NASA stations, three Department of Defense stations, and two instrumentation ships have been heavily committed to the support of the Gemini Program. Preparations for support of Gemini began in mid-1962 and by October 1964 the stations of the Mercury network had been augmented by the addition of telemetry receivers, command equipment, data processors, consoles, and other equipment and facilities amounting to approximately $55 million. Modification of the network was completed on schedule and

extensive simulations were conducted prior to the beginning of the flight program.

The network has successfully supported all Gemini flights to date, culminating in the unprecedented rendezvous mission of Gemini VII and VI in December of 1965. We made major steps in data handling and control during this mission, which gave us a valuable insight into the increased complexities of the future Apollo missions.

The network will continue to support Gemini missions through calendar year 1966 and into 1967. In the meantime Apollo missions will commence and require tracking and data acquisition support.

The network for support of manned lunar Apollo missions will consist of ten fixed land stations with 30-foot antennas, three stations with 85-foot antennas, one transportable station, five instrumentation ships, and eight instrumentation aircraft. In addition, three 85-foot diameter antenna stations normally used for deep space mission support will be used for support of Apollo.

The schedule for implementing these major augmentations to the network is shown in summary form by the first slide (fig. 169, see p. 199). Our efforts are directed toward having the network fully qualified for lunar mission support by late 1967. Substantial progress toward this goal was made during 1965 in the construction of facilities and we are presently well under way with installation and checkout of station equipment. These activities will continue in 1966 along with testing of the new Unified S-band equipment and initial operational use.

Construction has been completed at seven of the ten 30-foot antenna land stations at Guam; Carnarvon, Australia; Bermuda, Ascension Island; Guaymas, Mexico; Hawaii; and Cape Kennedy, Florida. Equipment installation and checkout at these stations is now under way and will be completed in 1966. Construction at the other three 30-foot antenna stations at Corpus Christi, Texas; Antigua; and Canary Islands will proceed in 1966 so that all of these stations will be operational in 1967.

Manufacturing of equipment for the transportable station has begun, and this station will be operational on Grand Bahama Island in mid-1967.

Facilities with 85-foot diameter antennas are being established at Goldstone, California; Canberra, Australia; and Madrid, Spain, for support of Apollo during lunar phases of the missions.

During 1965, necessary agreements were signed with the Australian and Spanish Governments, and construction is now under way at all three stations to meet operational dates in mid-1967.

The next slide (fig. 172, see p. 201) shows the schedule for the five ships which are being modified and instrumented to operate as integral stations of the network during critical phases of Apollo flights when spacecraft are out of sight of land stations.

Three of the ships, *Vanguard*, *Redstone*, and *Mercury*, are conversions of T–2 tanker hulls for support of the insertion of the Apollo spacecraft into Earth-orbit and the injection into the translunar trajectory. These ships will be deployed in the Atlantic, Indian, and Pacific Oceans.

The other two ships, the *Watertown* and the *Huntsville*, are being modified for coverage of the reentry phase when Apollo spacecraft

return to Earth from the Moon for a Pacific water landing. This capability is being provided by an extensive modernization and equipment updating of two 455-foot ships which had previously been in service with very limited instrumentation capabilities.

Incidentally, the first of the three major ships, the *Vanguard*, was turned over to the Government in February on schedule, with all of the ship work completed. It is in the instrumentation checkout and acceptance phase now.

The instrumentation ships will be operated for NASA by the National Range Division of the Air Force with contract technical crews and Military Sea Transportation Service ship crews. Referring again to the slide (fig. 172, see p. 201), it will be noted that testing and evaluation of the ships and instrumentation systems will begin on the Vanguard in June 1966. Apollo mission support will be provided by the ships during part of the checkout period and all ships will be fully operational and deployed on-site as required for Apollo by mid-1967.

Instrumented aircraft will be used for the Apollo lunar missions to provide telemetry coverage and voice communications with the astronauts during the critical period when the spacecraft is injected into the trajectory to the Moon. The aircraft also will be used to provide supplementary support in the reentry phase.

The high degree of mobility afforded by aircraft is needed because the point of injection will vary from day to day, depending upon the time of launch and the position of the Moon with respect to the Earth. Eight aircraft are required to provide the necessary coverage.

The Air Force is providing eight C-135 aircraft from inventory to be modified for this purpose. The modifications are being done under the overall management of the National Range Division (NRD) of the Air Force Systems Command (AFSC) to detailed technical specifications developed by NASA.

Supervisory responsibility for the project has been assigned to the Air Force Electronic Systems Division at Hanscom Field, Massachusetts.

In April 1965, fixed-price contracts for the Project Definition Phase were awarded to two contractors selected by NASA and DOD from nine firms submitting proposals. Based upon a joint NASA and DOD evaluation of the plans submitted by the two contractors, a fixed-price-incentive contract for modification of the aircraft and installation of instrumentation was awarded in October 1965 to a contractor team composed of Douglas Aircraft Corporation and Bendix Radio Division. The first two aircraft are scheduled to be operational early in 1967 with all aircraft to be fully operational by the end of 1967.

The activities at deep space facilities in 1967 were highlighted by the successful support of the Mariner IV, Ranger VIII, and Ranger IX missions.

The very excellent support provided for the Mariner IV mission permitted the spacecraft to pass within 6,000 miles of Mars on July 14, 1965, and to take the first close-up pictures of the Martian surface. After a flight of 325 million miles and an elapsed time of 228 days, there was a deviation of only 1,000 miles from the projected fly-by distance of 5,000 miles.

The deep space facilities continued to support the Mariner IV spacecraft until October 1, 1965, establishing a new two-way commu-

nications record of 191 million miles between network stations and the spacecraft. It was during this post-encounter period that the 22 photographs of Mars were transmitted back to Earth.

Less publicized than other aspects of the Mariner IV mission, but also of significance, was the occultation experiment which provided data for studying the Martian atmosphere. This experiment involved precise measurement of telemetry signals as the spacecraft passed behind the planet and again when it came into view. From analysis of this data, scientists have inferred that the surface pressure of Mars is less than 1 percent of that of Earth.

On January 4, 1966, the deep space instrumentation facility at Goldstone, Calif., again received a signal from the Mariner IV spacecraft over a distance of 216 million miles. It is planned to reestablish communications in mid-1967 when the spacecraft returns to within 30 million miles of Earth.

During the period Mariner IV was en route to Mars, the Ranger VIII and Ranger IX missions were launched in February and March 1965, respectively. In supporting Mariner and Ranger missions concurrently, the deep space facilities worked out the problems of supporting more than one deep space mission at the same time.

The workload on deep space instrumentation facilities will increase in 1966 and especially in 1967 (fig. 179, see p. 207). Pioneer VI was launched December 16, 1965, and this will be followed by four flights which will require support through 1968. Surveyor and Lunar Orbiter missions are scheduled to begin later this year with support extending into 1968. In 1967, support also will be required for the planned Mariner mission to Venus and for reacquisition of the Mariner IV spacecraft as it nears the Earth. The effect of the Apollo Program also must be taken into consideration in our planning since deep space facilities will provide support during Apollo lunar missions.

In anticipation of this workload, project-peculiar equipment is being installed at selected network stations and the capacity of the Space Flight Operations Facility at Pasadena is being expanded.

Much progress was made in 1965 on the first 210-foot Advanced Antenna System located at Goldstone, Calif. The entire antenna structure was erected and the actuation of all mechanical elements was demonstrated. Acceptance testing is underway and the facility is scheduled to be operational fairly early this year.

The unmanned satellite support facilities of the NASA tracking and data acquisition network support a wide variety of NASA, DOD, and international space programs. In 1966, the average number of satellites to be supported is expected to increase to more than 35, and in 1967 it is estimated to exceed 40. These spacecraft collectively will contact network stations more than 650 times daily. Among the new satellites to be supported in 1966 will be the Orbiting Astronomical Observatory, the Biosatellite, and the Applications Technology Satellite.

The increasing number of satellites is only one of the reasons for the growing workload of the satellite support facilities. Other factors are the greater number of scientific experiments carried by the newer satellites, which results in more transmitted data, and the more complex control features on satellites such as the Orbiting Astronomical Observatory and the Applications Technology Satellite which must be commanded from ground stations.

At the Goldstone and Rosman stations, facilities are being modified and equipment is being installed in preparation for support of the Applications Technology Satellite. These augmentations will be completed in 1966.

All NASA operational communications requirements are handled through the facilities of the NASA Communications System (NASCOM) which is managed by the Office of Tracking and Data Acquisition and operated by the Goddard Space Flight Center. This system provides reliable and rapid communications between all ground stations and control centers functioning as an integral part of the global instrumentation network.

During the past year, much effort has been directed toward meeting the communications requirements of the Apollo Program. In Project Mercury, when communications to the control center could not be maintained, the relatively small amount of critical data could be monitored, interpreted, and utilized at remote tracking stations by trained on-site flight controllers. The same situation generally prevails in the Gemini Program although the increased amount of data has required the installation at each key station of a data processing system to digest, summarize, and display information required for real-time decisions.

However, for the extremely complex Apollo lunar missions, real-time operational control will be maintained in the mission control center where large-scale data processing facilities and technical specialists will support the flight director in exercising mission control. This requires fully reliable communications links to all land stations and ships and communication links of a much higher capacity than are being used for Gemini.

For Apollo, communications must be markedly increased to provide the required centralized real-time control. These circuits will pass to the mission control center essential data such as the status of propulsion, electrical power, and life support systems; reports of critical events such as staging and engine ignition; and, of course, vital voice communications and tracking data. The circuits will also provide for the transmissions of commands to the spacecraft.

There are six stations planned for Apollo support that presently do not have the requisite communications capability for Apollo. From studies conducted with the National Communications System (NCS), it became evident that the Apollo communications requirements could not be met by conventional systems alone, but could be met through use of a communications satellite system.

In June 1965, NASA requested the manager of the NCS to initiate discussions with the Communications Satellite Corporation to determine whether it could provide the required service. A proposal was submitted by the Communications Satellite Corporation and evaluated by a joint NCS working group. As a result of this evaluation, the Secretary of Defense, who is the Executive Agent of the NCS, authorized NASA to act for NCS in negotiating with the Communication Satellite Corporation for the required communications services.

These communications satellite services will be provided to the three land stations at Canary Island, Ascension, and Carnarvon, Australia, and to three instrumentation ships. To receive this service, the ships must be equipped with communications terminals. Funds have been

reprogramed for this purpose and negotiations with the ship contractor have been completed to incorporate the changes.

During the past year a supplement to the joint agreement on design, acquisition, and modification of Apollo/Range Instrumentation Aircraft was executed which provides for cost sharing in this project. NASA is funding overall instrumentation and communications modifications, and DOD is funding some additional optical equipment required for DOD use. This results in a funding ratio of approximately 95 percent for NASA and 5 percent for DOD.

Agreement also was reached on funding for the maintenance and operation of Apollo instrumentation ships and aircraft. This agreement provides for sharing of the costs on the basis of the estimated proportion of use of the ships and aircraft for support of NASA and DOD projects. For example, in fiscal year 1967, NASA will fund about $14 million of a $17 million total cost for operating the ships which is approximately an 82½ percent versus 17½ percent. This ratio will be adjusted annually depending upon the yearly use.

The Environmental Science Services Administration (ESSA) is initiating the TIROS Operational Satellite system in 1966. Ground support for this system will be provided by 85-foot antenna facilities at Fairbanks, Alaska, and Wallops Island, Virginia.

The Fairbanks station will be operated under NASA's contract for maintenance and operation of large data acquisition facilities. ESSA will reimburse NASA for these services as well as for communications and other related costs. The station at Wallops will be operated by ESSA civil service personnel.

In closing, I would like to express my appreciation for this opportunity to report to the Committee on our progress and plans. Your continued support will assure our capability to provide effective tracking and data acquisition support for flight projects in the future, as in the past.

Mr. Chairman, this concludes my statement.

The CHAIRMAN. Thank you very much, Mr. Buckley.

Mr. Daddario?

Mr. DADDARIO. No questions.

The CHAIRMAN. Mr. Rumsfeld?

Mr. RUMSFELD. I would like to comment briefly on Dr. Adams' statement concerning research and operational problems, particularly noise. As I recall, it was in the fiscal 1965 budget that the committee increased the funding for NASA's effort in this area. Is that your recollection?

Dr. ADAMS. In fiscal 1965 did you say?

Mr. RUMSFELD. I believe the committee took some action to increase funding in the area of research on aircraft.

Dr. ADAMS. Yes, I understand it was increased about a million dollars.

Mr. RUMSFELD. Do you feel that the funding that has been requested this year is adequate for the problem as you see it in this area?

Dr. ADAMS. This year we have in the noise area a total of $3 million—this is in noise and sonic boom—as compared with $2 million in fiscal 1966.

We are using this money primarily for development of suppressors for both the exhaust as well as the components of the engine. We feel we can do a substantial amount of work in the laboratory with this money.

Now, as the program would evolve more toward actual flight tests of these suppressors that we are working on in the laboratory, then the expenditures will be required to increase, and hopefully we would see this effort going into the area of flight test of the suppessors in the future.

Mr. RUMSFELD. I see a variety of Congressional committees funds being spent for higher speed aircraft and the development of higher speed aircraft and the noise problem increases with this, and, of course, the population shifts in country bring about additional problems in this connection. I just would hate to see us arrive at a point a few years in the future where we would not keep pace with this.

Dr. Newell, I have one question, on page 5, concerning your testimony on the Sustaining University Program. You indicate there were 3,000 doctoral candidates in some 50 universities. What is the maximum number in any one university, just out of curiosity?

Dr. NEWELL. Congressman, the 3,000 doctoral candidates are in some 140-plus universities. The 50 universities are those that have our general supporting research grants from the Sustaining University Program.

Mr. RUMSFELD. Which is also distinct from the facility grants that are going to a completely different category?

Dr. NEWELL. That is correct.

Mr. RUMSFELD. So it is 150 universities where the doctoral candidates are?

Dr. NEWELL. Yes, roughly.

Mr. RUMSFELD. Do you know the maximum number at any one university?

Dr. NEWELL. The maximum number is 45.

Mr. RUMSFELD. Will this peak off as far as future year plans?

Dr. NEWELL. It is approaching a level. This year the numbers that we are adding are dropping, and the maximum number that we add every year is in the neighborhood of 15. One must take into account that it takes several years for a person to get out of a given university which may have up to 45 students in the program at one time.

Mr. RUMSFELD. Does NASA look at this as a program which would then level off and continue at a certain level or does NASA look at this program as a stimulus to make up for lost time and to develop the capabilities immediately needed and, hopefully, that they would then, or that the interest in the country would then sustain the program.

Dr. NEWELL. Our thought was that our primary job was to provide a stimulus to get work going in this area and that we should continually reassess the need for the program in the light of such things as our space science and applications effort, the Apollo effort, and so on. We projected that for some years into the future the program should go at a level which would produce a rate of about a thousand Ph. D.'s per year. As I say, we plan to continually reassess that need in the light of other programs in the Department of Education, the Science Foundation, our own growing programs, and so on.

Mr. RUMSFELD. Thank you.

The CHAIRMAN. Mr. Karth?

Mr. KARTH. Mr. Chairman, I know our time is limited. I have one question for Dr. Mueller.

Dr. Mueller, you are aware of the fact this committee has had a long, and continues to have, interest in development of large solids. We have had this interest because we feel that large solids will provide us with reliability, simplicity, and, once developed, substantial economies. I wonder, from the vantage point of manned space flight, whether or not you could tell us whether a combination of 260-inch solid-S–IVB would fit between the Saturn I and Saturn V and whether or not you have any plans to proceed along that line.

Dr. MUELLER. Mr. Karth, we have, of course, been examining the use of new launch vehicles in our advanced studies program for several years. We have looked at the combination of a 260-inch solid with S–IVB second stage. We have compared that with the use of the present Saturn IB or S–IB first stage with solid rocket motors attached to the S–IB stage, and we have also looked at other alternatives to this utilization of the present technology, or at least the technology we are developing. In all of these examinations the basic consideration of the need for additional weight in orbit has been a consideration that has caused us to look at this from the standpoint of trading off the costs of the development of a new vehicle versus the utilization of the present vehicles. One finds, of course, that we really are not in a position to fully utilize the investment we have already made in the Saturn IB project at this point in time.

As you know, our fiscal year 1967 request holds open the option for continuing that project and a decision on exercising the option to utilize the Apollo established capability. A determination as to the magnitude of the follow-on program associated with the manned space flight is required. It does not appear prudent to assume that we will even develop a new launch vehicle. We have also looked at it from the standpoint of what the requirements are as we foresee them in the next several years, for larger launch vehicles. It would appear that one could economically use the present two launch vehicles, the Saturn IB and Saturn V, for the missions that we have defined in the manned space flight program, so that there does not appear to be a need for the development of a new launch vehicle from the standpoint of the missions that we have defined.

Both from the standpoint of the development program itself and the utilization of the facilities and trained people and both for manufacturing and launching them, and from the standpoint of the projected needs as we presently see them, it does not appear to be desirable to initiate the development of a new launch vehicle.

Mr. KARTH. If you found it to be desirable, where would it fit between the S–IB and SV—halfway between?

Dr. MUELLER. The present indications are that the 260-inch solid with the S–IVB second stage would provide the capability of placing something like 80,000 pounds into Earth orbit. It is roughly twice the payload capability of Saturn IB. The solid rocket strap on to the Saturn IB's provide something like the same payload—perhaps a little less.

Mr. KARTH. Thank you.

The CHAIRMAN. Mr. Hechler?

Mr. HECHLER. Mr. Mueller, following on Mr. Karth's question, the testimony before the Subcommittee on Advanced Research and Technology revealed it would take about 50 percent of the costs of liquids to develop the 260 solid to a manned rated system. I wonder if you would speculate about post-Apollo missions for a minute and indicate to me whether the Office of Manned Space Flight would object violently if this committee should vote additional funds for both the 260-inch solid rocket motor development, and in addition to that add funds for on-board nuclear power such as SNAP–8?

Would it make you sleep any better at night, if and when you do get your post-Apollo missions, if you felt that these programs were moving any more rapidly?

Dr. MUELLER. Clearly, Mr. Hechler, I am always in favor of more funds that can be applied to useful objects in the national space program. I think that more funds, particularly for the development of nuclear power, both from the standpoint of nuclear propulsion and the application of that to post-Apollo activities, as well as the application of funds to the nuclear electrical power sources, is an important future development.

Now, I do believe from what I know of the situation that we do have at the present time a balanced program in the development of these devices, and in looking at the total NASA program, I believe that we have achieved about as good a balance as one can achieve in the expenditures of the funds.

Mr. HECHLER. Dr. Adams, on page 2 of your testimony, you indicated that OART budget would increase $16.1 million. I wouldn't want the impression to be left that this represents a major forward movement on the part of OART. As I pointed out yesterday, the research and development aspects of OART, exclusive of administrative operations, have repeatedly declined and have shown a decline for fiscal 1965, 1966, and 1967. I would certainly hope that you are not coming in as a new Associate Administrator to preside over the liquidation of a highly important office. I would hope that this downward trend would be reversed.

I do have one quick question to ask Mr. Buckley. I believe this is the first time you have appeared before the full committee as an Associate Administrator. I extend our congratulations to you.

Mr. BUCKLEY. Thank you.

Mr. HECHLER. Your budget, Mr. Buckley, for tracking and data acquisition is pretty much at the mercy of the requirements that are imposed by the operations offices of NASA. I wonder if you could indicate to us what is the mechanism that exists within NASA for keeping tracking and data acquisition budgets under control, within bounds and within limits.

Mr. BUCKLEY. The requirements are initiated by Centers and come up to the appropriate headquarters program office where they are reviewed. There is discussion then between that program office and my office about how to get the job done and whether it can be done any cheaper or whether this is technically the right way to do it or not.

Once generated, requirements are subjected to a number of reviews and, in some cases, periodic reviews. For instance, the data required by experimenters working on Dr. Newell's programs are reviewed periodically in an effort to hold down the amount of data taking.

Dr. Mueller and myself and the people in our offices work together almost continuously in an effort to minimize the requirements in the manned space flight area.

Mr. HECHLER. I wonder, Mr. Buckley, could you expand on this answer for the record?

(The information requested follows:)

OFFICE OF TRACKING AND DATA ACQUISITION

INFORMATION FOR THE RECORD

The size of the budget for the Tracking and Data Acquisition Program is directly related to the level of tracking and data acquisition support that is provided for flight projects. To control this support, procedures have been established for the documentation and approval by NASA management of the requirements for such support and the plans for providing it.

Support documentation and approval procedures for unmanned space flight projects are set forth in NASA Management Instruction 8430.1, text of which is included below. Similar procedures have been followed in establishing support requirements and plans for manned space flight projects since Project Mercury, and are being formalized in a management instruction which is in preparation at this time.

In implementing these procedures, tracking and data acquisition personnel maintain close association with the project and program offices throughout the life of a flight project to assure that adequate tracking and data acquisition support is provided at minimum cost. There are frequent, almost daily, contacts between project personnel and tracking and data acquisition personnel at field centers on specific problems, and complete project reviews are held periodically, involving both Headquarters and field center personnel. During this continuing review, the "hard" requirements for tracking and data acquisition support are identified and agreed upon so that the support documents which are finally approved, in fact, represent compromises between the project and support groups. It is these documents that form the basis for any changes in the operation of the network and for the procurement of any additional tracking and data acquisition equipment or facilities which are required for the project.

To control tracking and data acquisition support on a long-range basis, the Office of Tracking and Data Acquisition has membership in such NASA groups as the Planning Review Panel and the Space Science Steering Committee. In this manner, OTDA becomes cognizant of upcoming support requirements during the early planning phase of projects, and is able to guide these requirements so that they fall within the limits of technical feasibility and resource availability. As a result, long range requirements can be reasonably constrained and development efforts can be initiated on a timely basis, if necessary, to provide new support capability.

In summary, OTDA exercises continuing surveillance to assure that tracking and data acquisition support is provided at minimum cost without imposing undue restrictions on the objectives of the project.

MANAGEMENT INSTRUCTION

Subject. *Documentation of tracking and data acquisition support for NASA unmanned space flight projects.*

1. PURPOSE

This Instruction establishes the policy, authority, responsibility and procedures for documenting requirements and plans for tracking and data acquisition or range support of unmanned NASA flight projects.

2. APPLICABILITY

(*a*) This Instruction is applicable to NASA Headquarters, field installations and the Jet Propulsion Laboratory. For the purpose of this Instruction, the term "field installation" shall be construed to include the Jet Propulsion Laboratory.

(*b*) This Instruction is applicable to all new unmanned space flight projects except nonorbiting spacecraft launched from Wallops Island, initiated after the effective date of this Instruction and to the following projects already in progress: Lunar Orbiter, Biosatellite, Pioneer, and Surveyor.

3. DEFINITIONS

For the purpose of this Instruction, the following definitions apply:

(*a*) Tracking and data acquisition is the acquisition, transmission and processing of information which enables the determination of space vehicle position, velocity, direction, system and subsystem performance, and experiment measurements, all with respect to a common time base.

(*b*) Program requirements document (PRD) is the form prescribed by the Department of Defense for submitting to the National Range Commanders requirements for support by the National Ranges.

(*c*) Program support plant (PSP) is the form prescribed by the Department of Defense by which the National Range Commanders document plans for meeting the requirements in the PRD.

(*d*) Support instrumentation requirements document (SIRD) is the series of NASA forms prescribed in Attachment A for use in documenting and submitting requirements for support by NASA tracking and data acquisition facilities.

(*e*) NASA support plan (NSP) is the document by which managers of NASA tracking and data acquisition facilities document plans for meeting the requirements of the SIRD.

(*f*) Tracking and Data Acquisition Support Center (T/DA Center) is a NASA field installation designated by the Associate Administrator for Tracking and Data Acquisition, NASA Headquarters, for support of a specific unmanned space flight project.

(*g*) Launch vehicle systems manager is the Center official whom the Director of the Center designates to be responsible for the procurement of the launch vehicle and for insuring availability of launch support.

4. BACKGROUND

(*a*) Most NASA unmanned space flight projects have been managed by the same field installation responsible for rendering tracking and data acquisition support. This enabled a single Field Installation Director to exercise an integrated control over spacecraft configuration, support requirements, and associated tracking and data acquisition facilities. NASA programs now are developing toward increasingly varied and complex goals requiring corresponding development of tracking and data acquisition facilities. Management of some flight projects has been assigned and may continue to be assigned to field installations other than those that manage the tracking and data acquisition facilities. This leads to the need for a common means of delineating support requirements and planning the necessary facilities to meet such requirements.

(*b*) A support instrumentation requirements document (SIRD) has been developed for documenting that portion of the tracking and data acquisition support requirements of a NASA unmanned flight project which is to be supported by facilities under NASA cognizance. The SIRD complements the PRD and together they describe completely the tracking and data acquisition support requirements for a designated flight project. Use of the PRD/SIRD documents will aid substantially in clearly delineating support requirements in a format most useful and readily understood by all personnel concerned with planning unmanned project flight and support for such flights.

5. POLICY

(*a*) Requirements for tracking and data acquisition support shall be documented at the earliest practical date to insure sufficient time for—

(1) Scheduling and planning use of facilities.

(2) Planning needed modification of existing facilities.

(3) Developing and procuring any additional facilities needed for adequate ground support.

(*b*) Support requirements shall be documented with sufficient accuracy and completeness to permit development of detailed support plans. Continuous and effective liaison will be maintained between the Project Manager, Launch Vehicle Systems Manager, and the Tracking and Data Acquisition Systems Manager.

6. AUTHORITY AND RESPONSIBILITY

(*a*) The Associate Administrator for Tracking and Data Acquisition, NASA Headquarters, is responsible for—

(1) Designating a NASA Field Installation as the Tracking and Data Acquisition Support Center for support of a specific unmanned space flight project. This designation will be accomplished by memorandum from the Associate Administrator for Tracking and Data Acquisition immediately after approval of the Project Approval Document (PAD) unless the designation is included in the PAD.

(2) Approving all NASA support plans (NSP's) generated in response to requirements expressed by a SIRD.

(3) Insuring availability of resources committed by the NASA support plan.

(4) Prescribing the use of NASA forms and detailed procedures for the Support Instrumentation Requirements Document.

(*b*) The Officials-in-Charge of Headquarters Program Offices are responsible for approving the SIRD and submitting it to the Associate Administrator for Tracking and Data Acquisition.

(*c*) The Director of the Tracking and Data Acquisition Support Center is responsible for—

(1) Providing support called for in the NSP approved for a specific unmanned space flight project, and

(2) Designating a Tracking and Data Systems Manager to perform the functions set forth in subparagraph d, such designation to take place immediately after the Support Center responsibility is assigned.

(*d*) The Project Manager is responsible for—

(1) Preparing the Support Instrumentation Requirements Document (SIRD).

(2) Initiating through the Launch Vehicle Systems Manager, the preparation of the Program Requirements Document (PRD).

(*e*) The Tracking and Data Systems Manager is responsible for—

(1) Reviewing the SIRD and the instrumentation portions of the PRD:

(a) for compatibility of requirements imposed by the two documents; and

(b) to determine that all tracking and data acquisition requirements are imposed on the appropriate DOD or NASA organization for support.

(2) Preparing a NASA Support Plan in response to the SIRD.

(3) Reviewing the instrumentation portions of the PSP to insure:

(a) compatibility between the PSP and the NSP; and

(b) that all support planning is properly integrated and is complete.

(*f*) The Launch Vehicle Systems Manager is responsible for—

(1) Preparing and forwarding the PRD in accordance with Department of Defense criteria.

(2) Advising the Project Manager of any launch support instrumentation required of NASA Tracking and Data Acquisition facilities.

7. PRD-PSP PROCEDURES

(*a*) At the earliest practical date following approval of the Project Approval Document (PAD) the Project Manager will request the Launch Vehicle Systems

Manager, by memorandum, to prepare and submit the PRD. The Launch Vehicle Systems Manager will prepare the PRD and submit it to the National Range Commander via the appropriate NASA representative at the range—concurrently sending copies of instrumentation portions of the PRD to: (1) the Associate Administrator for Tracking and Data Acquisition, NASA Headquarters; and (2) the Director of the Tracking and Data Acquisition Support Center (Tracking and Data Systems Manager).

(*b*) The Tracking and Data Systems Manager will review the instrumentation portions of the PRD for compatibility with the SIRD and will advise the NASA representative at the range of any additional requirements necessary for operational compatibility between Department of Defense and NASA tracking and data acquisition facilities. Information copies will be sent to the Project Manager and the Launch Vehicle Systems Manager.

(*c*) The NASA representative at the range will forward the PRD to the National Range Commander and coordinate with him in the preparation of the Program Support Plan (PSP). The PSP will be distributed in accordance with established DOD/NASA procedures, insuring that a copy is sent to the Tracking and Data Systems Manager.

(*d*) The Tracking and Data Systems Manager will—

(1) Review the instrumentation portion of the PSP for adequacy and compatibility with the NSP (see paragraph 8c), and

(2) Submit comments to the Project Manager, the Launch Vehicle System Manager and to the Associate Administrator for Tracking and Data Acquisition, NASA Headquarters.

Particular attention will be given to any proposals for significant additional facilities.

8. SIRD–NASA SUPPORT PLAN PROCEDURES

(*a*) At the earliest practical date following approval of the Project Approval Document, the Project Manager will prepare a SIRD for his project and submit it to the Director of his field installation for review and transmittal to the Associate Administrator at NASA Headquarters having Program Management responsibility for the project. The Associate Administrator or his designated representative will review the SIRD, approve it and submit it to the Associate Administrator for Tracking and Data Acquisition. The Associate Administrator for Tracking and Data Acquisition will review the approved SIRD for impact on resources planning and transmit it to the Director of the Tracking and Data Acquisition Support Center (Tracking and Data Systems Manager).

(*b*) Upon receipt of the approved SIRD, the Tracking and Data Systems Manager will prepare a NASA Support Plan (NSP) in response to the SIRD, clearly identifying all major new resources needed. Concurrently, he will examine his copies of the instrumentation portions of the PRD–PSP documents to insure compatibility with the SIRD–NSP documents. He will then submit the NSP, via the Director of the Tracking and Data Acquisition Support Center, to the Associate Administrator for Tracking and Data Acquisition, NASA Headquarters.

(*c*) The Associate Administrator for Tracking and Data Acquisition will—

(1) Review the NSP noting what additional facilities or other resources, if any, will be required and initiate appropriate actions to correct the deficiencies;

(2) Approve the NSP, indicating what actions, if any, were initiated, and transmit the document to the Official-in-Charge of the cognizant Program Office who will forward it to the Project Manager.

(*d*) The Project Manager will review the PSP and NSP to determine that the project will be supported, as required, to achieve the Project Mission.

ROBERT C. SEAMANS, Jr.,
Associate Administrator.

FORMS REQUIRED FOR THE SUPPORT INSTRUMENTATION REQUIREMENT DOCUMENT

The following forms shall be used when preparing the Support Instrumentation Requirements Document as set forth in NASA Management Instruction 4–1–8.

Title	*NASA Form No.*
Front Cover	Unnumbered
Approval	985
Revision Control	986
Table of Contents	987
Security Classification—DOD	988
Security Classification—Command System	988a
Security Classification—Launch Schedule	988b
Responsibilities for Management, Operations and Support	989
Project Description	990
In-Orbit Operations—Spacecraft and Ground Systems	992
Flight Sequence	1006
Launch Vehicle Description	994
Spacecraft Description	996
Orbital Parameters	997
Trajectory Data	991
Space Path	998
Trajectory Profile	993
Earth Projection—Orbital Spacecraft	999
Earth Projection—Lunar/Planetary Probes	995
Spacecraft Telecommunications	1000
Spacecraft Telecommunication System Design Parameters	1002
Tracking Requirements	1001
Telemetry Data Acquisition Requirements	1003
Ground Command Requirements	1005
Special Requirements	1007
Data Rate Profile	1009
On-Site Data Processing and Display Requirements	1010
Central Facility Data Processing and Display Requirements	1004
Data Distribution	1011
Ground Communications	1012
Communications Requirements Diagram	1013
Timing	1014
Technical References	1016
Facility Requirements	1191
Back Cover	Unnumbered

An initial supply of the above forms has been furnished to NASA field installations involved in unmanned spaceflight programs. Additional forms may be obtained from the Administrative Services Division (Code BAM–4), Office of Administration, NASA Headquarters.

Mr. HECHLER. I want to shoot one other quick question. Are you talking any more frequently to the radio astronomers?

Mr. BUCKLEY. We have recently been to their station out in West Virginia and down to their headquarters in Charlottesville. We are formalizing a procedure by which radio astronomy experimenters can request the use of our antenna facilities during periods when they are not required for flight program support. This procedure will include an advisory committee with members from the scientific community to review and recommend experiments to be conducted on NASA facilities, and will facilitate cross-fertilization of ideas.

Mr. HECHLER. Excellent.

Thank you.

The CHAIRMAN. Mr. Roush.

Mr. ROUSH. No questions, Mr. Chairman.

The CHAIRMAN. Mr. Cabell?

Mr. CABELL. No questions.

The CHAIRMAN. Following on what Mr. Hechler has said, have you talked to the people in Australia, at Parkes? Couldn't that serve a good deal of the same character and in the same way that the Jodrue Bank instrument is used by the Russians?

Mr. BUCKLEY. I think, sir, it might work out much better for two reasons, one of which is that technically it is a much better facility. On the Mariner IV project there was equipment at Parkes and it was checked out daily and the facility was on standby status. If anything happened to our stations, the Parkes antenna would come right on the line.

As you know, we have made extensive use of some of the design techniques developed for the Parkes antenna, as well as structural deflection obtained for us, in designing our own 210-foot facility at Goldstone.

Dr. Bowen, the Director of that facility, was in this country recently and I saw him again in Australia and we are going to continue our relationship, and I think increase it a little bit. The details haven't been worked out yet though.

The CHAIRMAN. I was just going to say, Dr. Mueller, I can understand some of my colleagues' interest in the large solids and I realize that we have a well balanced program and I realize at the present time we are going through a period where we have got to watch all of our pennies because we are in competition and we have a war that is going on, but I hope it never dulls our desire to go forward in the whole field. I am conscious of one time out at the Air Force Academy, of talking to Gen. Benjamin Foulois. I think you all know General Foulois. You know he is a rather earthy fellow. I said, "General, we are working in space. We are about where you were in 1909."

He said, "Hell, young man, you aren't even where we were in 1907."

So we don't want to get trapped with 1909 or in 1907 type of airplanes and try to apply that to the space program. We have to continue to go forward.

I am certain that 35 years from now you can all look back like General Foulois and talk about the terrific things you had to work with in this decade, so let's go forward.

Mr. HECHLER. Could I ask a question?

The CHAIRMAN. Yes.

Mr. HECHLER. Dr. Mueller, after the very successful test on February 26, of the Saturn IB, there was some talk that this might make it possible to achieve a manned lunar landing as early as 1968. I wonder if you would comment on this?

Dr. MUELLER. Mr. Hechler, there are always problems associated with a development program of this magnitude. Although this test was successful, a series of tests following this one also have to be suc-

cessful. My own view is that we are striving very hard to move the date of the first lunar landing as far forward as possible, and yet I think the realistic goal of landing some time in calendar year 1969 is the only realistic way of expressing it.

Mr. HECHLER. Thank you.

The CHAIRMAN. Thank you very much.

Gentlemen, we appreciate your being here. I want to congratulate you, one and all, upon not only your statements but the fine work that you are doing. I hardly can conceive of a better team than has been put together by Mr. Webb, and we are all proud of you.

As far as the members of the committee are concerned, a memorandum is going out to you giving the schedules starting Wednesday, March 16. If we can hold to this, we should get to the Floor with our bill before Easter.

The committee now stands adjourned until Wednesday, March 16, when we will meet in Executive Session to receive the report of the Manned Space Flight Subcommittee and will go on with those executive sessions until we get that completed. I have allotted 3 days to it. I hope we can do it in 2.

The committee stands adjourned until March 16.

(Whereupon, the hearing was adjourned at 11:30 a.m., to reconvene, Wednesday, March 16, 1966.)

(The complete prepared statement of Edmond C. Buckley follows:)

PREPARED STATEMENT OF EDMOND C. BUCKLEY, ASSOCIATE ADMINISTRATOR FOR TRACKING AND DATA ACQUISITION, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Mr. Chairman and members of the committee, it is a pleasure to appear before the committee today to report on the progress we have made in the Tracking and Data Acquisition Program during the past year, to outline our plans for the future, and to present our fiscal year 1967 funding requirements.

OBJECTIVE

The objective of the Tracking and Data Acquisition Program (fig. 164) is to provide effective support for all NASA flight projects. Types of support provided are:

(*a*) Tracking of spacecraft to determine their precise location and trajectory in space;

(*b*) Acquisition of scientific and engineering data transmitted from spacecraft via telemetry;

(*c*) Transmission of commands from ground stations to direct the performance of specific missions by the spacecraft;

(*d*) Communication of voice information and data between ground stations and control centers, and between ground stations and manned spacecraft; and

(*e*) Processing of acquired data into a usable form for real-time decisions and flight control by project personnel, and for postflight analysis by scientific experimenters.

The projects supported are diverse. They include manned spacecraft, scientific and applications satellites, lunar and planetary missions, sounding rockets, and research aircraft. Support is provided, not only for NASA projects, but also upon request for projects of the Department of Defense, other Government agencies such as the Environmental Science Services Administration (ESSA), foreign countries, and corporations.

SUPPORT IMPLEMENTATION POLICIES

In the interest of conserving resources, we adhere to certain basic policies in implementing support for flight projects (fig. 165). These policies are:

To meet requirements of new projects wherever possible by using existing network capability. When adequate support cannot be provided by existing capability, we expand established facilities, rather than build new facilities, so that the required support may be provided at minimum cost consistent with project requirements.

To develop a network of ground stations designed for multiple program support. This provides for flexibilty of operations and minimizes costs, particularly in the maintenance and common support areas.

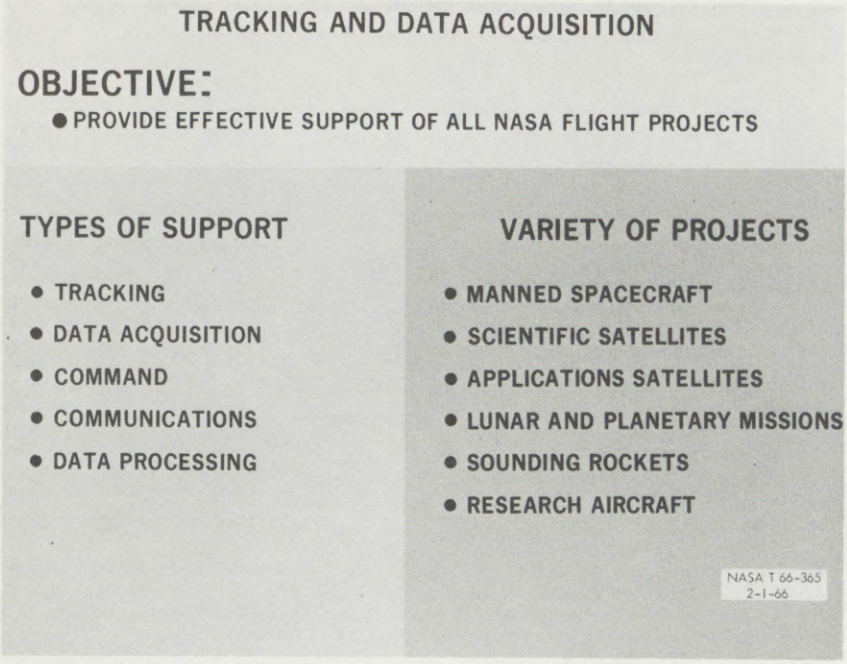

FIGURE 164

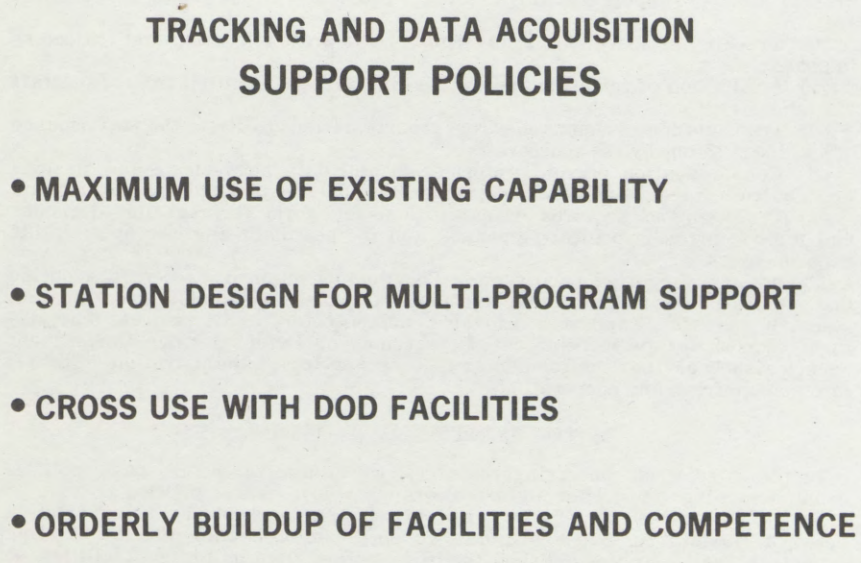

FIGURE 165

To make maximum use of Department of Defense facilities, rather than establishing duplicate facilities, and to reciprocate by providing support with our own facilities when requested by the Department of Defense and other agencies.

To provide for an orderly buildup of facilities and competence by determining future support requirements well in advance of the need and by keeping abreast of the state of the art in tracking and data acquisition systems.

GLOBAL INSTRUMENTATION NETWORK

Application of these policies in meeting the overall objective of providing effective support for a variety of flight projects has resulted in a global instrumentation network consisting of ground stations which are operational or under construction at twenty-eight locations at the present time (fig. 166). These

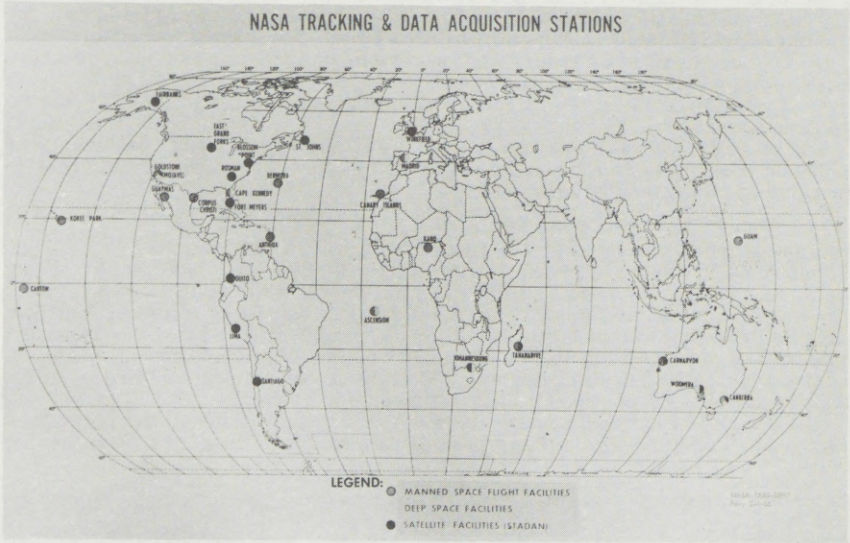

FIGURE 166

stations are located in the United States and sixteen foreign countries and territories. They represent a capital investment of over $600 million and are operated by more than twenty-five hundred highly trained NASA, contractor, and foreign national personnel. Among our assets are the formal agreements and good relations which have been established with foreign countries, some of which were initiated in connection with the International Geophysical Year Program in 1958. We have been familiar with the laws and customs of these countries, and have learned to operate effectively within a diversity of political and cultural environments. Perhaps our greatest asset is the large amount of experience which has been accumulated through the support of more than two hundred space missions over the past eight years.

PROGRESS AND PLANS

During the past year, NASA's program achievements have been very significant. The tracking and data acquisition support provided the flight programs during this period met all established NASA program requirements as well as requirements for programs of other agencies. In addition, much progress was made in the augmentation of facilities to meet future support requirements. These activities will continue in the coming year with somewhat greater emphasis on operational support of current missions. Most of the remainder of this statement will relate our progress in the past year, and our plans for the future, to flight programs.

Gemini support

During the past year, ten NASA stations, three Department of Defense stations, and two instrumentation ships have been heavily committed to the support of the Gemini Program. Preparations for support of Gemini began in mid-1962 and by October 1964 the stations of the Mercury network had been augmented by the addition of telemetry receivers, command equipment, data processors, consoles, and other equipment and facilities amounting to approximately $55 million. Modification of the network was completed on schedule and extensive simulations were conducted prior to the beginning of the flight program.

The network has successfully supported all Gemini flights to date, culminating in the unprecedented rendezvous mission of Gemini VII and VI in December of 1965 (fig. 167). The short time required to adapt the network for the rendezvous mission demonstrated the inherent flexibility which has been designed into the manned space flight support system. The system was originally planned to accommodate a single manned spacecraft and an unmanned Agena target vehicle. Through modification of station operating procedures and computer programs, the network was able to support the two manned spacecraft simultaneously. The experience gained by ground station personnel during the Gemini rendezvous mission was very valuable, particularly with respect to controlling the incremental velocity of one spacecraft in relation to another in performing the rendezvous maneuver.

The network will continue to support Gemini missions through calendar year 1966 and into 1967. In the meantime, Apollo missions will commence and require tracking and data acquisition support.

Preparations for support of Apollo

Many of the stations used for Gemini support will also be used for Apollo. Capabilities are being added at these stations while other stations are being established. This will result in the network shown in figure 168. The network for support of manned lunar Apollo missions will consist of ten fixed land stations with 30-foot antennas, three stations with 85-foot antennas, one transportable station, five instrumentation ships, and eight instrumentation aircraft. In addition, three 85-foot diameter antenna stations normally used for deep space mission support will be used for backup support for Apollo.

The schedule for implementing these major augmentations to the network is shown in summary form by figure 169. Our efforts are directed toward having

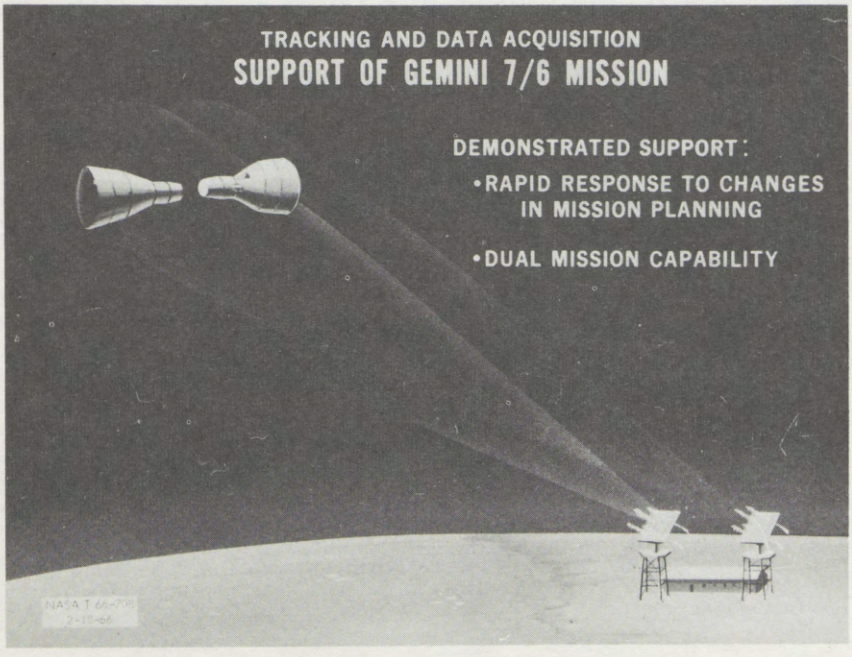

FIGURE 167

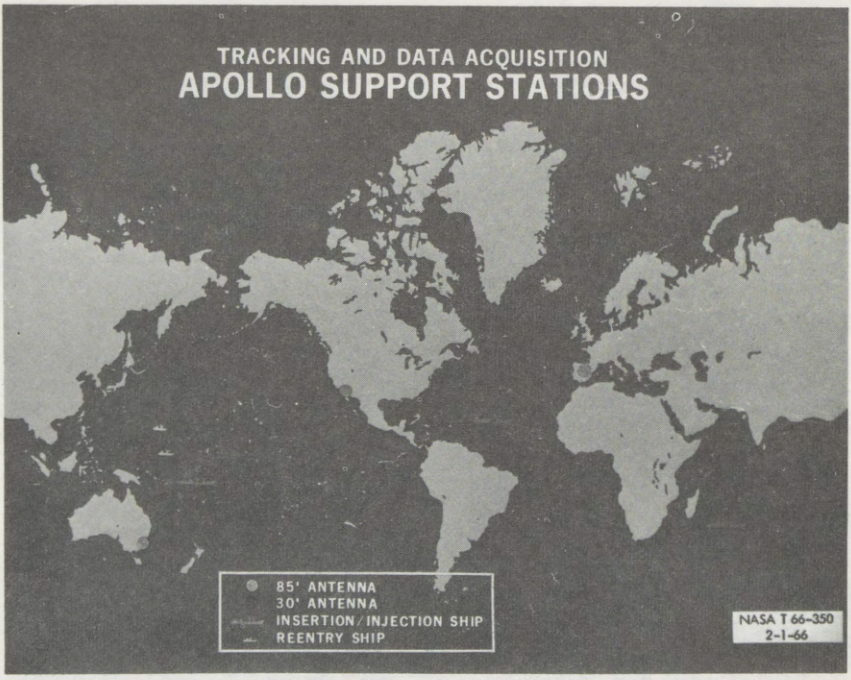

FIGURE 168

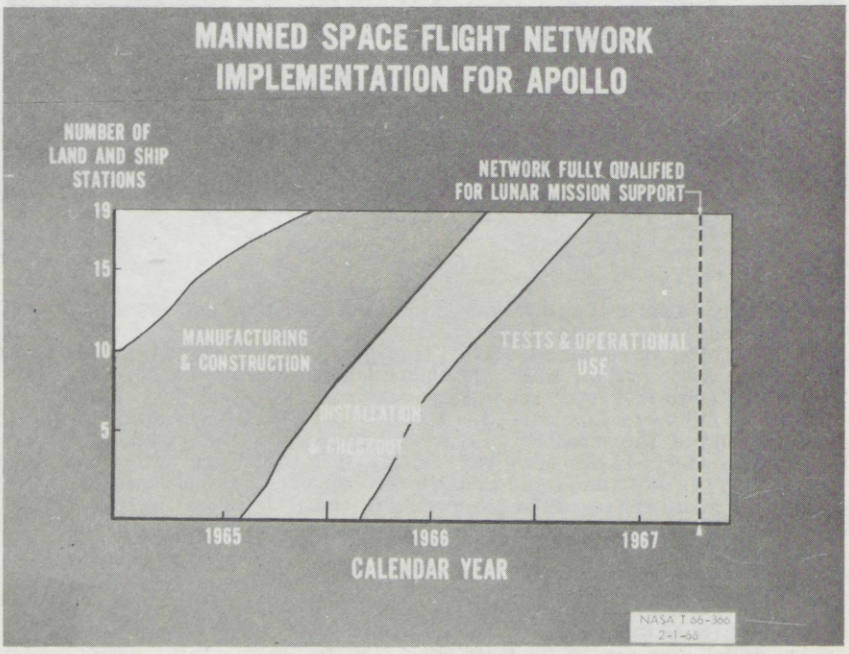

FIGURE 169

the network fully qualified for lunar mission support by late 1967. Substantial progress toward this goal was made during 1965 in the construction of facilities and we are presently well under way with installation and checkout of station equipment. These activities will continue in 1966 along with testing of the new Unified S-band equipment and initial operational use.

Construction has been completed at seven of the ten 30-foot antenna land stations at Guam; Carnarvon, Australia; Bermuda; Ascension Island; Guaymas, Mexico; Hawaii; and Cape Kennedy, Florida. Equipment installation and checkout at these stations is now under way and will be completed in 1966. Construction at the other three 30-foot antenna stations at Corpus Christi, Texas; Antigua; and Canary Islands will proceed in 1966 so that all of these stations will be operational in 1967. Figure 170 shows a typical 30-foot antenna station under

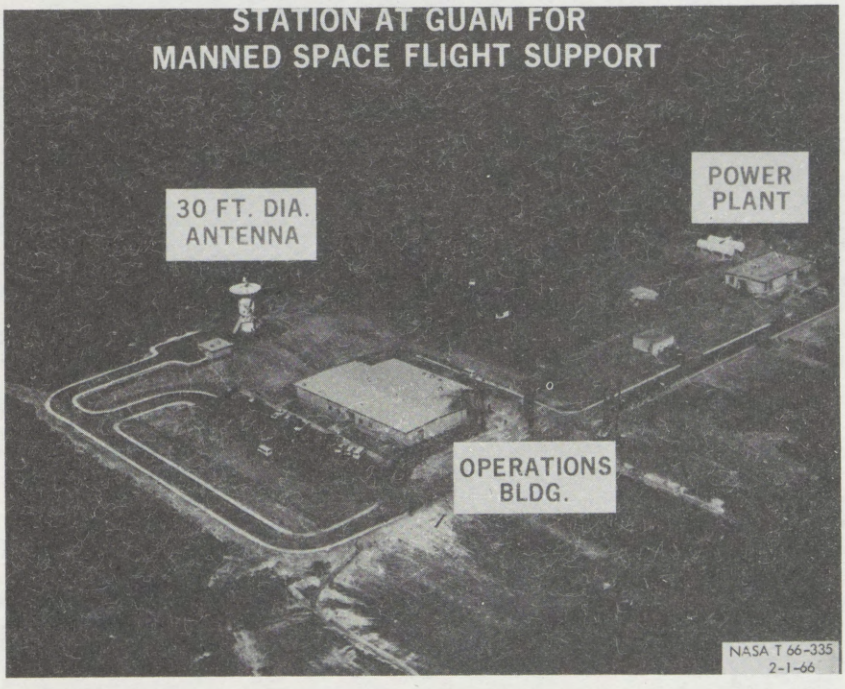

FIGURE 170

construction. This is the Guam station in December 1965 showing the antenna, the operations building, and the power plant.

Manufacturing of equipment for the transportable station has begun, and this station will be operational on Grand Bahama Island in mid-1967.

Facilities with 85-foot diameter antennas are being established at Goldstone, California; Canberra, Australia; and Madrid, Spain, for support of Apollo during lunar phases of the missions. Figure 171 illustrates these stations with a schedule for their implementation. During 1965, necessary agreements were signed with the Australian and Spanish Governments, and construction is now under way at all three stations to meet operational dates in mid-1967.

Apollo instrumentation ships

Figure 172 shows the schedule for the five ships which are being modified and instrumented to operate as integral stations of the network during critical phases of Apollo flights when spacecraft are out of sight of land stations.

Three of the ships, Vanguard, Redstone, and Mercury, are conversions of T–2 tanker hulls for support of the insertion of the Apollo spacecraft into Earth-orbit and the injection into the translunar trajectory. These ships will be deployed in the Atlantic, Indian, and Pacific Oceans.

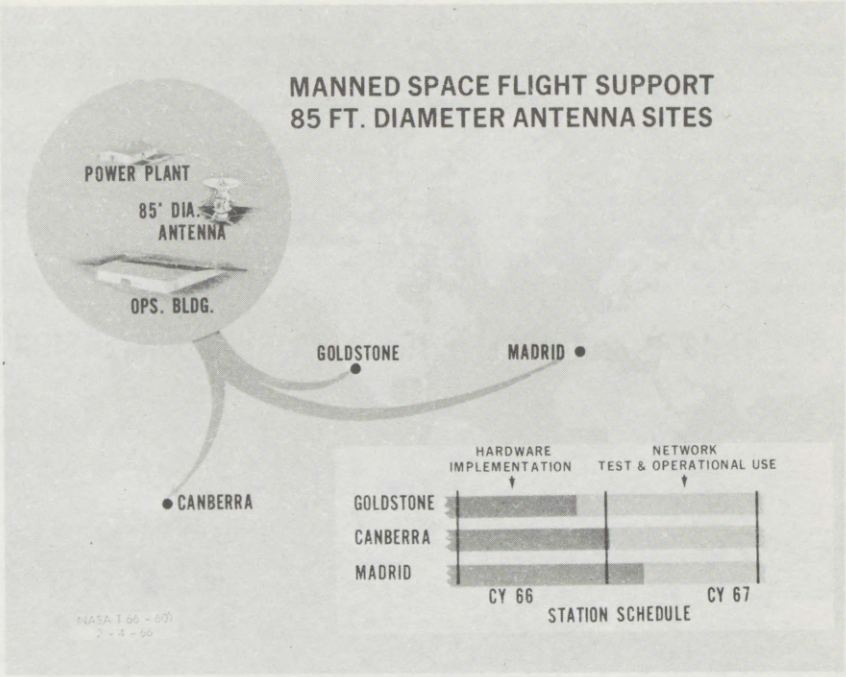

FIGURE 171

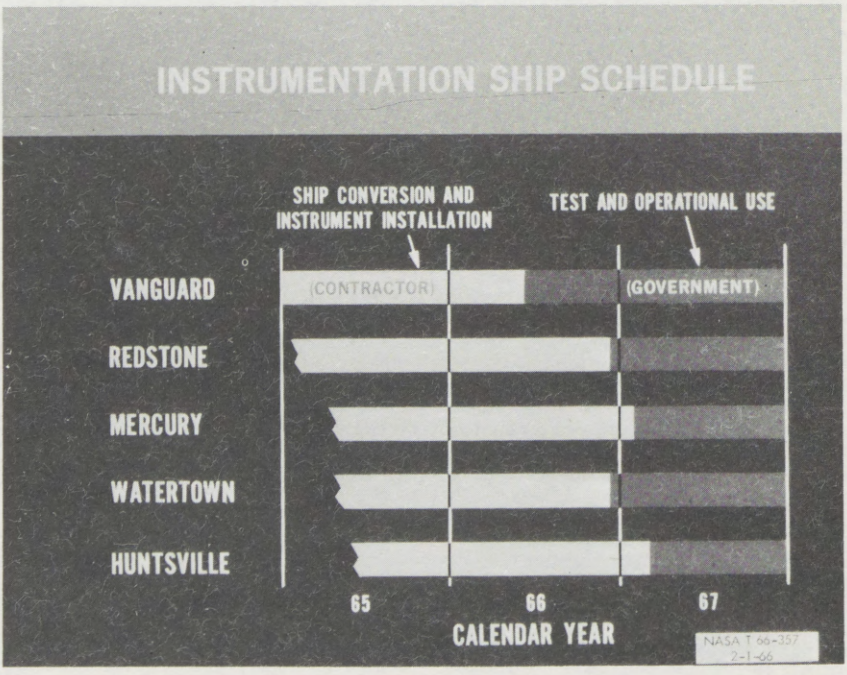

FIGURE 172

The other two ships, the Watertown and the Huntsville, are being modified for coverage of the reentry phase when Apollo spacecraft return to Earth from the Moon for a Pacific water landing. This capability is being provided by an extensive modernization and equipment updating of two 455-foot ships which had previously been in service with very limited instrumentation capabilities.

Responsibility for management of the ships construction program is assigned to the Instrumentation Ships Project Office (ISPO) which was established especially for this project directly under the Chief of Naval Material. The ISPO is headed by a senior Navy officer, Captain Alex F. Hancock, with NASA and U.S. Air Force deputy managers, and draws upon the Navy, NASA, and the Air Force for staffing and technical support. Captain Hancock and his associates are doing an excellent job in conducting this program and I feel we are indeed fortunate in having him as head of this office.

T-2 TANKER AND APOLLO TRACKING SHIP CONVERSION

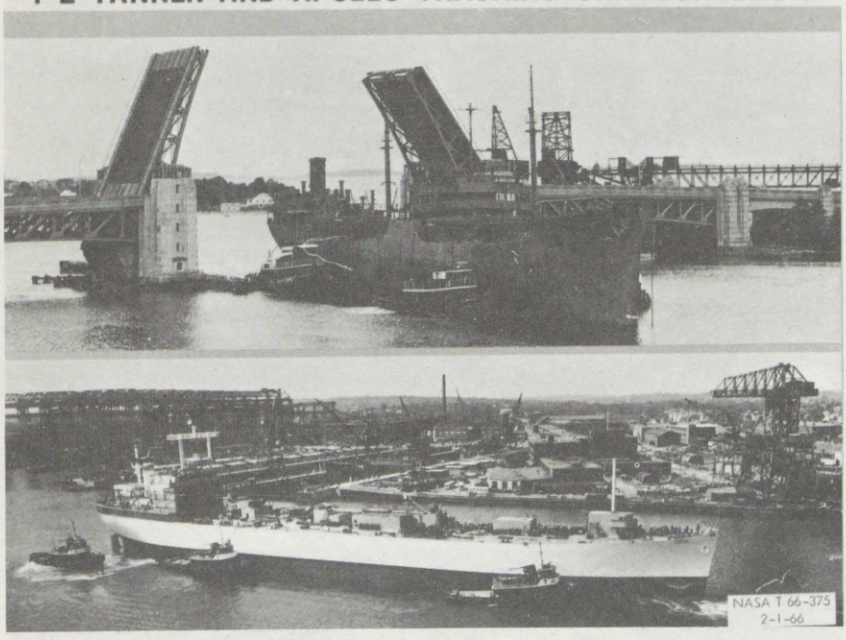

FIGURE 173

The contract for the conversion of the three T–2 tankers was awarded in September 1964 to the Electronics Division of General Dynamics Corporation. Structural work on the ships, procurement of instrumentation equipment, and installation of the equipment proceeded nearly on schedule during 1965. The photograph at the top of figure 173 shows a T–2 tanker hull leaving the James River, Virginia, Reserve Fleet area in 1964. The photograph at the bottom shows Vanguard as it was floated out of the construction drydock at Quincy, Massachusetts, one year later. During that year, the hull was cut into three pieces and a new mid-body section, 75 feet longer than the removed tank section, was installed. The new mid-body section is specifically designed and arranged for the instrumentation equipment which is now being installed.

Conversion work on the two reentry ships is being performed by the Ling-Temco-Vought Company under a contract awarded in March 1965. The shipyard work is being done at Avondale Shipyard, New Orleans. Figure 174 shows the damage sustained by the Huntsville and Watertown in September 1965 when Hurricane Betsy struck the New Orleans area. The ships schedule has been delayed about two months as a result of the hurricane damage and the cost of repair is estimated at $2.4 million. The delay is not expected to be critical for support of the Apollo Program.

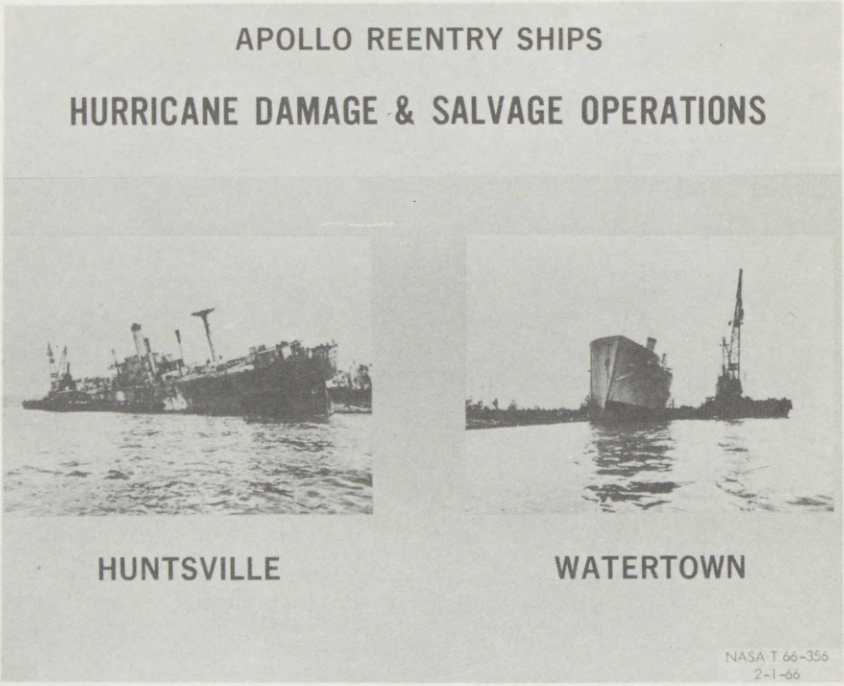

FIGURE 174

The instrumentation ships will be operated by the National Range Division of the Air Force with contract technical crews and Military Sea Transportation Service ship crews. Referring again to (fig. 172, see p. 201), it will be noted that testing and evaluation of the ships and instrumentation systems will begin on the Vanguard in June 1966. Apollo mission support will be provided by the ships during part of the checkout period and all ships will be fully operational and deployed on-site as required for Apollo by mid-1967.

Apollo/range instrumentation aircraft (A/RIA)

Instrumented aircraft (fig. 175) will be used for the Apollo lunar missions to provide telemetry coverage and voice communications with the astronauts during the critical period when the spacecraft is injected into the trajectory to the Moon. The aircraft also will be used to provide supplementary support in the reentry phase.

The high degree of mobility afforded by aircraft is needed because the point of injection will vary from day to day, depending upon the time of launch and the position of the Moon with respect to the earth. Eight aircraft are required to provide the necessary coverage.

The Air Force is providing eight C–135 aircraft from inventory to be modified for this purpose. The modifications are being done under the overall management of the National Range Division (NRD) of the Air Force Systems Command (AFSC) to detailed technical specifications developed by NASA. Supervisory responsibility for the project has been assigned to the Air Force Electronic Systems Division at Hanscom Field, Massachusetts.

In April 1965, fixed-price contracts for the Project Definition Phase were awarded to two contractors selected by NASA and DOD from nine firms submitting proposals. Based upon a joint NASA and DOD evaluation of the plans submitted by the two contractors, a fixed-price-incentive contract for modification of the aircraft and installation of instrumentation was awarded in October 1965 to a contractor team composed of Douglas Aircraft Corporation and Bendix Radio Division. The first two aircraft are scheduled to be operational early in 1967 with all aircraft to be fully operational by the end of 1967.

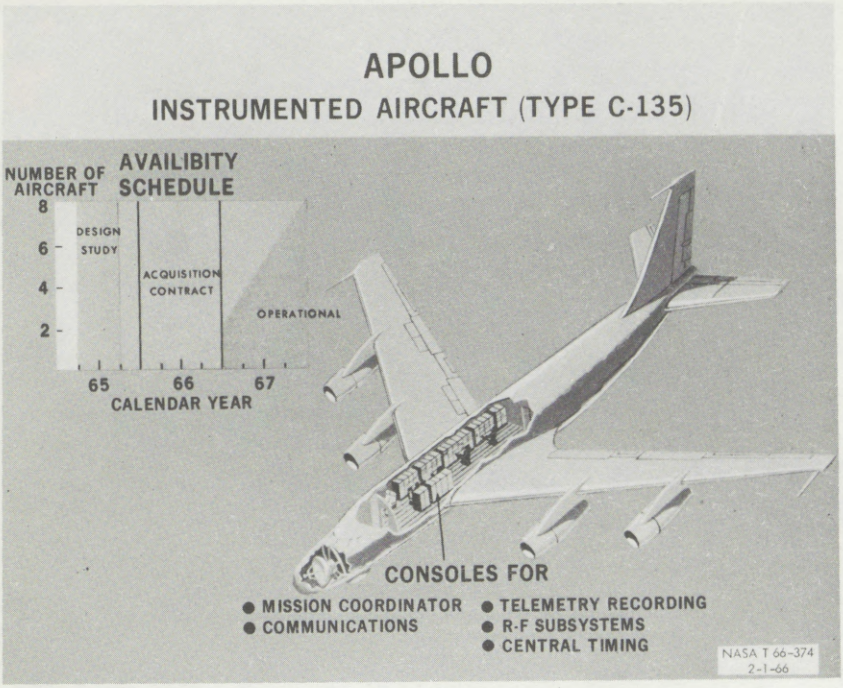

FIGURE 175

Mariner IV and Ranger support

The activities at deep space facilities in 1965 were highlighted by the successful support of the Mariner IV, Ranger VIII and Ranger IX missions.

The very excellent support provided for the Mariner IV mission (fig. 176) permitted the spacecraft to pass within 6,000 miles of Mars on July 14, 1965, and to take the first close-up pictures of the Martian surface. After a flight of 325 million miles and an elapsed time of 228 days, there was a deviation of only 1,000 miles from the projected fly-by distance of 5,000 miles.

The deep space facilities continued to support the Mariner IV spacecraft until October 1, 1965, establishing a new two-way communications record of 191 million miles between network stations and the spacecraft which is nearly four times the previous record set by the Mariner II flight to Venus in 1962. It was during this post-encounter period that the 22 photographs of Mars were transmitted back to Earth.

Less publicized than other aspects of the Mariner IV mission, but also of significance, was the occultation experiment which provided data for studying the Martian atmosphere. This experiment involved precise measurement of telemetry signals as the spacecraft entered the Martian atmosphere before passing behind the planet and again when it came into view. From analysis of this data, scientists have inferred that the surface pressure of Mars is less than one percent of that of Earth.

On January 4, 1966, the deep space instrumentation facility at Goldstone, California, again received a signal from the Mariner IV spacecraft over a distance of 216 million miles. It is planned to reestablish communications in mid-1967 when the spacecraft returns to within 30 million miles of Earth.

During the period Mariner IV was en route to Mars, the Ranger VIII and Ranger IX missions were launched in February and March 1965, respectively. In supporting Mariner and Ranger missions concurrently, the deep space facilities demonstrated the capability of supporting more than one deep space mission at the same time.

The excellent support provided by the deep space facilities was instrumental to the success of the Ranger missions (fig. 177). The precise operation of these

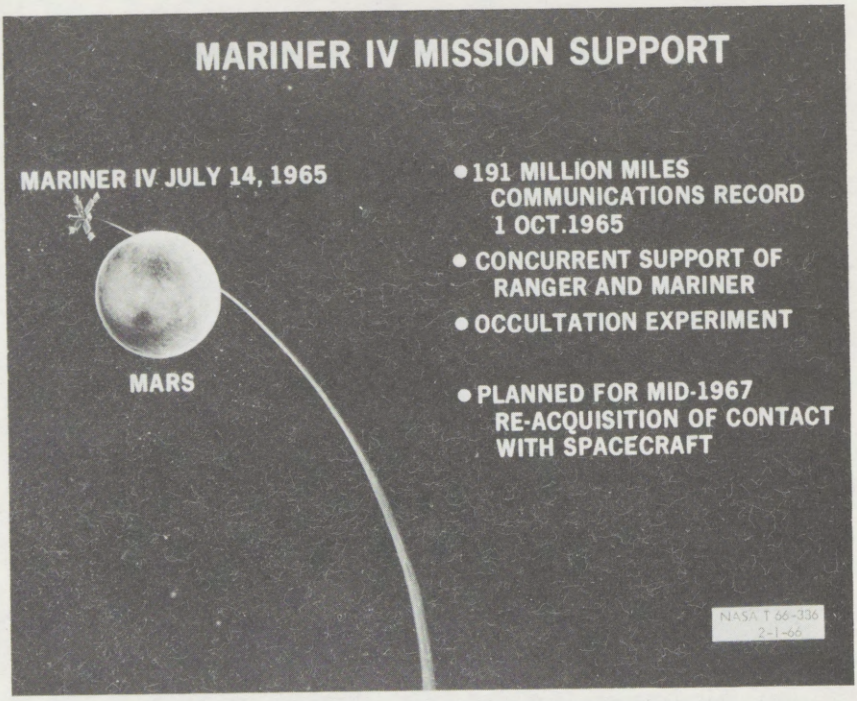

FIGURE 176

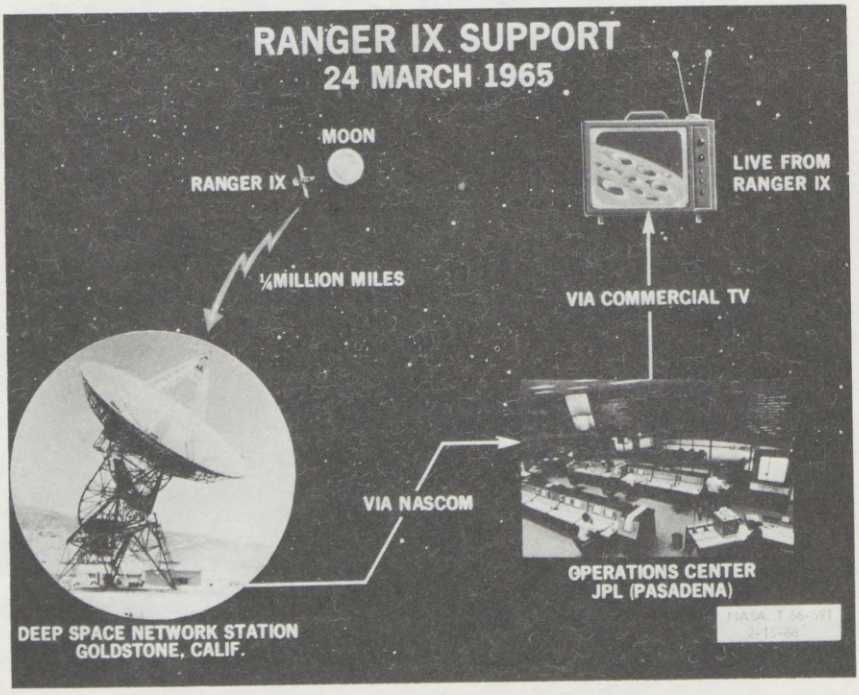

FIGURE 177

facilities was essential to the activation of the cameras and to the accuracy achieved in impacting on the surface of the Moon. The highlight of the program was the transmission of live television pictures from the Moon on March 24, 1965. The pictures were received from the Ranger IX by the deep space facility at Goldstone, transmitted by microwave to the Space Flight Operations Facility in Pasadena, and broadcast to the world through commercial television media.

To keep pace with the increasing lunar and planetary program activity, two deep space facilities were completed in 1965. Figure 178 shows photographs of these new facilities at Madrid, Spain, and Canberra, Australia. Both of these facilities became operational during the Mariner IV flight and provided mission support.

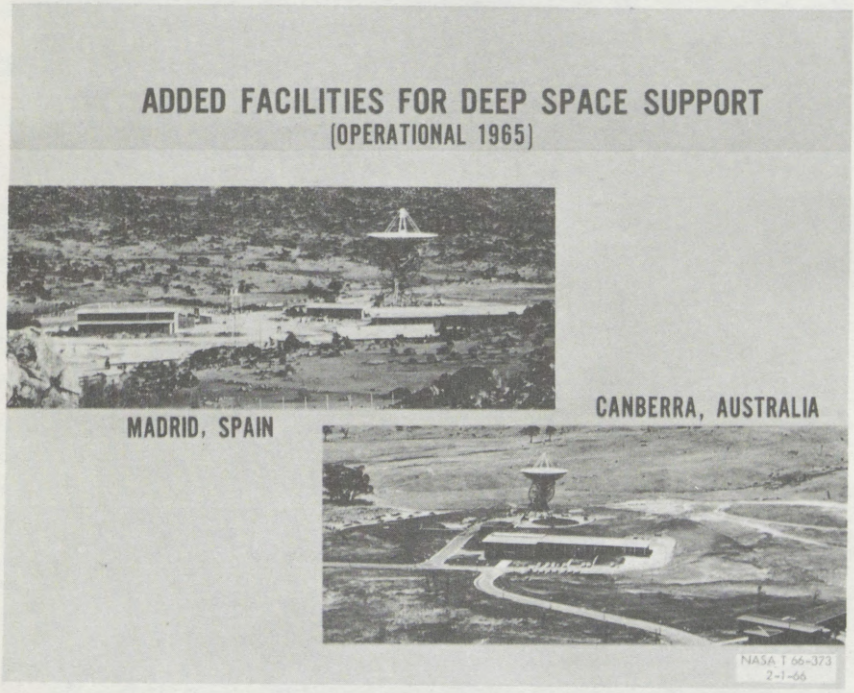

FIGURE 178

Future lunar and planetary program support

The workload on deep space instrumentation facilities will increase in 1966 and especially in 1967 (fig. 179). Pioneer VI was launched December 16, 1965 and this will be followed by four more flights which will require support through 1968. Surveyor and Lunar Orbiter missions are scheduled to begin later this year with support extending into 1968. In 1967, support also will be required for the planned Mariner mission to Venus and for reacquisition of the Mariner IV spacecraft as it nears the Earth. The effect of the Apollo Program also must be taken into consideration in our planning since deep space facilities will provide backup support during Apollo lunar missions.

In anticipation of this workload, project-peculiar equipment is being installed at selected network stations and the capacity of the Space Flight Operations Facility at Pasadena is being expanded. For example, special telemetry processing equipment was installed at the stations which are supporting Pioneer, ground photographic reconstruction equipment is being provided to the stations which will support Lunar Orbiter, and special command and data console equipment is being installed at Surveyor support stations.

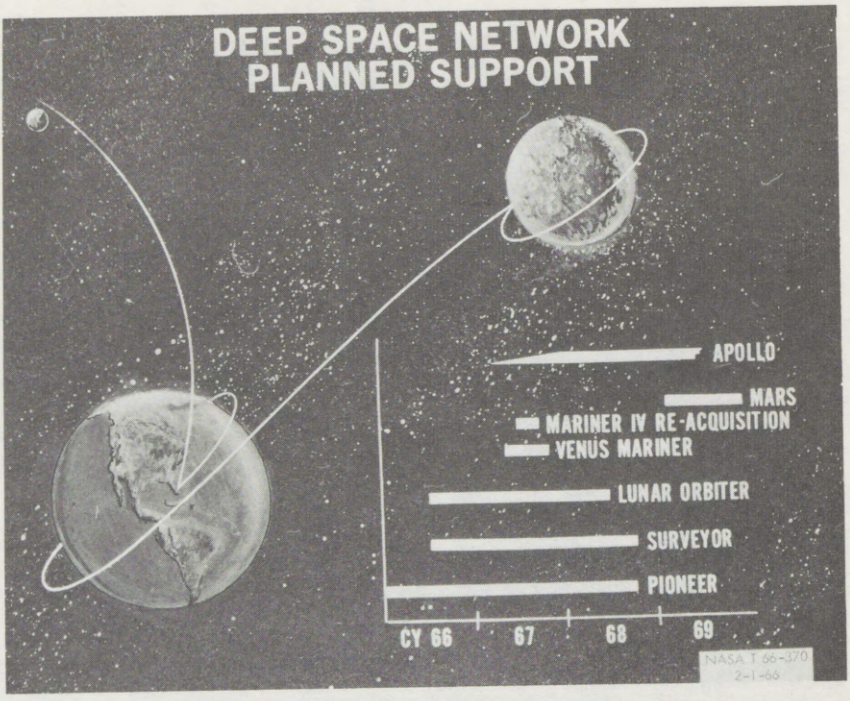

FIGURE 179

The 210-foot advanced antenna system

Much progress was made in 1965 on the first 210-foot Advanced Antenna System located at Goldstone, California (fig. 180). The entire antenna structure was erected and the actuation of all mechanical elements was demonstrated. Acceptance testing is under way and the facility is scheduled to become operational in 1966.

The 210-foot antenna and associated electronics offer an overall ten fold improvement in telecommunications support over that achievable with the present 85-foot antenna facilities. It is planned to use the Goldstone 210-foot antenna facility for operational support of certain phases of the Pioneer, Surveyor, Mariner, and other flight projects where telecommunications with the present 85-foot antenna facilities are marginal, and if these phases occur at the time the spacecraft is visible from this single facility. However, the greatest benefit from the 210-foot antenna will occur when a three-station network is available to provide this ten fold increase of support capability on a 24-Earth-hour basis.

Scientific and applications satellite support

The unmanned satellite support facilities of the NASA tracking and data acquisition network support a wide variety of NASA, DOD, and international space programs. As shown by figure 181, the average number of scientific and applications satellites supported by the network continues to increase. During 1965, an average 32 satellites was supported at any given time. This included satellites launched in prior years which were still transmitting useful data plus new satellites launched in 1965 such as Tiros IX and X, Orbiting Solar Observatory II, Orbiting Geophysical Observatory II, the Early Bird commercial communications satellite, the FR–1 French cooperative satellite, and several Explorers.

In 1966, the average number of satellites to be supported is expected to increase to more than 35, and in 1967 it is estimated to exceed forty. These spacecraft collectively will contact network stations more than 650 times daily. Among the new satellites to be supported in 1966 will be the Orbiting Astronomical Observatory, the Biosatellite, and the Applications Technology Satellite.

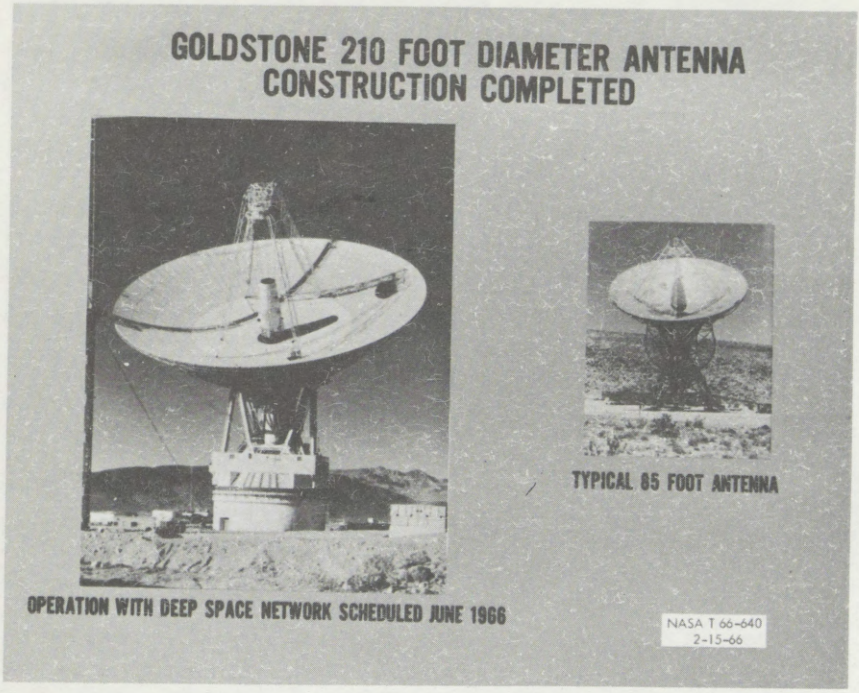

FIGURE 180

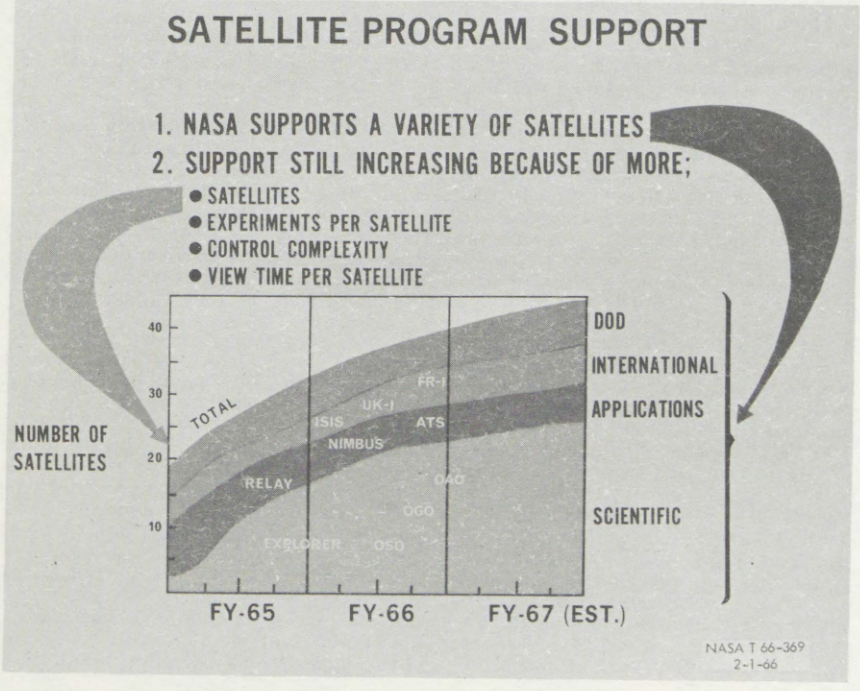

FIGURE 181

The increasing number of satellites is only one of the reasons for the growing workload of the satellite support facilities. Other factors are the greater number of scientific experiments carried by the newer satellites, which results in more transmitted data, and the more complex control features on satellites such as the Orbiting Astronomical Observatory and the Applications Technology Satellite which must be commanded from ground stations. The trend toward higher, more elliptical, and even synchronous orbits is also a consideration since they increase the time a ground station views the satellite and receives data.

Planning for the modification and augmentation of satellite support facilities is a continuing process in response to the requirements of individual projects as well as the total workload. Not only does this planning indicate where additional capabilities are needed, but it also points up areas where consolidation is possible, thereby effecting cost savings with little or no impact on the support offered.

Figure 182 shows major changes in satellite support facilities accomplished in 1965 and planned for 1966. During 1965, an 85-foot antenna data acquisition facility was completed at Canberra, Australia, and a Range and Range Rate system was added at the Tananarive, Madagascar, station, both to improve southern hemisphere coverage. Also in 1965, a second 85-foot antenna facility was completed at Rosman, North Carolina, to handle the increasing workload at that station.

During 1966, additional Range and Range Rate facilities will be installed at existing stations at Fairbanks, Alaska, and Santiago, Chile. In Australia, the consolidation of Woomera facilities with Canberra, already partially accomplished, will be competed. Also scheduled for 1966 are deactivations of the stations at Blossom Point, Maryland, and East Grand Forks, Minnesota.

At the Goldstone and Rosman stations, facilities are being modified and equipment is being installed in preparation for support of the Applications Technology Satellite (ATS). These augmentations will be completed in 1966.

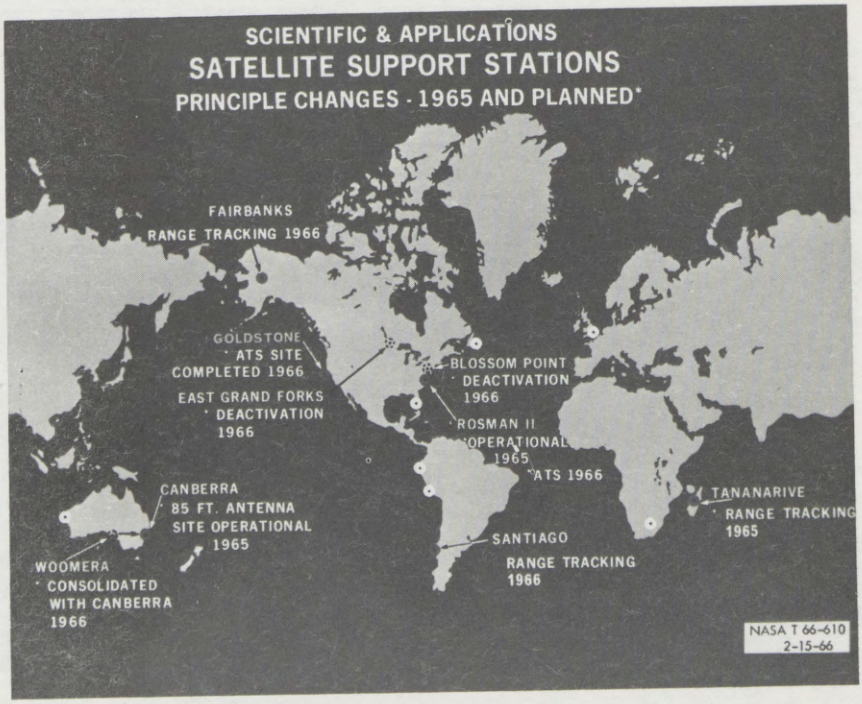

FIGURE 182

ATS support planning

Figure 183 illustrates the support which will be provided for the ATS project. The ATS–B satellite will be placed in an equatorial, synchronous orbit over the Pacific Ocean at 151° west longitude. The light area on the map shows the wide field of view from a synchronous satellite. The Rosman and Goldstone stations, together with a transportable station that will be located at Toowoomba, Australia (near Brisbane), will provide very long base lines for the triangulation measurements necessary to precisely inject and maintain the spacecraft in synchronous orbit. In addition to the capabilities necessary to direct the spacecraft into the proper orbit and to control its attitude, these three stations are being equipped to conduct the ATS experiments.

Figure 184 is a photograph of the station at Rosman, North Carolina, showing both 85-foot antennas, the operations buildings, and supporting facilities. The antenna in the background is the primary scientific satellite data acquisition antenna. In the foreground is the second Rosman antenna which will provide specialized ATS support as well as support of other unmanned scientific satellities.

Figure 185 shows the 40-foot antenna which is part of the transportable station. The electronics and supporting equipment for the station will be trailerized. Agreement has been reached with the Australians for location of the station at Toowoomba and plans for providing basic facilities such as concrete pads and utilities are well underway.

Communications

All NASA operational communications requirements are handled through the facilities of the NASA Communications System (NASCOM) which is managed by the Office of Tracking and Data Acquisition and operated by the Goddard Space Flight Center. NASCOM provides reliable and rapid communications between all ground stations and control centers functioning as an integral part of the global instrumentation network.

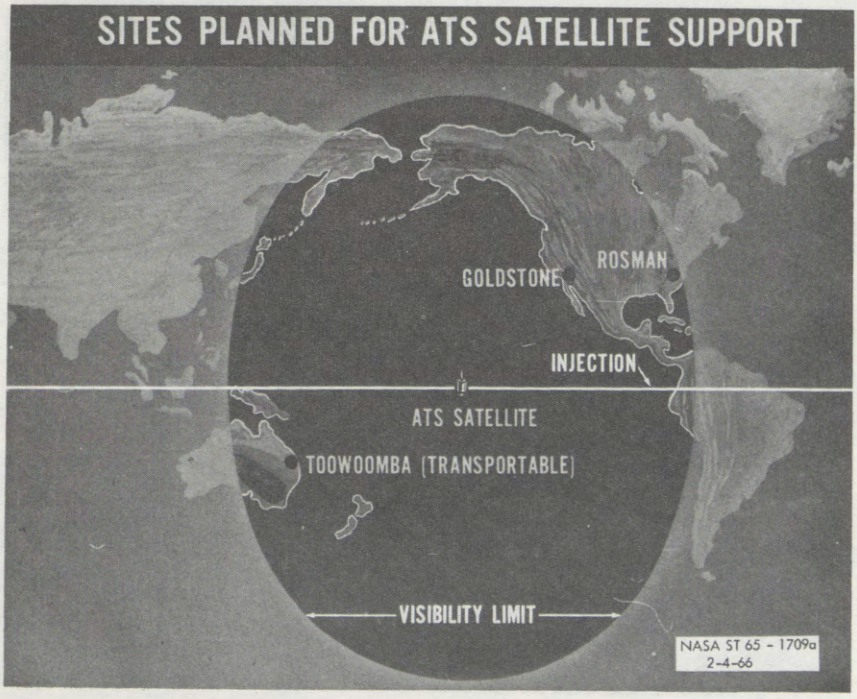

FIGURE 183

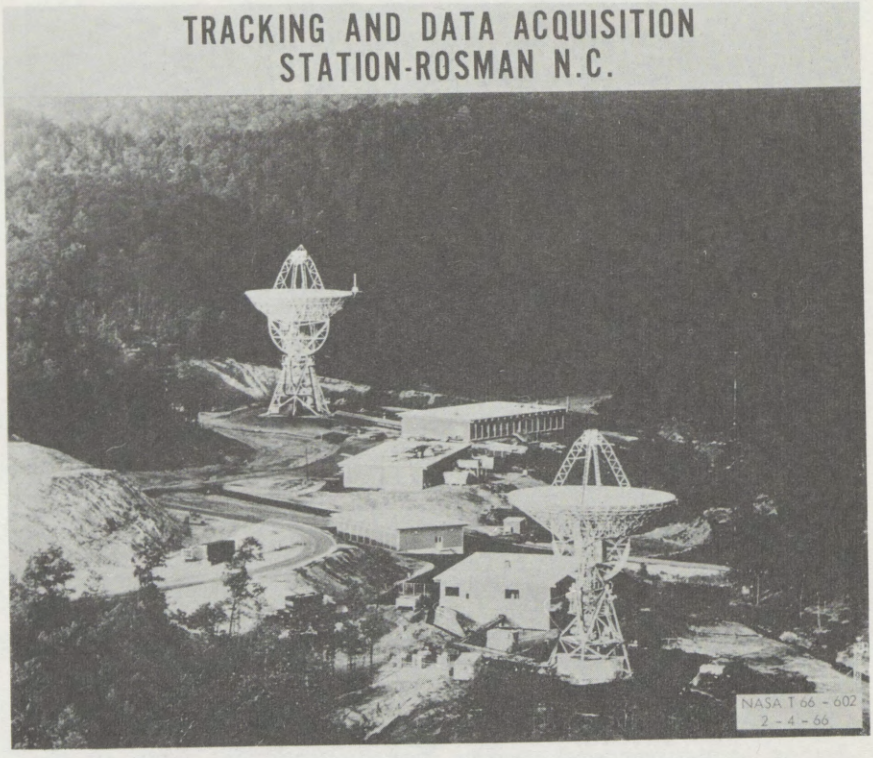

FIGURE 184



FIGURE 185

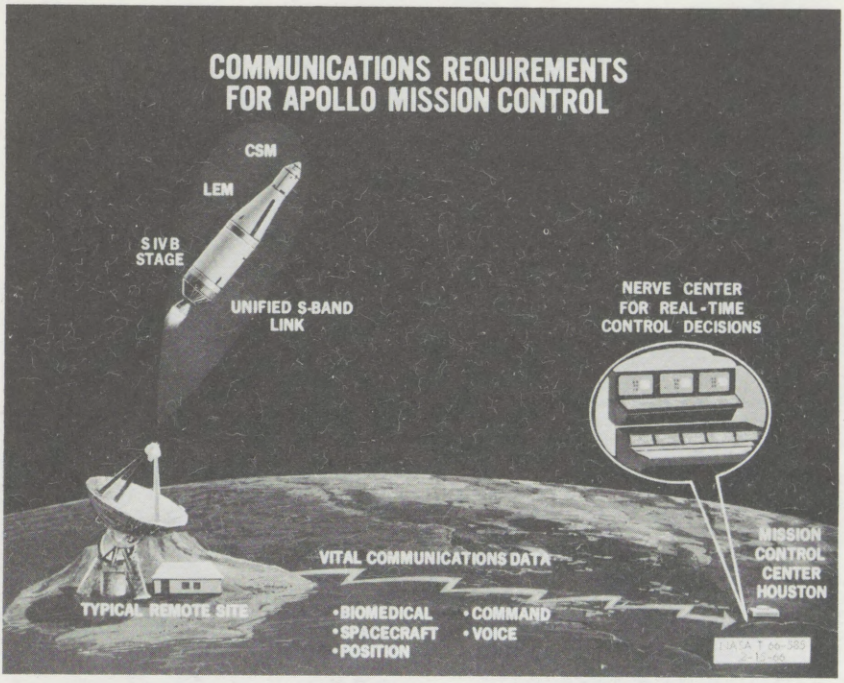

FIGURE 186

During the past year, much effort has been directed toward meeting the communications requirements of the Apollo Program (fig. 186). In Project Mercury, when communications to the control center could not be maintained, the relatively small amount of critical data could be monitored, interpreted, and utilized at remote tracking stations by trained on-site flight controllers. The same situation generally prevails in the Gemini Program although the increased amount of data has required the installation at each key station of a data processing system to digest, summarize, and display information required for real-time decisions.

For the extremely complex Apollo lunar missions, real-time operational control will be maintained in the mission control center where large-scale data processing facilities and technical specialists will support the flight director in exercising mission control. This requires fully reliable communications links to all land stations and ships.

For Apollo, communications must be markedly increased to provide the required centralized real-time control. These circuits will pass to the mission control center essential data such as the status of propulsion, electrical power, and life support systems; reports of critical events such as staging and engine ignition; and, of course, vital voice communications and tracking data. The circuits will also provide for the transmissions of commands to the spacecraft.

There are six stations planned for Apollo support that presently do not have the requisite communications capability for Apollo. From studies conducted with the National Communications System (NCS), it became evident that the Apollo communications requirements could not be met by conventional systems alone, but could be met through use of a communications satellite system (fig. 187).

In June 1965, NASA requested the manager of the NCS to initiate discussions with the Communications Satellite Corporation to determine whether it could provide the required service. A proposal was submitted by the Communications Satellite Corporation and evaluated by a joint NCS working group. As a result of this evaluation, the Secretary of Defense, who is the Executive Agent

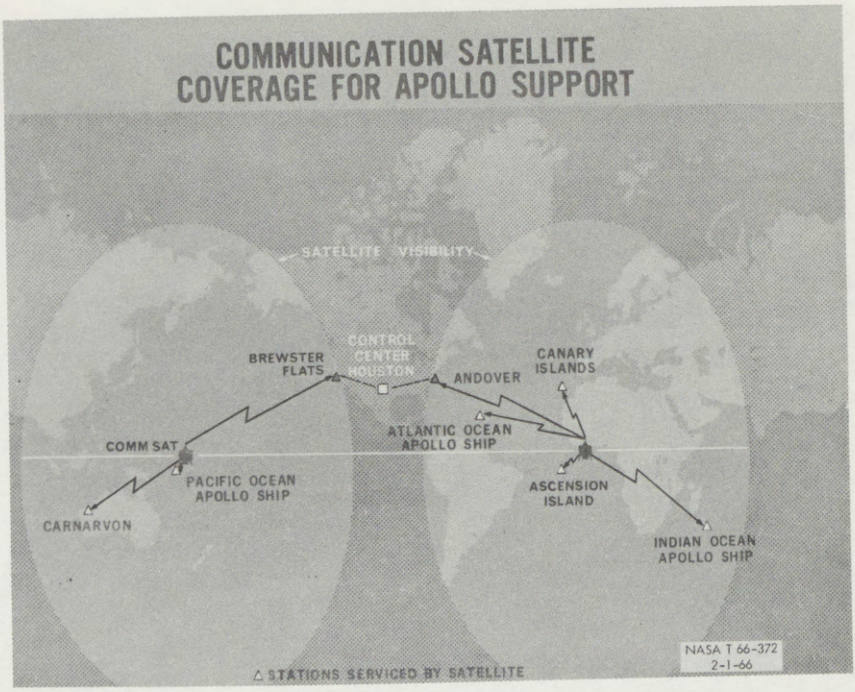

FIGURE 187

of the NCS, authorized NASA to act for NCS in negotiating with the Communications Satellite Corporation for the required communications services.

Communications satellite services will be provided to the three land stations at Canary Island, Ascension, and Carnarvon, Australia, and to three instrumentation ships. To receive this service, the ships must be equipped with communications terminals. Funds have been reprogrammed for this purpose and negotiations with the ship contractor have been completed to incorporate the changes.

NASA/DOD cooperation

The past year was one of accomplishment in the coordination of plans, programs, and operations with the Department of Defense (fig. 188).

A comprehensive agreement concerning land-based tracking, data acquisition, and communications facilities was reached between NASA and DOD, providing for improved planning coordination, single-agency maangement of logistics support and operations at collocated stations, and other measures to assure efficient utilization of the ground instrumentation facilities of both agencies in support of the national space program. As a result of the agreement, the Air Force will provide base support for the Apollo stations at Ascension Island and Antigua. The agreement also prescribes procedures for coordination of planning to assure that the network planning and development of each agency take into account the requirements of the other. Another part of the agreement states general operating policies and gives a framework for establishing procedures for operational cross-servicing to assure full utilization of each agency's resources.

A supplement to the joint agreement on design, acquisition, and modification of Apollo/Range Instrumentation Aircraft was executed which provides for cost sharing in this project. NASA is funding overall instrumentation and communications modifications, and DOD is funding some additional optical equipment required for DOD use. This results in a funding ratio of approximately 95 per cent for NASA and 5 per cent for DOD.

Agreement also was reached on funding for the maintenance and operation of Apollo instrumentation ships and aircraft. This agreement provides for sharing of the costs on the basis of the estimated proportion of use of the ships and

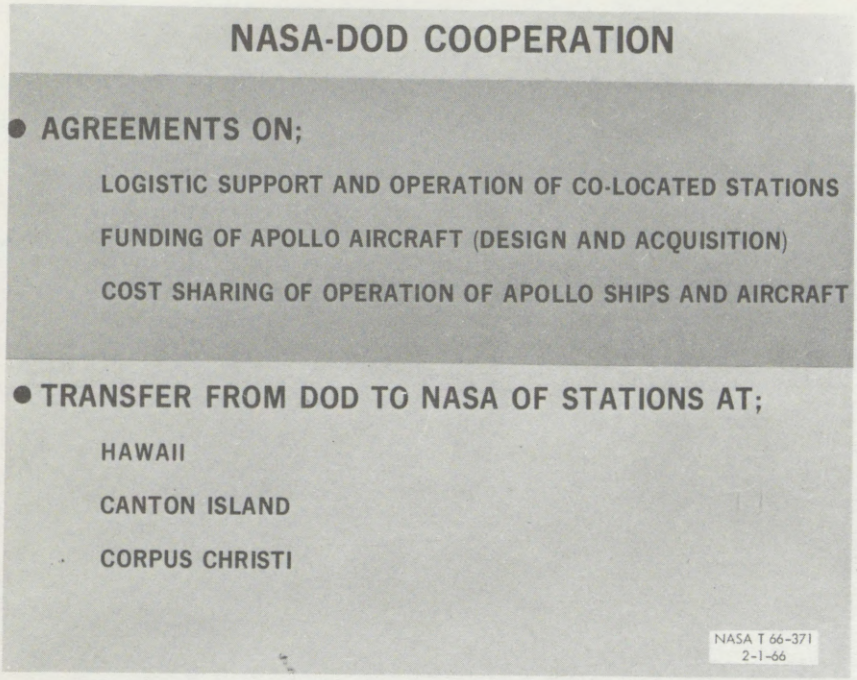

FIGURE 188

aircraft for support of NASA and DOD projects. For example, in fiscal year 1967, NASA will fund about $14 million of a $17 million total cost for operating the ships which is approximately an 82½ percent versus 17½ percent ratio.

Also during the past year, operational responsibility for three tracking stations was transferred from DOD to NASA. These three stations, at present heavily involved in support of the Gemini Program, are located at Canton Island; Corpus Christi, Texas; and Kauai, Hawaii.

Cooperation with other agencies

The Environmental Science Services Administration (ESSA) is initiating the TIROS Operational Satellite system in 1966. Ground support for this system will be provided by 85-foot antenna facilities at Fairbanks, Alaska, and Wallops Island, Virginia.

Figure 189 is a photograph of the station at Wallops Station which was constructed for ESSA under NASA supervision and is currently undergoing operational checkout. The facility at Fairbanks was built adjacent to NASA's tracking and data acquisition station at that location under a similar arrangement, and is now operational.

The Fairbanks station will be operated under NASA's contract for maintenance and operation of large data acquisition facilities. ESSA will reimburse NASA for these services as well as for communications and other related costs. The station at Wallops will be operated by ESSA civil service personnel.

FUNDING REQUIREMENTS

Funding requirements for the Tracking and Data Acquisition Program are summarized on figure 190. To continue the program in fiscal year 1967, a total of $279.3 million is needed from the Research and Development Appropriation and $1.7 million is needed from the Construction of Facilities Appropriation.

An amount of $199 million is required for operation of network stations and for related services such as communications and data processing. Most of the large increase from fiscal year 1966 is due to support requirements for the Apollo



FIGURE 189

TRACKING AND DATA ACQUISITION PROGRAM
FUND REQUIREMENTS
(IN MILLIONS OF DOLLARS)

	FY-65	FY-66	FY-67
●RESEARCH AND DEVELOPMENT			
• OPERATIONS	$ 95.2	$129.6	$199.0
• EQUIPMENT	144.5	87.7	66.5
• SUPPORTING RESEARCH AND TECHNOLOGY	13.5	13.8	13.8
TOTAL R&D	$253.2	$231.1	$279.3
●CONSTRUCTION OF FACILITIES	$18.0	$14.4	$1.7
TOTAL R&D AND CofF	$271.2	$245.5	$281.0

NASA T 66-338
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FIGURE 190

Program. Included are additional funds for operating the instrumentation ships and aircraft, for increased staffing levels at network stations to man the more complex Apollo support equipment, and for leasing of communications satellite services.

In the equipment area, $66.5 million is needed in fiscal year 1967 to sustain the capability of the network and to provide the additional equipment and modifications necessary to meet the projected workload and specific project requirements. The total amount required for equipment continues to decrease primarily because most of the equipment procurements for support of the Apollo Program were funded in prior years.

For supporting research and technology, $13.8 million is needed to continue the program of developing advanced systems, components, and techniques to meet the requirements of future flight projects and to improve the efficiency and effectiveness of support operations.

The facilities program for fiscal year 1967 is substantially reduced from prior years. Funds are requested for only two projects. One is a 40-foot antenna to be installed at Goddard Space Flight Center for use in the development, evaluation, and testing of equipment and components, and for conducting compatibility tests between ground and spacecraft systems. The other facilities project is the installaion of a badly needed water distribution system and additions to the sewage disposal system at the large tracking and data acquisition complex at Goldstone, California.

CONCLUSION

In closing, I would like to express my appreciation for this opportunity to report to the Committee on our progress and plans. Your continued support will assure our capability to provide effective tracking and data acquisition support for flight projects in the future, as in the past.

Mr. Chairman, this concludes my statement.

THE 1967 NASA AUTHORIZATION

TUESDAY, MARCH 22, 1966

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The Committee on Science and Astronautics met, pursuant to notice, at 10:15 a.m., room 2318, Rayburn House Office Building, Washington, D.C., Hon. George P. Miller (chairman of the committee) presiding.

The CHAIRMAN. The committee will be in order.

Members of the committee, the witness this morning is Dr. Robert C. Seamans, Jr., Deputy Administrator for NASA, whom we have asked to testify on those portions of the NASA authorization bill which are not covered by the three subcommittees during the hearing.

Briefly these items are as follows: facilities planning and design, administrative operations as it pertains to headquarters and the Western Operations Office; administrative funds; section 3 of the bill which pertains to reprograming, a new section of the bill which would permit the administrator to enter into contracts for architectural-engineering services without regard to the limitation of a 6 percent (of construction cost) fee as provided by law.

Dr. Seamans, I understand you have a general statement together with five prepared statements which deals with the items I have just read. I will ask that you delay the reading of the general statement and proceed to give us a summary of the papers which deal with the items you have enumerated. It is necessary that we have testimony in these sections of the bill before the full committee can begin to mark it up. When we have concluded those items, then will you proceed with your general statement?

STATEMENT OF DR. ROBERT C. SEAMANS, JR., DEPUTY ADMINISTRATOR, NASA

Dr. SEAMANS. Mr. Chairman, I'll first cover the five items that you have just listed. Each one of these items is covered in some detail in the five prepared papers that we have submitted along with my general statement. These papers which I will summarize briefly, involve the language differences between the fiscal year 1966 authorization and the bill proposed for the fiscal year 1967 authorization; the fiscal year 1967 budget estimates for NASA headquarters; a summary on the Office of Industry Affairs; a review of provisions covering financial management and extraordinary expenses; and facilities planning and design. I will take them up individually, in that order.

The language differences between the 1967 request and the 1966 authorization act show a number of changes. Two of these we consider to be items of substance; the remainder are either editorial changes due to changes in our program requirements or because of certain omissions to be made in the proposed fiscal year 1967 bill.

The first language change of substance relates to our request for a permissive exemption from the 6 percent of estimated construction costs limitation on the fee—total price—for architect-engineering contracts. This statutory limitation has caused difficulties with regard to the A. & E. work on nuclear test facilities in Nevada where we are working jointly with the AEC.

As I'm sure the committee recognizes there are very special technical requirements involved in design of the testing facilities for nuclear reactors. This takes additional A. & E. work to be sure that we are taking proper safeguards. Because we were limited to the 6 percent, we found that we had a situation that could have involved our transferring funds from NASA to the AEC in order to carry out the complete design.

We felt that this was not a good way to approach the matter. We thought it was much better to come before our authorization committees and discuss this frankly, particularly in the light of a GAO report which raises some question as to overall practices in this area.

The other language change item of substance involves our recommending an increase from ½ to 1 percent in the amount of funds which may be reprogramed from R. & D. to C. of F. This is a matter that has been discussed extensively with this committee both last year and this.

It is our experience that due to the complexities and uncertainties involved the exploration of space and development of systems for that purpose, we may require this flexibility and it is in the interest of the country to have this flexibility available, if required, with proper reporting and safeguards between NASA and the Congress.

My second prepared statement is on the fiscal year 1967 budget estimates for NASA headquarters. I will summarize it very briefly, pointing out that the overall manpower in NASA headquarters is estimated to be 2,227 people at the end of fiscal year 1966 with a reduction of 27 going through fiscal 1967 giving us an estimated 2,200 personnel at the end of fiscal year 1967.

However, the dollar request in AO shows an increase from $56.3 million in 1966 to $58 million in 1967. The increase is partly attributable to salary rates. The personnel budget shows an increase from $29.4 to $30.3 million; and there is also some increase in the "All other" category from $26.8 to $28.3 million, largely in the area of reporting on our scientific and technological progress. The funds required for this, we feel, will increase.

The third paper provides a summary on our Office of Industry Affairs activity. The Office of Industry Affairs includes procurement, facility management, labor relations, reliability and quality insurance, and the NASA Inventions and Contributions Board.

I would like particularly to note in this area that we are steadily increasing the number of competitive procurements, that in 1962 we had 55 percent and this increased in 1966 to 65 percent, and we are

estimating a still further increase in 1967. In addition more and more of our procurement is through incentive contracting. This is moving ahead very rapidly. The figures shown for the end of calendar 1965 are at a level of around $2.2 billion. Since then we have already increased our incentive contracting by another $1.8 billion so that we are now at a level of $4 billion under incentive contracting.

We believe that incentive contracts are extremely important management tools by helping, to be sure that industry assumes its rightful responsibility. Incentive contracts allow contractors to get paid an increased fee when the work is well done. They are penalized when the work is not well done. We believe this does bring industry top management's attention to the problems that we face. In this way the Government is relieved of a large amount of detailed supervision of industry.

In my fourth prepared paper, a review of provisions covering financial management and extraordinary expenses, there are three items discussed. One of these you mentioned, Mr. Chairman, the Administrator's fund. This fund in the amount of $35,000 is for extraordinary expenses, for consultation and other purposes, other activity that must be approved by the Administrator which are not covered in any other account.

My fourth prepared paper also explains the desirability of continuing the authority that we had last year, which provides needed flexibility in the contracting for maintenance and operation of facilities and other services under the administrative operation appropriation. Until last year this was on a fiscal year basis. With certain of our support contracts this has proved to be awkward because if let late in the fiscal year these contracts could only be for a term of a few months, only to the end of the fiscal year. Then it would be necessary to renegotiate. We feel it important to have these contracts run on a minimum 1-year term even though they may then overlap fiscal years.

The other item contained in my fourth paper relates to the desirability of continuing the authority for initially financing certain procurements for common use supplies or services out of one account and then later allocating them to the proper appropriation. This saves a tremendous amount of internal bookkeeping and at the same time we are able to account properly for the final use of the various items. This authority, in short, permits us to have common stores supplied out of a single fund.

Finally, my fifth paper is on the facility planning and design submission. We are requesting $7 million for continuing facility planning and design. This is an area that permits us to save time in our space program because we can start these designs earlier this way. It also permits us, before a commitment is made for actual construction, to come before our authorization committees and give much more precise estimates of what the cost will be. We feel that this $7 million is an extremely important investment in our long-term planning.

In brief, then, I have summarized the five submissions and, of course, I will be happy to answer any questions you may have on them, Mr. Chairman.

(The complete statements of Dr. Seamans follow:)

PREPARED STATEMENT OF DR. ROBERT C. SEAMANS, JR., DEPUTY ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1967 BUDGET ESTIMATES, NASA HEADQUARTERS

ADMINISTRATIVE OPERATIONS APPROPRIATION

The fiscal year 1967 budget estimates for NASA Headquarters activities are funded under the administrative operations appropriation. The budget request for these activities is shown in volume IV of the congressional justification book beginning on page AO–4–1.

NASA Headquarters fiscal year 1967 budget estimates are discussed in the following order:

Summary of funding requirements.
Summary of personnel requirements.
Analysis of costs:
(*a*) By a division of funds between NASA-wide functions and Headquarters operations;
(*b*) By major activity.
Included is a statement of justification by object classification.

SUMMARY OF FUNDING REQUIREMENTS

The fiscal year 1967 budget request for NASA Headquarters funded under the administrative operations appropriations is $58,667,000. This is an increase of $2,381,000 over the $56,286,000 available for the current fiscal year. Comparable estimates for the 3 fiscal years are as follows:

[In thousands of dollars]

	Fiscal year 1965, actual	Fiscal year 1966, estimate	Fiscal year 1967, estimate	Increase
Personnel costs	27,270	29,448	30,319	+871
All other costs	24,246	26,838	28,348	+1,510
Total	51,516	56,286	58,667	+2,381

Of the total fiscal year 1967 request of $58,667,000 for NASA Headquarters activities 51 percent or $30.3 million is estimated for personnel costs. This is an increase of $871,000 over the amount available in fiscal year 1966 and is required to cover the cost of the recent pay increases on a full-year basis, for within-grade-step increases and additional retirement contributions and other benefits.

The balance of the $28.3 million is for all other activities, an increase of $1.5 million over fiscal year 1966, of which about 80 percent or $1.2 million is for costs associated with the Scientific and Technical Information Program and $300,000 for various minor adjustments in other activities.

SUMMARY OF PERSONNEL REQUIREMENTS

The fiscal year 1967 budget request includes a total of 2,200 civilian positions—a reduction of 27 permanent positions below fiscal year 1966. A summary comparison of positions for the 3 fiscal years is as follows:

	Number of positions			
	Fiscal year 1965	Fiscal year 1966	Fiscal year 1967	Decrease
Permanent	2,163	2,162	2,135	−27
Temporary	100	65	65	
Total	2,263	2,227	2,200	−27

The following table shows the distribution of permanent positions for the 3 fiscal years by major activity and between NASA-wide and Headquarters operations:

	Permanent positions		
	Fiscal year 1965	Fiscal year 1966	Fiscal year 1967
NASA-wide:			
Direct program support:			
Manned Space Flight	453	453	447
Space science and applications	296	296	292
Advanced Research and Technology	217	217	214
Tracking and Data Acquisition	60	62	61
Technology Utilization	14	14	14
Total program support	1,040	1,042	1,028
Functional and staff support:			
Scientific and Technical Information	63	64	63
Public Affairs	118	118	116
Administration	248	248	244
Industry Affairs	148	148	146
General Counsel	51	52	51
Programing	71	71	70
Administrator	19	19	19
Executive Secretary	64	64	64
Defense Affairs	10	10	10
International Affairs	27	27	27
Legislative Affairs	30	29	29
Policy Analysis	17	17	17
Total functional and staff support	866	867	856
Total NASA-wide	1,906	1,909	1,884
Headquarters operations	257	253	251
Total	2,163	2,162	2,135

Of the 2,135 permanent positions shown for fiscal year 1967, about one-half are for direct program support in the Office of Manned Space Flight, Office of Space Science and Applications, Office of Advanced Research and Technology, Office of Tracking and Data Acquisition, and in the Office of Technology Utilization. Of the balance of 2,135 positions, 856 are for NASA-wide functional and staff support relating to the review, coordination, direction, and planning of activities, such as procurement, fund management, audit, and for the acquisition and dissemination of scientific and technical information. The remaining 251 positions are for support of headquarters administrative operations concerned with administrative services, personnel, security, accounts and reports, and contracts.

ANALYSIS OF COSTS

Funding requirements for NASA Headquarters fiscal year 1967 estimates may be analyzed as follows:

1. By a division of funds for NASA-wide functions which provide service to all NASA Centers and are conducted or administered centrally, and for headquarters operations which are for the support of the day-to-day operations of all headquarters offices; and
2. By major activity.

Analysis of costs between NASA-wide and headquarters operations

The fiscal year 1967 request of $58,667,000 includes a net increase of $2,381,000 over the $56,286,000 available in fiscal year 1966. A distribution of costs by major activity and between NASA-wide and headquarters operations is as follows:

[In thousands of dollars]

	Fiscal year 1965	Fiscal year 1966	Fiscal year 1967	Increase or decrease
NASA-wide costs:				
Direct program support:				
Manned Space Flight	7,292	7,637	7,808	+171
Space Science and Applications	4,319	4,726	4,830	+104
Advanced Research and Technology	3,680	3,811	3,887	+76
Tracking and data acquisition	975	1,098	1,122	+24
Technology utilization	178	193	198	5
Total, program support	16,444	17,465	17,845	+380
Functional and staff support:				
Scientific and Technical Information	7,515	9,882	11,111	+1,229
Public Affairs	6,685	7,127	7,159	+32
Administration	6,653	7,073	7,196	+123
Industry Affairs	2,674	2,955	3,247	+292
General Counsel	707	827	866	+39
Programming	1,426	1,710	1,730	+20
Administrator	751	686	641	−45
Executive Secretary	525	572	591	+19
Defense Affairs	159	169	173	+4
International Affairs	534	679	717	+38
Legislative Affairs	322	342	349	+7
Policy Analysis	360	382	388	+6
Total, functional and staff support	28,311	32,404	34,168	+1,764
Total NASA-wide costs	44,755	49,869	52,013	+2,144
Headquarters operations	6,761	6,417	6,654	+237
Total	51,516	56,286	58,667	+2,381

Analysis by major activity

The distribution of NASA-wide and Headquarters Operations costs shown in the above table for fiscal year 1967 may be analyzed further by major activity. These are:

1. *NASA-wide costs:*

(*a*) *Direct program support, $17,845,000.*—Includes the costs of program direction in the Office of Manned Space Flight, Office of Space Science and Applications, Office of Advanced Research and Technology, Office of Tracking and Data Acquisition, and in the Office of Technology Utilization.

Of the $17.8 million requested for fiscal year 1967, 88 percent or $15.8 million is for personnel compensation and benefits covering the cost of about one-half of the total Headquarters positions—an increase of $380,000 over fiscal year 1966; and the balance of 12 percent or $2 million is for travel and transportation of persons and for design and operation of the supporting research and technology documentation program in OART, for operation of a small scientific computer in OMSF, and for reimbursable costs for personnel administrative support furnished at overseas tracking stations.

(*b*) *Functional and staff support, $34,168,000.*—Includes costs with NASA-wide direction and for coordination of various functional activities such as scientific and technical information, public affairs, administration, industry affairs, and programing.

Of the $34.2 million requested for fiscal year 1967, 34 percent or $11.9 million is for personnel compensation and benefits covering the costs of some 850 positions; and the balance of 65 percent or $22.3 million is for all other functions. The major programs and their associated costs are as follows:

(1) The scientific and technical information program is estimated at $11.1 million—an increase of $1.2 million over fiscal year 1966. This includes:

$7.9 million for the scientific and technical information services activity—an increase of $774,000 over fiscal year 1966. The major items under this

activity include $5,745,000 for the NASA Scientific and Technical Information Facility of which $5,388,000 is for documentation operations and $357,000 for the rental of space; $1,810,000 for the documentation of worldwide aerospace journal literature; and $350,000 for translating services of foreign technical books, reports, and journal literature.

$1,973,000 for the technical publications activity—an increase of $438,000 over fiscal year 1966. This includes $881,000 for the preparation of manuscript material, such as handbooks, data compilations, monographs, and technical reviews. The balance of $1,092,000 represents the cost for printing by GPO and by the Langley Research Center of the above-described materials, as well as NASA's semimonthly abstracting-indexing journal, Scientific and Technical Aerospace Reports.

$355,000 for the technical information system activity—the same amount as for fiscal year 1966. This requirement is for the continued improvement and refinement of a program to identify, analyze, evaluate, and test new methods and systems in the field of scientific communications to increase the effectiveness of the NASA technical information program.

$878,000 is for costs of positions and for travel and transportation of persons. This includes $848,000 for personnel costs and benefits—an increase of $17,000 over fiscal year 1966; and $30,000 for travel and transportation of persons—the same amount as for the current fiscal year.

(2) The public affairs program is estimated at $7,159,000 in fiscal year 1967. This includes $1,445,000 for personnel costs and benefits, an increase of $32,000 over fiscal year 1966; and $114,000 for travel and transportation of persons. The balance of the program of $5.6 million for fiscal year 1967 is projected at the same level as for fiscal year 1966. This includes:

$1,260,000 for the spacemobile activity. The estimate includes $1,105,000 for the operation and maintenance of 34 spacemobiles and $155,000 for the procurement of replacement vehicles for the spacemobile fleet and for purchase of additional models and equipment for the spacemobiles.

$205,000 for the educational activity. This covers assistance to school and nonschool agencies at the elementary and secondary levels and to institutions training teachers at those levels. This covers conferences, youth activities, adult education, materials of instruction, teacher indoctrination, and special projects—all designed to convey the latest developments in the space program.

$2,080,000 for educational and information media activity. The estimate includes the preparation, production, printing, and distribution of nontechnical information on research and development activities and results to students, teachers, and to the public.

$2,055,000 for the exhibits activity. This estimate includes the cost of design and construction and transportation of exhibit material which will provide up-to-date coverage of NASA programs, particularly those in the Manned Space Flight program. The estimate also includes costs associated with setting up and disassembling NASA exhibits throughout the United States, and foreign countries.

(3) Administration costs for NASA-wide programs is estimated at $7,196,000 for fiscal year 1967. This is a net increase of $123,000 over fiscal year 1966. The items included under this activity are:

$3,675,000 for personnel and travel costs; 88 percent, or $3,235,000, of this amount covers costs of positions—an increase of $71,000 over fiscal year 1966; 7 percent, or $259,000, for workmen's compensation, and the remaining 5 percent, or $181,000, covers the costs of travel and transportation of administration personnel.

$1,300,000 for the personnel security investigation activity—the same level as in fiscal year 1966. This estimate provides reimbursement to the Civil Service Commission for the number of security investigations to be conducted in fiscal year 1967, and for routine, periodic updating of security investigations of NASA employees assigned to sensitive positions.

$871,000 for communications—the same level as in fiscal year 1966. Covered in this estimate are $611,000 for postage which is funded centrally by headquarters for all NASA centers, and $260,000 to cover leased lines between headquarters and various NASA installations.

$435,000 for printing and reproduction. The estimate for fiscal year 1966 is the same amount. Accounted for are costs of NASA-wide printing and reproduction of forms, statements, regulations, and miscellaneous procurement and other administrative issuances.

$915,000 for other administrative activities. This is $37,000 less than the fiscal year 1966 estimate for these costs. Included in this category are NASA-wide services such as personnel training, management information systems development, financial management, and occupational medicine.

(4) Industry affairs costs for NASA-wide programs is estimated at $3,247,000, an increase of $292,000 over fiscal year 1966. Of these costs 66 percent or $2,155,000 is for cost of positions—an increase of $48,000 over fiscal year 1966; 4 percent or $130,000 is for incentive awards; 5 percent or $145,000 is for travel costs and 25 percent or $817,000 is for all other costs which include:

$500,000 for reliability and quality assurance activities which provide for studies such as reliability of selected hardware assessments to locate areas of design weakness in time to permit corrections; development of nondestructive test techniques; and development of quality assurance publications to serve as aids to NASA employees engaged in the reliability and quality assurance program.

$317,000 for procurement and construction activities such as studying the effectiveness of incentive contracts, development, and maintenance of the subcontractor reporting system, revising procurement regulations, and reviewing facility plans and designs.

(5) Other NASA-wide supporting and staff activities are estimated to cost $5,455,000 in fiscal year 1967, a net increase of $88,000 over fiscal year 1966. Of the fiscal year 1967 estimate 71 percent or $3,869,000 is for personnel costs, an increase of $87,000 over the current fiscal year; 4 percent or $210,000 is for travel and transportation; and 25 percent or $1,376,000 is for all other costs which include items such as the Missile Sites Labor Commission, patent services, International Graduate Fellowships, aerospace chronology preparational launch vehicle cost estimate studies, and facilities maintenance standards.

2. *Headquarters operations costs*

The fiscal 1967 estimate for the cost of the day-to-day operations is $6,654,000. This is an increase of $237,000 over the fiscal year 1966 estimate; 38 percent or $2,547,000 of the fiscal year 1967 estimate is for personnel costs and benefits—an increase of $115,000 over the current fiscal year; and 62 percent or $4,107,000 is for all other costs as follows:

[In thousands of dollars]

	Fiscal year 1965 actual	Fiscal year 1966 estimate	Fiscal year 1967 estimate	Increase or decrease
Administrative services	3,567	2,945	2,945	----------
Automatic data processing	408	444	542	+98
Security operations	149	183	192	+9
Personnel operations	79	85	100	+15
Technical library	94	117	117	----------
Miscellaneous services	208	211	211	----------
Total	4,505	3,985	4,107	+122

Of the $4.1 million estimated in fiscal year 1967 for headquarters operations, one major activity—administrative services—accounts for over $2.9 million or 72 percent of the total. These major costs include purchase of supplies and equipment, maintenance and repair of equipment, and communications. The remaining 28 percent or $1.2 million covers automatic data processing analysis, programing and computer operations; security alarm systems and guard services; training for career development of headquarters personnnel; maintenance of the headquarters technical library; and miscellaneous services such as contract administration, occupational medicine and health programs, and financial management.

FISCAL YEAR 1967 BUDGET ESTIMATES, ADMINISTRATIVE OPERATIONS APPROPRIATION FOR NASA HEADQUARTERS

JUSTIFICATION BY OBJECT LESSON

This statement covers the justification of NASA headquarters fiscal year 1967 estimates by object class. A summary comparison is as follows:

[In thousands of dollars]

	1965 actual	Fiscal year 1967 budget submission		
		1966 estimate	1967 estimate	Increase or decrease
Personnel compensation and benefits	27,270	29,448	30,319	+871
Travel and transportation of persons	2,550	2,642	2,642	
All other costs:				
Transportation of things	341	295	295	
Rents, communications, and utilities	1,899	2,341	2,390	+49
Printing and reproduction	1,580	1,925	2,075	+150
Other services	15,432	17,520	18,831	+1,311
Supplies and materials	500	555	555	
Equipment	1,936	1,550	1,550	
Insurance claims and indemnities	8	10	10	
Subtotal, all other costs	21,696	24,196	25,706	+1,510
Total	51,516	56,286	58,667	+2,381

DIVISION OF FUNDS BETWEEN NASA-WIDE AND HEADQUARTERS ACTIVITIES

The following description covers fiscal year 1967 estimates in two categories, i.e., (1) NASA-wide costs and (2) headquarters operations. Of the $58.7 million estimate 88.7 percent or $52 million is for NASA-wide activities and 11.3 percent or $6.7 million for day-to-day operations of NASA headquarters. A distribution of costs by object class between NASA-wide and headquarters activities is as follows:

[In thousands of dollars]

	Fiscal year 1967 estimates		
	NASA-wide	Headquarters operations	Total
Personnel compensation	25,563	2,383	27,946
Personnel benefits	2,209	164	,2373
Travel and transportation of persons	2,588	54	2,642
Transportation of things	234	61	295
Rents, communications, and utilities	1,319	1,071	2,390
Printing and reproduction	1,922	153	2,075
Other services	16,818	2,013	18,831
Supplies and materials	15	540	555
Equipment	1,345	205	1,550
Insurance claims and indemnities		10	10
Total	52,013	6,654	58,667

(a) Personnel compensation and benefits

The fiscal year 1967 estimate for personnel compensation and benefits is $30,319,000, slightly more than half of the total headquarters request. This is an increase of $871,000 over the $29,448,000 estimated for the current fiscal year. Of the $30.3 million estimate for fiscal year 1967, $27.9 is requested for personnel costs and $2.4 for personnel benefits. Comparable estimates for the 3 fiscal years are as follows:

[In thousands of dollars]

	Fiscal year 1965, actual	Fiscal year 1966, estimate	Fiscal year 1967, estimate	Increase
Personnel compensation	25,311	27,281	27,946	+665
Personnel benefits	1,959	2,167	2,373	+206
Total	27,270	29,448	30,319	+871

The items included in personnel compensation and benefits are shown in the following table:

[In thousands of dollars]

	Fiscal year 1965, actual	Fiscal year 1966, estimate	Fiscal year 1967, estimate	Increase or decrease
Personnel compensation:				
Net cost of positions	24,258	26,192	26,852	+660
Reimbursable positions	619	650	650	
Overtime and nightwork differential	434	439	444	+5
Total personnel costs	25,311	27,281	27,946	+665
Personnel benefits:				
Life insurance and health benefits	189	204	215	+11
Retirement	1,533	1,673	1,729	+56
Workmen's compensation	15	20	20	
Incentive and inventions awards	55	100	150	+50
Other personnel benefits	167	170	259	+89
Total personnel benefits	1,959	2,167	2,373	+206
Total personnel costs and benefits	27,270	29,448	30,319	+871

The increase of $871,000 in personnel compensation and benefits for fiscal year 1967 is required to cover the cost of recent pay increases on a full-year basis, for within-grade step increases and career development, for retirement contributions, and other benefits.

NASA-wide costs.—Of the $30,319,000 requested for personnel costs, $27,772,000 is estimated for salaries and benefits of employees engaged in NASA-wide programs and activities which are conducted or administered centrally for the benefit of all centers.

Headquarters costs.—The balance of funds requested for personnel compensation and benefits, or $2,547,000 will be used to pay costs of personnel engaged in headquarters operations.

(b) Travel and transportation of persons

The fiscal year 1967 estimate for travel and transportation of persons is $2,642,000, the same amount estimated for fiscal year 1966. Of the $2.6 million estimated for fiscal year 1967, $2.4 million is for NASA employees travel and transportation and $217,000 for non-NASA-employee travel of technical and re-

search advisory committees and for other transportation charges. Comparable figures for the 3 fiscal years by purpose of travel are as follows:

[In thousands of dollars]

	Fiscal year 1960, actual	Fiscal year 1966, estimate	Fiscal year 1967, estimate	Increase or decrease
NASA-employee travel and transportation:				
Direction and coordination of program and administrative actiivities	2,105	2,370	2,370	
Initial duty stations, temporary duty assignments and transfers	37	41	41	
Attendance at meetings	6	14	14	
Total NASA employee travel and transportation	2,148	2,425	2,425	
Non-NASA-employee travel of technical and research advisory committee	171	174	174	
Local transportation and toll charges and rental of passenger motor vehicles	43	43	43	
Subtotal	214	217	217	
Total, travel and transportation of persons	2,362	2,642	2,642	

NASA-wide costs.—$2,588,000 or 98 percent of the fiscal year 1967 estimate of $2,642,000 is for travel and transportation in connection with NASA-wide programs and activities.

Headquarters costs.—Travel and transportation of persons involved in the day-to-day headquarters operations will account for the remaining 2 percent or $54,000 of the total request.

(c) *Transportation of things*

The fiscal year 1967 request for funds to cover transportation of things is $295,000. This is the same amount requested for the current fiscal year. Of the $295,000 requested for fiscal year 1967 it is estimated that $195,000 will be spent for domestic and overseas shipments of exhibits and spacemobiles; $56,000 for transporting household goods and personal effects; and $44,000 for freight, express, drayage, and parcel post costs of shipments to NASA installations, and rental of trucks from GSA. Comparable figures for fiscal years 1965, 1966, and 1967, are as follows:

[In thousands of dollars]

	Fiscal year 1965 actual	Fiscal year 1966 estimate	Fiscal year 1967 estimate	Increase or decrease
Freight, express, parcel post, and other transportation costs	206	239	239	
Household goods and personal effects	60	56	56	
Cargo airlift shipments	75			
Total	341	295	295	

NASA-wide cost.—Of the $295,000 requested for this coming fiscal year, slightly more than 79 percent or $234,000, is for the support of NASA-wide activities. The activities funded under this object class are for transportation of major domestic and foreign exhibits, including reshipment or replacement of spacemobiles to overseas areas and also for bulk shipments of forms and other media to NASA locations.

Headquarters operations.—The fiscal year 1967 costs for transportation of things for headquarters operations are estimated at $61,000. This includes transportation of household goods for NASA employees when they are transferred from one installation to another, or on reporting to a first-duty station when such transportation is specifically authorized.

(d) Rents and communications

The fiscal year 1967 estimate for rents and communications is $2,390,000 a net increase of $49,000 over the $2,341,000 available for fiscal year 1966. Rents will account for $590,000 and communications for the balance of $1,800,000. A comparison of the actual fiscal year 1965 costs and the estimated fiscal year 1966 and fiscal year 1967 costs is as follows:

[In thousands of dollars]

	Fiscal year 1965, actual	Fiscal year 1966, estimate	Fiscal year 1967, estimate	Increase or decrease
Rents	357	541	590	+49
Communications	1,542	1,800	1,800	
Total	1,899	2,341	2,390	+49

NASA-wide costs.—Of the $2,390,000 requested for fiscal year 1967, about 55 percent, or $1,319,000, is estimated for rents and communications for NASA-wide activities. A comparison of these costs for the 3 fiscal years is as follows:

[In thousands of dollars]

	Fiscal year 1965, actual	Fiscal year 1966, estimate	Fiscal year 1967, estimate	Increase or decrease
Rents	87	390	448	+58
Communications	541	871	871	
Total	628	1,261	1,319	+58

Of the $448,000 requested for rents in fiscal year 1967, $367,000 is for rental of space, including cost of utilities on a full-year basis, for the Scientific and Technical Information Facility. This is an increase of $58,000 over fiscal year 1966. The fiscal year 1967 estimate provides for payment to General Services Administration for a full year's rental of premises acquired in the early part of fiscal year 1966. In previous years, the rental of space for the Facility was a part of a the contract with Documentation, Inc. The remaining $81,000 is for the continued rental of ADP equipment in the Office of Manned Space Flight used in the calculation of Gemini versus LEM rendezvous modes in order to simulate an operational environment with the Gemini spacecraft that closely approximates the Apollo Lunar rendezvous requirements.

The fiscal year 1967 estimate for communications is $871,000, the same as in fiscal year 1966. The two main items in this request include a pro rata share of NASA's costs for leased circuits and terminal equipment between Headquarters and NASA locations and the cost of postage which is funded centrally by Headquarters for all NASA centers.

Headquarters operations.—Of the $2.4 million requested in fiscal year 1967 for rents and communications, the balance, or $1,071,000, is applicable to Headquarters operations. A comparison of these costs for the 3 years is as follows:

[In thousands of dollars]

	Fiscal year 1965, actual	Fiscal year 1966, estimate	Fiscal year 1967, estimate	Increase or decrease
Rental of office equipment	170	151	142	−9
Communications	1,000	929	929	
Total	1,170	1,080	1,071	−9

The fiscal year 1967 request of $142,000 is for rental of miscellaneous office equipment for Headquarters Operations. This is $9,000 less than the fiscal year 1966 estimate. The fiscal year 1967 estimate includes rental of items such as office copying and reproduction equipment and EAM equipment.

The fiscal year 1967 estimate for communications is $929,000. This is the same as fiscal year 1966. The main item chargeable against Headquarters operations includes local telephone and exchange service, Federal Telecommunications Systems, long distance toll charges, telegraph and TWX service, and a pro rata share of postage costs.

(e) *Printing and reproduction*

The fiscal year 1967 request for printing and reproduction is $2,075,000; an increase of $150,000 over the amount estimated for fiscal year 1966. A 3-year comparison of the major activities funded under this object class is as follows:

[In thousands of dollars]

	Fiscal year 1965, actual	Fiscal year 1966, estimate	Fiscal year 1967, estimate	Increase or decrease
Scientific and technical information	705	950	1,100	+150
Educational and information publications	247	350	350	
Printing and reproduction of administrative issuances, forms, etc	628	625	625	
Total	1,580	1,925	2,075	+150

NASA-wide costs.—Of the $2,075,000 proposed in the fiscal year 1967 estimates for printing and reproduction, 92.6 percent or $1,922,000 is for NASA-wide activities. The fiscal year 1967 estimate includes printing of publications as follows:

Scientific and technical aerospace reports cover NASA's abstracting and indexing journal. This periodical, issued semimonthly, covers worldwide literature in the aerospace field. It announces and abstracts aerospace reports issued by NASA, other Government agencies, universities, industry, and research organizations in the United States and abroad.

Procedings of symposia and conferences cover printing of papers prepared for or resulting from NASA scientific and technical meetings and workshops.

Handbooks and data compilations are publications which eliminate or reduce the need for users to consult scattered sources of information. Handbooks are reference tools which summarize basic data, procedures, and principles in an area of science or technology. Data compilations are aids to calculations in the form of tables, charts, and graphs.

Special publications cover selected aerospace topics which summarize significant research program developments, and integrated reports on orbital, lunar, and planetary flights.

Technology utilization publications are published in the form of reports, technical briefs, and handbooks, covering new techniques or processes which may be of interest to business or to the industrial community.

Educational publications disseminate results of research and technical findings in forms which are suitable for use by students, teachers, and the public. This includes booklets for layman readers which deal with topics such as lunar exploration, communications and meteorological satellites, and other phases of missions. This category of publications also includes wall display sheets for distribution to schools concerning specific programs such as Ranger, Syncom, and Surveyor.

Headquarters operations.—Of the $2,075,000 requested for fiscal year 1967, 7.4 percent or $153,000 is estimated for printing and reproduction in support of headquarters operations. This is $37,000 less than the $190,000 estimated for fiscal year 1966. The major cost items include printing and reproduction of forms, statements, regulations, and miscellaneous procurement and administrative issuances and reports.

(f) Other services

The fiscal year 1967 request for "Other services" is $18,831,000. This is an increase of $1,311,000 over the $17,520,000 estimated for fiscal year 1966. A 3-year comparison of the major activities funded under this object class is as follows:

[In thousands of dollars]

	Fiscal year 1965 actual	Fiscal year 1966 estimate	Fiscal year 1967 estimate	Change from fiscal year 1966
NASA-wide costs:				
Scientific and technical information program:				
Scientific and technical information facilities	5,084	4,967	5,308	+341
Documentation of journal literature	489	1,510	1,810	+300
Scientific information system development	59	355	355	
Technical publications preparation	172	597	885	+288
Translating services	224	275	350	+75
Subtotal	6,028	7,704	8,708	+1,004
Educational services:				
Dissemination of information through educational channels	1,428	1,305	1,305	
Educational media services	1,610	1,725	1,725	
Educational exhibits services	777	745	745	
Subtotal	3,815	3,775	3,775	
Other services:				
Security investigations	1,591	1,300	1,300	
Reliability and quality assurance	386	440	500	+60
Incentive contracting study			197	+197
Training programs	326	350	400	+50
Miscellaneous studies and services	1,775	2,069	1,938	−131
Subtotal	4,078	4,159	4,335	+176
Subtotal, NASA-wide costs	13,921	15,638	16,818	+1,180
Headquarters operations	1,511	1,882	2,013	+131
Total	15,432	17,520	18,831	+1,311

NASA-wide costs.—Of the $18,831,000 requested for fiscal year 1967, 89 percent or $16,818,000 is for NASA-wide activities.

The scientific and technical information program is estimated to cost $8.7 million in fiscal year 1967—over one-half of the $16.8 million. This includes—

$5.3 million for the NASA Documentation Facility—an increase of $341,000 over fiscal year 1966. The main services and products provided by the facility include (*a*) acquisition of all scientific and technical documents resulting from NASA-supported research and development programs including reports and materials prepared by NASA personnel and contractors and those resulting from NASA interagency agreements with domestic and foreign organizations; (*b*) preparation and distribution to NASA field centers and major contractors of updated computer-prepared magnetic tapes carrying all bibliographic information produced in the NASA documentation system; (*c*) abstracting of newly acquired significant material and indexing in depth to provide maximum efficiency in subsequent retrieval of information at the NASA facility and at NASA centers and contractor locations; and (*d*) preparation of records of full texts of documents in the form of microtransparencies and for automatic dissemination of such information by subject categories to official users.

$1.8 million for documentation of journal literature—an increase of $300,000 over fiscal year 1966. This activity supplements and provides direct input into the mechanized reference system of the NASA Documentation Facility. The increase provides for processing the increased volume of valuable foreign aerospace journal literature for immediate use in the U.S. aerospace programs.

$355,000 for scientific information systems development—projected at the same level as for fiscal year 1966 and provides for the continued improvement and refinement of the scientific information system to increase the effectiveness of NASA's technical information program, and to permit the most economical interchange of NASA computerized documentation output with that of DOD, AEC, and other Government agencies. The fiscal year 1967 estimate provides for the design and preparation of written computer programs to convert multiple-computer outputs into machine language for use by a series of computers with diverse capacities; and for the development of a remote console interrogation system for acquiring and transmitting information from a central bank to users not having local computer facilities.

$885,000 for technical publications preparation—an increase of $288,000 over fiscal year 1966. This estimate covers the preparation of manuscript material for specialized publications such as handbooks, data compilations, and monographs, and for preprinting art and related services. Handbooks are reference tools summarizing the basic data procedures, and principles in a definitive area of science or technology; data compilations are aids to calculations in the form of tables, charts, and graphs, presenting calculated or experimental values in an orderly fashion. Both of these types of publications collect, organize, and package in the most useful form the specialized scientific or technical data available only in scattered reports and journal literature. Monographs are publications which furnish the working scientists with current information in highly specialized technical areas. They cover a narrow technical area of greater complexity, in greater depth, and are produced primarily for the laboratory-bench scientist. Monographs provide comprehensive, state-of-the-art summaries in scientific areas where the output of technical reports and articles is so voluminous as to make it difficult, time consuming, and expensive for many users to handle and absorb.

Translating services will require an estimated $350,000 in fiscal year 1967. This is $75,000 more than the $275,000 estimated for fiscal year 1966. These funds are required for services for translating foreign language technical books, reports, and journal articles required to meet the needs of NASA and its contractor scientific personnel. Translations are used to (a) keep abreast of world developments in the space sciences and related fields; (b) avoid duplication of research done in foreign nations; and (c) evaluate present status of research in foreign nations. The $75,000 over the fiscal year 1966 level will pay for additional translating services required to handle the rise in the worldwide journal activity in the aerospace sciences and the availability of a continually increasing volume of material originally published in foreign languages.

Educational programs and service are estimated to cost $3.8 million in fiscal year 1967—the same as in fiscal year 1966. These programs and services include:

$1.3 million for dissemination of information through educational channels. This estimate covers space science lecture demonstration programs which provide current information direct to assembled students, teachers and other groups throughout the United States and several foreign countries, by the use of models, experiments, and other visual aids. The fiscal year 1967 estimate is at the same level as fiscal year 1966. It includes funds for the operation of spacemobiles. In addition, the estimate covers assistance to schools and nonschool educational agencies at the elementary and secondary levels, and to institutions training teachers at these levels. This program is carried out in cooperation with the U.S. Office of Education. Individual projects include teacher workshops, conferences of State career guidance and vocational supervisors and workshops and seminars of professional educators in the development of materials of instruction.

$1.7 million for educational media services. This includes the preparation, production, and distribution of nontechnical information on research and development activities and dissemination of results to students, teachers, and to the public.

$745,000 for exhibits services. This includes the cost of design and construction of exhibit material which will provide up-to-date coverage of NASA programs, particularly those in the Manned Space Flight program. This estimate also includes costs associated with setting up and disassem-

bling NASA exhibits throughout the United States, Canada, and overseas countries.

Other activities are estimated to cost $4.3 million in fiscal year 1967, an increase of $176,000 over fiscal year 1966.

Security investigations are estimated to cost $1.3 million in fiscal year 1967, the same level as in fiscal year 1966. This estimate provides for reimbursement to the Civil Service Commission for the number of security investigations to be conducted during this coming fiscal year.

Reliability and quality assurance studies costs for fiscal year 1967 are estimated at $500,000, an increase of $60,000 over the fiscal year 1966 level. This is requested for studies such as reliability of selected hardware assessments to locate areas of design weakness in time to permit corrections: development of nondestructive test techniques; and development of quality assurance publications to serve as aids to NASA employees engaged in the reliability and quality assurance program.

$197,000 for studying the effectiveness of NASA's incentive contracts. These funds will be used for studies related to the effectiveness of NASA's incentive contracts. A minimum of 15 seleced NASA incentive-type contracts will be examined and analyzed in order to provide a concrete basis for judging past effectiveness of this type of contract and for developing techniques to increase the effectiveness of future incentive contracts.

$400,000 for training programs—an increase of $50,000 over fiscal year 1966. This estimate provides for agencywide training of personnel in areas which are common to several NASA centers. Heavy emphasis is placed on the development of training programs in the management field such as program and project management, supervisory management, incentive contracting, procurement and financial management, reliability and quality assurance, and contract administration.

$1.9 million for miscellaneous studies and services represents a $131,000 decrease below the fiscal year 1966 level. This includes studies and services covering broad areas of selected topics which cut across functional or center activities. These topics include launch vehicle cost data, facility maintenance standards, occupational medicine, patent search services, patent foreign filing services, NASA's share of costs in support of the Missile Sites Labor Commission and administrative costs in support of overseas personnel.

Headquarters operations.—Of the $18.8 million request for other services in fiscal year 1967, the balance of 11 percent, or $2 million is for support of headquarters operations—an increase of $131,000 over fiscal year 1966 estimates. The main items included in the estimates are maintenance and repair of office and printing plant equipment, chart and related artwork, movement of partitions, security guard services, health services, computer operation, programing and systems design services, contract administration, and miscellaneous minor contractual services.

(g) Supplies and materials

The fiscal year 1967 request for supplies and materials is $555,000—the same amount as estimated for fiscal year 1966. The fiscal year 1967 estimate covers expendable office supplies, printing and photographic supplies and materials, pamphlets and documents for technical documentation services, and books and periodical subscriptions for the technical and law libraries. Comparable estimates for the 3 fiscal years are as follows:

[In thousands of dollars]

	Fiscal year 1965, actual	Fiscal year 1966, estimate	Fiscal year 1967, estimate	Change
Office supplies and materials	$394	$400	$400	
Reproduction and related supplies	4	35	35	
Miscellaneous subscriptions and books	87	101	101	
Pamphlets and documents	15	19	19	
Total	500	555	555	

Of the $555,000 requested in fiscal year 1967 for supplies and materials, $15,000 is for NASA-wide purchases of pamphlets and documents in connection with the scientific and technical programs. The remaining $540,000 is for office and printing supplies and subscriptions and books required for headquarters operations.

(*h*) *Equipment*

The fiscal year 1967 estimate for equipment is $1,550,000, the same as estimated for fiscal year 1966. This estimate includes purchase of mechanical, photographic, and miscellaneous equipment and replacement vehicles for the existing spacemobile fleet which will exceed the 80,000-mile mark in fiscal year 1966 and will become uneconomical to maintain and repair. A 3-year breakdown of the figures for equipment is as follows:

[In thousands of dollars]

	Fiscal year 1965, actual	Fiscal year 1966, estimate	Fiscal year 1967, estimate	Change
Office furniture and equipment	$156	$140	$140	
Motor vehicles (spacemobiles)	64	40	40	
Reproduction and miscellaneous equipment	890	260	260	
Procurement of educational exhibits and materials	826	1,110	1,110	
Total	1,936	1,550	1,550	

NASA-wide costs.—Of the $1,550,000 requested in fiscal year 1967 for equipment, 87 percent or $1,345,000 is estimated for NASA-wide support. This includes $1,110,000 for procurement of educational exhibits and materials which will provide up-to-date coverage of NASA programs in the manned and unmanned exploration of space and to update the exhibit inventory to keep abreast of technical programs. It also includes $235,000 to cover the purchase of (1) spacemobile vehicles which have become uneconomical to maintain and (2) mechnical and reproduction equipment.

Headquarters operations.—The balance of the fiscal year 1967 estimate or $205,000 is for equipment needed in the day-to-day headquarters operations. This covers the purchase of miscellaneous office equipment, and equipment for mailroom, warehousing, and reproduction operations.

(*i*) *Insurance claims and indemnities*

The fiscal year 1967 estimate of $10,000 projects requirements at the same level as fiscal year 1966. This estimate for insurance claims and indemnities covers payment of tort claims of $2,500 or less. Such claims arise as the result of damage to or destruction of property or of personal injury or death caused by the negligent or wrongful act or omission of any NASA employee that occurs while he is on duty performing the official duties of his office or employment. All claims of $1,000 or over are paid from headquarters funds, regardless of the installation assignment or location of the NASA employee.

National Aeronautics and Space Administration Facility Planning and Design

The funds requested for facility planning and design are used to conduct advance planning and design activities on proposed construction projects for which funds will be requested in subsequent budgets. These funds provide for completion of preliminary design of facilities prior to their submission in the budget so as to establish a sound basis for describing each facility and estimating the cost. These funds also provide for preparation of complete plans and specfications on construction projects in the following year's budget. Such final design activities begin soon after the budget is prepared so that the appropriated funds can be utilized in a timely manner. Special studies relating to such things as facility improvements and master planning are also supported by the facility planning and design funds.

The amount requested for facility planning and design is $7 million. These funds will support work in four areas. It is estimated that $1 million will be required for preliminary design of fiscal 1969 facilities; final design of fiscal year 1968 facilities is estimated to require $3.5 million: special design and master planning activities are estimated to require $500,000; and $2 million is requested for completion of plans and detailed specifications for the highly complex two-position engine test stand associated with the NERVA program.

Financing by fiscal year.—The $7 million requested for fiscal year 1967 compares with the current $3.3 million operating plan for fiscal year 1966 and the $10 million appropriated for fiscal year 1965. Although a total of $5 million was authorized for fiscal year 1966, only $2.7 million of fiscal year 1966 construction-of-facilities funds were put into the facility planning and design account. The balance of $2.3 million represented the reduction in the construction-of-facilities appropriation below the authorization. Accordingly, it is planned that all of the fiscal year 1966 authorized facilities will be constructed. Subsequently, $600,000 of prior year construction-of-facilities funds have been identified and are in the process of being returned from the program offices to be added to the fiscal year 1966 planning and design account to bring it up to the $3.3 million operating plan. The funding summary by fiscal year is shown in attachment 1.

Although the fiscal year 1966 facility planning and design operating plan is considerably less than the fiscal year 1965 level or the fiscal year 1967 request, it is augmented by $1.9 million of fiscal year 1965 planning and design funds. As shown in attachment 2, only $8.1 million of facility planning and design work was carried on during fiscal year 1965. The $1.9 million carryover was thus held to support fiscal year 1966 activity. It was in light of this carryover that the decision was made to take all of the fiscal year 1966 construction-of-facilities appropriation reduction in F.P. & D., thereby retaining funds for construction of all authorized fiscal year 1966 facilities. Thus, with the $1.9 million carryover from fiscal year 1965 and the application of $600,000 from prior year unobligated construction-of-facilities funds, the total funds expected to be obligated in support of facility planning and design activity during fiscal year 1966 amounts to $5.2 million.

Activity comparisons by fiscal year.—The $1 million requested in the fiscal year 1967 budget for preliminary design of fiscal year 1969 facilities was based on an estimated $80 to $100 million of proposed construction with preliminary design costs of 1 to 1¼ percent. The amount spent for preliminary design of fiscal year 1967 facilities was $2.8 million and it is estimated that approximately $1.3 million will be required for fiscal year 1968 facility preliminary design.

The $3.5 million requested in the fiscal year 1967 budget for final design of fiscal year 1968 facilities was also based on an estimated $80 to $100 million of proposed construction with final design costs at 3½ to 4⅜ percent. Final design funds spent for fiscal year 1966 facilities amounted to $3.8 million and approximately $3.4 million will be required for fiscal year 1967 facility final design.

The $500,000 requested for special design and master planning activities can be compared to $900,000 to support similar fiscal year 1965 work and an estimated $500,000 for fiscal year 1966 special study and master planning effort.

Two contracts amounting to a total of $600,000 were awarded recently for design studies and preliminary design effort on the engine/stage test stand 2 and 3 complex for the NERVA nuclear rocket engine. This facility is a two test stand complex that consists of two static test stands, a control center, and ancillary equipment. Each test stand will be capable of testing a nuclear rocket propulsion module in a vertical position during 5,000-megawatt power operations. The $2 million requested for fiscal year 1967 is required to continue into the final design activity on this facility. Design funds for this facility are identified separately from those related to other future construction because it is a major construction effort currently estimated to cost in the neighborhood of $50 million to construct.

ATTACHMENT 1

Facility planning and design summary by fiscal year

	Fiscal year 1965	Fiscal year 1966	Fiscal year 1967
Preliminary design	2.8	1.3	1.0
Fiscal year 1967 facilities	2.8		
Fiscal year 1968 facilities		[1] 1.3	
Fiscal year 1969 facilities			1.0
Final design	5.4	1.8	3.5
Fiscal year 1966 facilities	3.8		
Fiscal year 1967 facilities	1.6	1.8	
Fiscal year 1968 facilities			3.5
Special studies and master plans	1.2	.2	.5
Fiscal year 1965 activity	.9		
Fiscal year 1966 activity	.3	.2	
Fiscal year 1967 activity			.5
Engine test stands 2 and 3	.6	0	2.0
Total	10.0	[1] 3.3	7.0

[1] Includes $600,000 from prior years.

ATTACHMENT 2

Facility planning and design summary by activity

	Preliminary design	Final design	Special studies	Engine test stands 2 and 3	Total
Fiscal year 1965 activity (all fiscal year 1965 funds)	2.8	3.8	0.9	0.6	8.1
Fiscal year 1966 activity	1.3	3.4	.5	0	5.2
Fiscal year 1965 funds		1.6	.3		1.9
Fiscal year 1966 funds	[1] 1.3	1.8	.2		3.3
Fiscal year 1967 activity (all in fiscal year 1967 budget)	1.0	3.5	.5	2.0	7.0

[1] Includes $600,000 from prior years.

LANGUAGE DIFFERENCES BETWEEN THE "NASA AUTHORIZATION ACT, 1967" AS SUBMITTED TO THE CONGRESS BY NASA AND THE "NASA AUTHORIZATION ACT OF 1966" (PUBLIC LAW 89–53)

SUMMARY

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I. ITEMS OF SUBSTANCE

1. Section 5: Permissive exemption from the limitation on the fee for architect-engineer contracts

Section 5 of the proposed "National Aeronautics and Space Administration Authorization Act, 1967," would amend the National Aeronautics and Space Act of 1958 to authorize NASA to enter into contracts, when determined to be necessary by the Administrator, for architect-engineer services for highly complex research and development facilities without regard to the limitation imposed by 10 U.S.C. 2306(d) on contracts for architect-engineer services. The need for this legislation arises as a direct result of a June 1965 report to the Congress by the Comptroller General entitled "Noncompliance with Statutory Limitation on Amount Allowable for Architectural-Engineering Services for the Design of a Facility at the Nuclear Rocket Development Station, Nevada." In that report the Comptroller General took issue with the way in which NASA had applied the limitation on the cost of architect-engineer contracts imposed by 10 U.S.C. 2306(d) to the design of the so-called E–MAD facility at NRDS. This facility is a complex structure for the testing of nuclear engines. The cited statute limits the amount to be paid for architect-engineer services under a cost-plus-fixed-fee contract to 6 percent of the estimated cost of the construction project to which such services relate. (This should be distinguished from the statutory fee limitations imposed on contracts other than A-E contracts which relate to the percentage of fee or profit which may be added to the estimated cost.)

The crux of the issue created by the report is to be found on page 12 thereof in the statement that GAO "decisions have consistently held that the limitation applies to amounts payable to architect-engineers for any service performed under contract for the production and delivery of designs, plans, drawings, and specifications."

Most NASA A–E contracts are not cost-plus-fixed-fee contracts. However, with respect to those that are, NASA has consistently applied an interpretation to the statutory limitation which is in consonance with that followed by other agencies subject to the same statutory limitation. This interpretation is that only the work performed by an architect-engineer which relates to the production and delivery of design, plans, drawings, and specifications is subject to the 6-percent limitation. All other work, such as master planning, feasibility studies, subsurface investigations, research and development for structures or on materials or methods, engineering for future equipment and facilities (i.e., expansion) and special engineering required because of the particular nature of facility (i.e., nuclear, or otherwise hazardous to neighboring activities) is not subject to the 6-percent limitation on A-E fees. Most of such other work is subject, however, to the 15-percent-maximum-fee limitation on CPFF research and development contracts also imposed by 10 U.S.C. 2306(d).

As a general rule, those elements of such other work which are preparatory in nature and can reasonably be separated from the production and delivery of designs, plans, etc., are performed under a separate contract. This is so because such work normally precedes the decision to construct the structure. However, for sound business, engineering or management reasons it is not always possible to separate preparatory work from the production and delivery of designs, plans, etc. In such a case it is not practical to break the overall requirement for architect-engineer services down into two or more contracts in order to make the one calling for production and delivery of designs, etc., fall within the statutory limitation. It should be borne in mind that architect-engineer contracts are not advertised. Competition with respect to such contracts is limited to an evaluation of the competence of a particular firm for the project in question. Fees are regulated to an extent by the applicable professional societies.

The contract for the design of the E–MAD facility which was reviewed by the Comptroller General required the production and delivery of designs, etc., but also included a substantial amount of "other work" which, as previously stated, was not considered by NASA to be subject to the limitation of 10 U.S.C. 2306(d).

The above described method of applying the statutory limitation had definite support in past opinions of the Comptroller General. (See, for example, 21 Comp. Gen. 580, 22 id. 464, and 40 id. 188.) However, the June 1965 report of the Comptroller General has given rise to questions as to how the statutory limitation is to be applied in the future to complex research and development facilities. Since the building of such facilities today involves far more than the type of traditional architect-engineer services to which the 6 percent limitation had orig-

inally been intended to apply, it is evident that a need exists for clarifying legislation. In fact, the Comptroller General's report itself suggested the desirability of legislative action to deal with this problem. The recommended legislation represented by section 5 of the National Aeronautics and Space Administration Authorization Act, 1967, would, if enacted, clarify the law to the extent necessary.

2. Increase from one-half to one percent in amount of funds which may be reprogramed from "R. & D." to "C of F"

Section 3 as submitted by NASA would authorize the transfer of 1 percent (rather than the one-half of 1 percent provided in last year's act) of the "Research and development" appropriation to the "Construction of facilities" appropriation, and the use of such funds, after the requisite determination, finding and notification have been made, for construction projects not otherwise presented to, and approved by, the Congress.

The reprograming authority provided under section 3 has not been used in the past to initiate new agency objectives or to carry out new programs which have not been fully discussed with the Congress. Rather, the stated programs of the agency have been carried out within the funds made available under the three appropriations, although the method of achieving those stated objectives in the most expeditious and prudent manner has often required flexibility in the application of the funds between appropriations. Our experience has shown that when a change in the method of achieving a stated objective is determined to be desirable, associated facilities construction frequently turns out to be the pacing element of the revised approach. Consequently, it has often been necessary to utilize funds authorized for research and development under the original program plan for the construction of facilities needed under the revised plan.

We are still in the development phase of major R. & D. programs. If future events should indicate the need for major changes in our planned methods of achieving our stated objectives, it is entirely conceivable that necessary facilities changes may amount to more than the aggregate of transfer authority available at the current limitation level. The requested increase of transfer authority to 1 percent is, therefore, for the important purpose of assuring that NASA has available to it on a timely basis, the flexibility that might be needed to take the most prudent advantage of unforeseen changes in the methods of attaining its program objectives.

II. EDITORIAL CHANGES

1. Section 3—Correction of Error in Cross Reference to a Paragraph in Section 1(b)

As enacted, the National Aeronautics and Space Administration Authorization Act of 1966 provided that a specified sum of "Construction of facilities" funds "other than funds appropriated pursuant to paragraph (12)" may be used for reprograming actions at the discretion of the Administrator of NASA. Paragraph (12) is the "Various locations" line item. However, in prior years, and in the draft bill submitted by NASA for the fiscal year 1966, the reference was to the "Facility planning and design not otherwise provided for" line items, which is paragraph (13) of Public Law 89–53. The apparent error in the cross reference crept in during the course of congressional action on the NASA authorization bill for fiscal year 1966. The draft bill submitted to the Congress by NASA would correct this apparent error by returning the cross reference to the "Facility planning and design not otherwise provided for" line item.

2. Section 1(b)(4)—Change in Post Office Address of KSC

The Post Office address of the John F. Kennedy Space Center, NASA, has been changed to Kennedy Space Center, Fla., as a consequence of a post office so identified having been established to serve the John F. Kennedy Space Center.

3. Section 1(b)(9)—Renaming of Michoud Assembly Facility

The name of the facility located at New Orleans, La., has recently been changed to the Michoud Assembly Facility, and the submitted bill reflects this change also.

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III. REASONS FOR OMISSIONS FROM THIS BILL

1. Omission of last year's section 5 relating to geographical distribution of research funds

The fiscal year 1967 bill omits the text of what was section 5 of the fiscal year 1966 Act which read as follows:

"It is the sense of Congress that it is in the national interest that consideration be given to geographical distribution of Federal research funds whenever feasible, and that the National Aeronautics and Space Administration should explore ways and means of distributing its research and development funds whenever feasible."

In our opinion the language of the section made it clear that the Congress was making a one-time pronouncement intended to guide NASA for some time to come. It was, therefore, deemed unnecessary to repeat the language in this year's bill.

2. Why "Voyager" is not a separate R. & D. line item

The Senate Committee on Aeronautical and Space Sciences, in its report on the NASA authorization for fiscal year 1966 (S. Rept. 188, 89th Cong., 1st Sess. at p. 32), requested that the Voyager program be carried as a separate program line item in subsequent years if NASA continues to support the program. The President's budget for NASA for fiscal year 1967 proposes no commitment to Voyager flight hardware, the work planned being confined to certain design studies. As such, the proposed work remains an integral part of the "Lunar and planetary exploration" program as presently constituted and, therefore, it is not being recommended in fiscal year 1967. If, in the future, Voyager is recommended to the Congress for funding as a flight program, then NASA will comply with the Senate committee's request and make it a separate program line item. Until then, it is considered more appropriate for the Voyager study effort to remain a separate project to be described in detail as a part of the current "Lunar and planetary exploration" program line item.

IV. LISTING OF OTHER CHANGES DUE TO PROGRAM REQUIREMENTS

1. Changes in dollar amounts.

2. The fiscal year 1966 act's section 1(a)(8) "Communications satellites" and section 1(a)(9) "Applications technology satellites" have been combined into this year's section 1(a)(8) "Communications and applications technology satellites."

3. Last year's section 1(a)(17) "Nuclear rockets" and section 1(a)(18) "Solar and chemical power" have been combined into this year's section 1(a)(15) "Space power and electric propulsion systems."

4. Ames Research Center has been omitted from section 1(b) as a locational line item since no construction funds for this Center are requested.

5. ERC and JPL have been added to section 1(b) as locational line items since funds are requested this year for those locations.

6. Section 6 would make the short title of the bill "The National Aeronautics and Space Administration Authorization Act, 1967" rather than "1966."

OFFICE OF INDUSTRY AFFAIRS

Among the staff offices which report to the Office of the Administrator is the Office of Industry Affairs. That Office is headed by Assistant Administrator William Rieke.

The touchstone of the industry-Government relationship is the communication system which links industry and Government. It is Mr. Rieke's general responsibility to initiate, maintain, improve and promote communications so that the industry and Government segments of the Nation's space team function together effectively and in harmony to achieve our goals in the most economic manner.

Organizational elements reporting to the Assistant Administrator for Industry Affairs are as follows:

The Office of Procurement.
The Facilities Management Office.
The Labor Relations Office.
The Reliability and Quality Assurance Office.
The Inventions and Contributions Board.

Probably a few words about each will describe the functions performed and indicate certain achievements. Also described briefly are some of the objectives for the next year which is part of a continuing program to implement new, promising ideas which will further promote our industry relationships.

The Office of Procurement issues NASA-wide procurement policy and regulations, reviews and approves major contracts, and evaluates operations. Testimony of previous years describes in detail the policies we pursue and our actual practices. As in the past, the principal goals are maximizing competition and motivating quality performance at the lowest cost. In both of these areas the past year has been one of accomplishment, and next year is viewed as one in which the healthy trends which have been established will continue. For example, NASA's competitive procurements have been as follows:

Fiscal year	Percent	Amount (billions)
1962	55	$0.565
1963	58	1.3
1964	60	2.1
1965	63	2.6
1966 (6 months)	65	1.5

With respect to improvements in contracting methods, NASA has continued to encourage the use of incentive contracts wherever appropriate and, conversely, to limit cost-plus-fixed-fee contracts to those cases where the uncertainties involved clearly dictated use of this kind of contractual arrangement. As of December 31, 1965, NASA had 159 active incentive contracts with a target value of $2.2 billion. This compares to 121 contracts with a target value of $1.8 billion as of June 30, 1965. In this 6-month period a 31-percent increase in the number of incentive contracts was realized and a 22-percent increase in dollar volume. Currently 13 additional contracts are in negotiation with target values estimated to be $1.8 billion. Contrasting with this upward trend in incentive contracts is the striking decrease in new cost-plus-fixed-fee contracts. NASA placed $2.2 billion of this type in fiscal year 1963, $1.8 billion in fiscal year 1964, $207 million in fiscal year 1965, and only $31 million during the first half of fiscal year 1966.

A management tool which will be of increasing use in NASA is Phased Project Planning. To assure that all the benefits of this technique are fully and consistently utilized, a policy directive on this subject was issued on October 28, 1965. Each phase of a major project is a specifically approved activity undertaken after review and analysis of preceding effort. NASA believes that implementation of the directive will result in more intensive competition in industry and in better Government management in many areas, including procurement.

The Facilities Management Office was established on December 15, 1965, to effect consolidation of related activities and is the result of continuing efforts to adapt management structures to changing conditions faced by NASA. This organization will provide, within NASA's headquarters, a single authority responsible for the development of agency policies and practices relating to management of NASA controlled facilities and real property, including acquisition, design, construction, repair, alteration, maintenance, operation, utilization, and disposal. NASA expects that the operations of this Office will result in increased economy and will assure the most efficient application of facilities management experience throughout the agency.

The Labor Relations Office has NASA-wide responsibility for establishing and maintaining labor relations which promote stability in the performance of our programs. This Office works almost daily with the Department of Labor, the President's Missile Sites Labor Commission, and labor organizations at the headquarters and local levels to avoid work stoppages which might disrupt the launch and other schedules we have established. A most significant development in recent experience was a gratifying sharp decline in man-days lost by construction workers at the Kennedy Space Center during the final half of calendar 1965. Of course, this improvement could not have been made without the cooperation and dedication of other Government agencies, our contractors, and the labor community itself.

The Reliability and Quality Assurance Office develops agencywide policies and procedures in its area of responsibility, studies special reliability and quality

problems, develops new methodology and techniques and represents and coordinates NASA's reliability and quality assurance program with the Department of Defense and industry. Significant accomplishments during the past year include working with industry to identify those of our quality requirements which might cause unnecessary costs. It is expected that continuing work in this area will result in cost reductions without lowering required performance characteristics. Also of significance are the economies which will flow from Department of Defense and NASA cooperation in identifying needed study and research areas and sharing work assignments to preclude duplications of effort.

The responsibilities of the Inventions and Contributions Board include receiving and evaluating applications for award for scientific or technical contributions to NASA which have significant value in the conduct of aeronautical and space activities. While awards have been made to Government employees as the result of ongoing programs and a few awards have been made to contractor employees, NASA has had no widely publicized program which would give incentive to contractor employees to make and report new inventions and technical discoveries. NASA is now planning a broad program to give individual recognition for these innovations. Where the contribution is of significant value, a monetary award may be made as provided in section 306 of the National Aeronautics and Space Act of 1958. It is expected that this program will encourage the flow and dissemination of information growing out of NASA contracts so that maximum application thereof to the economy generally will be promoted.

Review of Provisions Contained in Sections I(e)(2), I(f), and I(h) of H.R. 12718

The language contained in section I(e)(2) continues the authority granted last year to the effect that when so specified in an appropriation act, any amount appropriated for "Administrative operations" may be available for contracts for maintenance and operation of facilities and other services to be provided during the fiscal year after that for which appropriations would be authorized in this bill.

Until last year, under applicable law, "Administrative operations" appropriations were not available for payments under severable contracts for services rendered at any time after the end of the fiscal year for which the funds were appropriated. In order to obtain such services in the following fiscal year (which might start only a month or two after entering into such contract), either the entire procurement process had to be undertaken again, or the initial contract had to be entered into on the basis of options or some similar device which placed a further administrative burden on the Government and was unattractive to contractors because of the obvious risks involved. In consequence, contractors' bids would not be as low as otherwise possible, particularly where substantial "startup" costs were involved; and, as indicated above, such procurements required some form of additional administrative handling at the end of the fiscal year in which the contract was entered into. Thus, the July to June procurement cycle resulted in excessive administrative costs, scheduling difficulties, and high bids.

Continuation of last year's language will enable NASA to enter into contracts, during fiscal year 1967, for procurement of maintenance and other services, performance of which may be rendered at any time until the close of fiscal year 1968. Thus, contract administration can be improved and the higher costs of contracting on a July–June cycle can be avoided.

Section I(f) authorizes funds for scientific consultation or extraordinary expenses. The utilization of the fund requires the approval or authority of the Administrator and his determination will be final and conclusive.

It is the National Aeronautics and Space Administration policy to reimburse

agency officials who, during the conduct of official business, incur expenses for which established reimbursement procedures do not apply and which fall within the authority of the act. Such reimbursement, however, will be limited to those expenses required in order to promote or protect the interests of the National Aeronautics and Space Administration and the United States either within the United States or abroad and, as in the past, will be administered judiciously and prudently.

The availability of these funds are necessary to carry out NASA's overall program efficiently and effectively.

The language contained in section I(h) continues the authority granted last year to the effect that any appropriation authorized for NASA under this act may be initially used during the fiscal year 1967 to finance work or activities for which funds have been provided in any other appropriation available to the Administration, and appropriate adjustments between such appropriations shall subsequently be made in accordance with generally accepted accounting principles.

The language provides authority for initially financing such procurements as common use supplies or services related to approved work or activities from any appropriation available to NASA, with subsequent distribution of the charges to benefited appropriations, such distribution being based on later information as to actual application of charges. The use of this authority is restricted to situations in which an accurate distribution of such charges is not possible at the time of obligation, but is possible at a later date based on receipt of additional information. This authority enables NASA to expedite payments to its contractors and simplify its accounting by avoiding numerous adjustments which would otherwise be necessary to reflect final distribution of charges. For example, under the authority, inventories of common use supplies, materials, and equipment may be purchased exclusively from one appropriation, with subsequent charges to other appropriations on the basis of stock issues from inventory.

The authority is particularly useful in connection with many types of consolidated contracts in which the services contracted for are utilized by a number of programs and projects, and for purposes associated with more than one appropriation, such as utilities; computer rentals; contractor furnished support services involving technical support to in-house effort; arts and graphics services; security services; and contract administration services. In each of these contracting situations, the distribution of services received between appropriations cannot be determined accurately at the time of obligation, since such distribution will necessarily be based on demand for these services. Also the information for such distribution may not be available at the time of payment, but would become available later, at which time a final adjustment between appropriations could be made.

All necessary adjustments between appropriations are made before closing the accounts at the end of each fiscal year, in order to provide, for budget submissions and other purposes, an accurate distribution of all charges to appropriations for the fiscal year.

Fiscal Year 1967 Budget Estimates, Western Operations Office

ADMINISTRATIVE OPERATIONS APPROPRIATION

The fiscal year 1967 budget estimates for the Western Operations Office activities are funded under the "Administrative operations" appropriation. The budget request for these activities is shown in volume IV of the congressional justification book beginning on page AO–4–16.

SUMMARY OF FUNDING REQUIREMENTS

The fiscal year 1967 budget request for the Western Operations Office and NASA-Resident Office, Jet Propulsion Laboratory (JPL) funded under the "Administrative operations" appropriation is $6,149,000. This is an increase of $162,000 over the $5,987,000 available for the current fiscal year. Comparable estimates for the 3 fiscal years are as follows:

	Actual, fiscal year 1965	Estimate, fiscal year 1966	Estimate, fiscal year 1967	Increase or decrease
11. Personnel compensation	$4,115,000	$4,289,000	$4,426,000	$+137,000
12. Personnel benefits	289,000	309,000	317,000	+8,000
Total, personnel costs	4,404,000	4,598,000	4,743,000	+145,000
21. Travel and transportation of persons	247,000	282,000	282,000	
22. Transportation of things	8,000	45,000	50,000	+5,000
23. Rent, communications, and utilities	349,000	402,000	402,000	
24. Printing and reproduction	15,000	15,000	15,000	
25. Other services	522,000	514,000	517,000	+3,000
Services of other agencies	12,000	14,000	58,000	+44,000
26. Supplies and materials	51,000	53,000	53,000	
31. Equipment	17,085,000	64,000	29,000	−35,000
32. Lands and structures				
42. Insurance claims and indemnities				
Total	22,693,000	5,987,000	6,149,000	+162,000

Of the total fiscal year 1967 requests of $6,149,000, for the Western Operations Office and JPL activities, 77 percent, or $4,743,000 is estimated for personnel costs. This is an increase of $145,000 over the amount available in fiscal year 1966 and is required to cover the cost of the recent pay increase on a full-year basis and for within-grade step increases and retirement contributions. The balance, or $1,406,000 is for all other objects, an increase of $17,000 over fiscal year 1966.

SUMMARY OF PERSONNEL REQUIREMENTS

The fiscal year 1967 budget request includes a total of 386 civilian positions—a reduction of five permanent positions below fiscal year 1966. The fiscal year 1965 civilian authorization was 405 positions.

JUSTIFICATION BY OBJECT CLASS

Personnel compensation and benefits

The fiscal year 1967 estimate for personnel compensation and benefits is $4,743,000. Comparable estimates for the 3 fiscal years for these services are as follows:

[In thousands of dollars]

	Fiscal year 1965 actual	Fiscal year 1966 estimate	Fiscal year 1967 estimate	Increase or decrease
Personnel compensation	4,115	4,289	4,426	+137
Personnel benefits	289	309	317	+8
Total, personnel costs	4,404	4,598	4,743	+145

Personnel costs in fiscal year 1967 are estimated to be $145,000 higher than in fiscal year 1966, of which $137,000 is for personnel compensation and $8,000 is for personnel benefits. The estimate reflects the additional cost resulting from higher pay scales in effect for a full year, and for within-grade step increases, retirement contributions and other benefits.

Travel and transportation of persons

Travel and transportation requirements in fiscal year 1967 are $282,000—the same as for fiscal year 1966. The total estimate includes $230,000 needed for employee travel to direct and coordinate technical program and administrative activities; to attend NASA technical meetings and working panels; and for the cost of temporary assignments and transfers. The balance of $52,000 will be used for the expense of local transportation and toll charges, and the rental of passenger motor vehicles from the General Services Administration.

Transportation of things

Transportation of things is estimated to cost $50,000 in fiscal year 1967, an increase of $5,000 over fiscal year 1966. This increase is related to the movement of household goods to accommodate the personnel turnover anticipated in fiscal year 1967. The estimate also includes $38,000 for transportation of NASA exhibits in the western area of the United States.

Rent, communications, and utilities

Fiscal year 1967 requirements in this area are estimated to cost $402,000, the same as for fiscal year 1966.

The estimate includes $192,000 required for the commercial lease of real property and the rental of equipment, of which $168,000 is to continue the lease of 46,800 square feet of office space at an average annual cost of $3.60 per square foot. The remaining amount of $24,000 covers the rental of office and other equipment on a term basis.

The fiscal year 1967 requirement of $205,000 for communications and utilities includes $4,000 for leased lines; $39,000 for long-distance tolls; $71,000 for local telephone and exchange; $91,000 for all other communications; and $5,000 for utilities.

Printing and reproduction

The fiscal year 1967 cost of printing and reproducing technical and administrative reports, publications, and forms is estimated to continue at the fiscal year 1966 level of $15,000. The estimate includes $3,000 to cover the printing of administrative materials by other Government agencies, and $12,000 for the commercial printing of technical documents and related publications.

Other services

The following table indicates estimated fiscal year 1967 funding for other services by the major requirements:

ADP equipment operation	$30,000
Custodial services	18,000
JPL administrative aircraft lease, maintenance, and operation	245,000
Technical reference library	80,000
Reliable electrical connections school	120,000
Contract administration services	50,000
Miscellaneous minor services	32,000
Total	575,000

Other services in fiscal year 1967 are estimated to cost $575,000, a net increase of $47,000 over fiscal year 1966. This results from planned expansion of the Reliable Electrical Connection School facilities at an additional cost of $12,000, an $8,000 increase for the augmentation of the technical reference library staff, and $44,000 additional for providing contract administration services. These estimated increases are partially offset by the expected reduction of $17,000 in the cost of leasing, maintenance, and operation of administrative aircraft at the Jet Propulsion Laboratory because of the disposal of a NASA-owned aircraft.

Supplies and materials

The cost of supplies and materials for fiscal year 1967 is expected to remain at the fiscal year 1966 level of $53,000. The estimate includes $48,000 for replacement of office supplies and $5,000 for purchase of expendable photographic, maintenance, and operating supplies.

Equipment

The fiscal year 1967 estimate of $29,000 is $35,000 below fiscal year 1966. The estimate includes $16,000 for the procurement of two replacement engines

for leased administrative aircraft supporting the Jet Propulsion Laboratory; $4,000 to purchase two passenger motor vehicles (for replacement); and $9,000 for acquisition of photographic and noncapitalized equipment, and replacement of office furniture and equipment.

The CHAIRMAN. Well, Doctor, the committee, as you know, has long insisted on better advanced planning for construction of facilities, judicial use in facilities planning, and design funds. We have seen the emergence of good sound planning procedures for construction within NASA which I compliment you. There are some areas of construction management requiring attention, however, and I would like to go into some of these.

Over the past 5 years the Congress has authorized about $58.4 million for facility planning and design. How much of this has been funded and why haven't you elected to fund the balance of the money?

Dr. SEAMANS. We would be happy to submit for the record a full account of our activity for the past 5 years.

(The information follows:)

Most of the $11.9 million of unfunded facility planning and design authorization occurred in fiscal year 1964. In our fiscal year 1964 budget we had requested $10 million for this purpose. However, a total of $20 million was authorized by Congress for facility planning and design. After reviewing our facility design requirements for that year, it was found that only $10.5 million was actually required. Thus, $9.5 million of the fiscal 1964 additional authority provided by Congress was not used. Nearly all of the remaining $2.4 million of unfunded authority occurred in fiscal year 1966. The reduced funding requirement during this year was made possible in view of the unprogramed $1.9 million of fiscal year 1965 facility design funds that were carried over into fiscal year 1966 to support the facility design activity during the current year.

Status of facility planning and design account, fiscal years 1962–66

[Amounts in thousands]

	Authorized		Total	Funding plan
	In authorized activities	Through statutory reprograming		
1962	$10	----------	$10.0	$9.7
1963	8	$5.4	13.4	13.0
1964	20	----------	20.0	10.5
1965	10	----------	10.0	10.0
1966	5	----------	5.0	3.3
Total	53	5.4	58.4	46.5

Dr. SEAMANS. In the submission to this committee on facility planning, we do show our activities for the last 3 years. We show in 1965 the use of $10 million; in 1966, $3.3 million, and the estimated 1967 of $7 million. I do not have with me the data on the prior years. As you know, I'm sure you are aware the facility planning item includes preliminary design, final design, special studies, and master planning. We were extremely active during the 1963–64 period, having placed under contract each year the construction of facilities valued on the order of $700 million. From the standpoint of our appropriation we did not actually expend all of these funds in the year appropriated,

each year there has been some carryforward funding from our C of F account. But, during this whole process there was no delay in construction because we were able to carry out our preliminary design using the planning funds for this purpose from previous years.

We are now over this very large peakload and consequently do not require as substantial funding for planning as we did require in prior years. We did have $1.9 million of fiscal year 1965 funds that we plan to use in support of fiscal year 1966 facility design activity. This is the reason why only $3.3 million was reprogramed in 1966. We have about $10 million which is unobligated at this time, all of which is programed for specific design work.

The CHAIRMAN. Our records show that the authorized total was $58.4 million. You funded about $46.5 million which leaves about $11.9 million, and this was one of the reasons we were wondering why at this time you needed additional money. Has the peak of construction been reached?

Dr. SEAMANS. As I mentioned in answering your question, Mr. Chairman, we are over the peak. We have come from the $700 to $800 million per year construction program down to the order of a hundred to $120 million per year. However, this is still a very important part of the program and does take very careful planning and design if we are to come in with meaningful estimates to this committee. On occasion we have programed some of these funds over into other areas because of the total demands on our budget. As you indicated, $58.4 million has been authorized and $46.5 million has actually been funded. In addition, we had the problem, Mr. Chairman, that the C of F appropriation was less than the authorization. Therefore we have to find a way to live within the appropriation and this was one area where we did make a reduction.

The CHAIRMAN. Of course, the thing that concerns me is that many of the projects for fiscal 1968 and 1969 have had their preliminary design and some of their engineering done out of this $46 million, so you still have $11.9 million. I was just wondering frankly, whether you needed this other $7 million.

Dr. SEAMANS. It is our strong recommendation that the $7 million be included in the authorization in order to continue both preliminary design, final design, and the special studies. Also included is the work on the test facilities in Nevada for the nuclear rocket program. A complete breakdown of the $7 million shows that $2 million are estimated for the test stands No. 2 and No. 3 in Nevada for this purpose. In addition, we have $500,000 for special studies, $3.5 for final design and $1 million for preliminary design.

These are our estimates, taking into account the carryforward funding and the other matters that we have been discussing here this morning.

The $7 million is the additional requirement that we see for fiscal year 1967.

The CHAIRMAN. Are there any questions?

Mr. WYDLER. Yes, Mr. Chairman.

The CHAIRMAN. Mr. Wydler?

Mr. WYDLER. Doctor, maybe it would help if you could tell us what these various things are on; for instance, the $1 million for preliminary design. Design of what? What are the items?

Dr. SEAMANS. These are primarily associated with the design for the 1968 and 1969 construction. These will be facilities that we will bring before this committee in 1968 and 1969, to authorize for actual construction.

Mr. WYDLER. How many items are there? I mean, are there many?

Dr. SEAMANS. I cannot give you the complete listing right here from my own knowledge of the specifics, but would be happy to submit for the record the basis for our estimates identifying the types of design activities projected for fiscal years 1968 and 1969.

(The information follows:)

With the exception of the Engine Stage Test Stands 2 and 3 complex for the NERVA Nuclear Rocket Engine the specific fiscal years 1968 and 1969 facilities to be constructed have not as yet been defined by NASA. $2 million of the fiscal year 1967 facility design request has been identified as required for the final design activity on the Nuclear Engine Stage Test Stand. The funds requested for design of the remaining fiscal years 1968 and 1969 facilities have been based on the magnitude of our facility construction program in fiscal year 1966 and 1967.

$3.5 million of the requested facility design funds will be for the final design of fiscal year 1968 facilities estimated at $80 to $100 million of proposed construction with the design cost at about 4 percent of this amount. Final design of these facilities will begin early in calendar year 1967, after the facilities to be included in the President's budget have been defined.

$1 million of the facility design money requested is for the preliminary design of fiscal year 1969 facilities, also based on an estimated $80 to $100 million of proposed construction with preliminary design cost amounting to slightly more than 1 percent of this amount. This preliminary design activity will also begin early in calendar 1967 so that we will have a sound basis for the construction cost estimates of these facilities before the budget is submitted to the Congress the following January.

The remaining $500,000 requested for facility planning is an amount estimated to be required for special design and master planning activities. One such activity in this area will be master planning relating to all of the NASA overseas tracking and data acquisition installations. Another activity in this area will be the development of NASA-wide standard construction specifications. Also included as a special design activity is the study of Government facilities located at contractor plants for the purpose of defining how these facilities should be upgraded to maintain their effectiveness.

Mr. WYDLER. Yes, and for the other items as well, the $3.5 million, the $500,000, and the $2.0 million. I would like to know what items we are considering here.

Dr. SEAMANS. The final design are items that make use of 1966 funds, 1967 funds and also will show up in the 1968 budget.

Mr. WYDLER. Now, as I understand your testimony here today you say you still have $10 million unobligated funds; is that right?

In that account?

Dr. SEAMANS. That is correct.

Mr. WYDLER. That's all, Mr. Chairman.

The CHAIRMAN. Any other questions?

All right, thank you, Doctor.

Now, the next one we will go to is "Administrative operations" pertaining to headquarters, and are there any questions on this? This is generally more or less a fixed sum, and it follows pretty closely last year's program.

Any questions on that?

If not, hearing none, we will go to the No. 3, the administrative fund of $35,000. This is the same as it has been for since the fund was established. Is that not correct? Are there any questions on this?

Next, section 3 which pertains to reprograming. Why is it necessary to raise this reprograming from one-half percent to 1 percent? I thought we went through this last year pretty thoroughly and came up with one-half percent. Has this in any way inhibited or restricted NASA in its reprograming?

Dr. SEAMANS. I think the answer to that, Mr. Chairman, is that no, last year were were not restricted. However, we did have one very significant item which I will discuss in some detail in my testimony on my prepared statement, relating to Apollo communications. This time last year we were carrying out a study of the Apollo communication requirements. We had not finished this study. It wasn't until after the fiscal year 1966 authorization bill was passed that we made the decision to use satellites to tie in our ships and our tracking stations with Mission Control in the Apollo communications network. Our study showed this was necessary in a program with the complexity of the Apollo. The conclusion was reached that we should have a centralized place to control the Apollo mission. To do this, to tie in with the three ships and three of the ground stations required the use of satellites. We found that we could lease services for the ground station terminals and for the satellite but that we could not make this lease kind of arrangement for the on-board ship equipment. They are Government ships and this had to be procured by the Government. The cost came to the sum of $22.5 million. Reprograming was necessary to cover this item. This, however, was not done out of fiscal year 1966 reprograming authorization. Since there was enough reprograming authority available in a prior year, 1964. The ships had been procured from 1964, therefore we felt it more appropriate to tie it in with that authorization. If it had been neecssary to use fiscal year 1966 authority, the 22.5 would have used up all that was available for this unanticipated requirement. Operational need, can arise again, hence our requested increase from one-half to 1 percent.

Likewise, we could have some form of unforeseen operational event in the program which would require us to make additional special tests that would require special facilities. We think it is a safeguard for the space program to have this additional capability for reprograming and strongly recommend it to the Congress.

The CHAIRMAN. Of course, none of us wanted to do anything to jeopardize the program. But, when there seems to have been sufficient flexibility to reduce from $30 to $10 million, money which you could use in construction of facilities. You recognize that in Congress there is always a hesitancy to make approvals where reprograming has to be used. Congress has been very lenient and generous but you are growing up and can make better estimates than you have in the past. I realize that changes take place, but frankly, Doctor, we want to protect NASA. That's why we are going into the budget quite carefully because this is the protection that you have within the Congress. It helps us all; it helps you. And, I just can't see where we should raise this one-half percent to 1 percent with the flexibility that you have.

Are there any questions?

Mr. KARTH. I think just to comment, Mr. Chairman, I doubt very seriously that Dr. Seamans would expect enough catastrophic events or unexpected circumstances to arise that would cause us to have to

exceed the half percent. If that occurs, of course, I can foresee it is not making our Apollo objective, just to pick one isolated program, until well into the seventies. We would hardly expect a catastrophic or unexpected event to occur at this point of time to warrant increasing the half percent reprograming allowance to 1 percent.

Dr. SEAMANS. Congressman Karth, I pointed out in answer to the chairman's question that last year we did require reprograming authority of $22,500,000 for shipborn equipment in connection with the Apollo communication. Despite the fact that we were able to use prior year authorization for this, it is still an example that if we had not had the prior year capability, we would have just barely had the capability of reprograming this whole amount within the half percent limitation.

I think it is a question of risk. It is our feeling that we would be taking less risk if we had 1 percent rather than half a percent reprograming authorization from research and development to construction of facilities. And, in programs that are very costly day to day, we think that it is in the Nation's interest to be able to make necessary reprogramings expeditiously so that we can assure getting a day's work done in a large program for the amount expended. I say this because it could be that a large program could be held up for lack of the reprograming authority to make a change in a facility or to add a new facility.

Mr. KARTH. I appreciate that, Dr. Seamans, and I think that the only point I choose to make at this point is that we resort to other alternatives that are available to us rather than change the law so as to provide 100 percent control in the authority NASA is provided at this time.

Mr. HECHLER. Mr. Chairman, I concur with the statement Mr. Karth has made. I think NASA would find Congress most sympathetic if there were an additional urgent requirement. It could be taken care of without changing the law. It could be taken care of in other ways if the situation was sufficiently urgent.

Dr. SEAMANS. I'm sure that you recognize Congressman Hechler, that if there were an emergency in which time was important, the Congress as they have been, would be sympathetic to the requirements of the program. But that procedure would take extra time.

Mr. WYDLER. Mr. Chairman?

The CHAIRMAN. Mr. Wydler?

Mr. WYDLER. Let me see if I understand this. How much of the one-half of 1 percent did you use last year, Dr. Seamans?

Dr. SEAMANS. So far we have used or planning to use about a million dollars of which most of it is in one facility at the Jet Propulsion Lab. This is a facility to develop a better understanding of the problems of contamination and how to avoid contamination of the planets when one launches a probe into the planetary atmosphere.

Mr. WYDLER. What I mean is this: You had one half of one percent last year. How much did that amount to in dollars?

Dr. SEAMANS. That amounted to slightly in excess of $20 million.

Mr. WYDLER. And, you used it all for this unexpected need for the Satellite services?

Dr. SEAMANS. No, we did not use fiscal year 1966 authorization in that case. We used available prior year authorization. But, this is an example of the kind of reprograming that can involve approximately a half of one percent of our R. & D. budget.

Mr. WYDLER. You didn't give us that particular instances as something in the nature of a catastrophic happening, the need for that satellite?

The CHAIRMAN. Will the gentleman yield?

Mr. WYDLER. Yes.

The CHAIRMAN. So that we can get this into the record.

In 1963 there were 24 reprograming actions. There was $87 million available, $83 million was used, or 95 percent of the amount available was used.

1964 there were seven reprograming actions, there were $79 million available, $42 million was used for 55 percent.

1965 there were six reprograming actions, $87 million was available, $8 million was used, or 9 percent.

1966, fiscal 1966 there was one action available, $23 million, one million dollars was used, or about 4 percent of the money available.

I want to get that into the record.

Mr. WYDLER. I appreciate that. That is the exact information I was seeking.

The CHAIRMAN. I think this shows that in the last two years you have had money available that you haven't had occasion to use at all. I think this shows the fact that you are maturing very rapidly and you can anticipate these things. This is the kind of thing I believe that gives Congress more confidence in NASA policy.

I want to make that clear here.

Mr. WYDLER. Also, I just want to say as a member of the subcommittee that has been considering the tracking needs of NASA in the Apollo program for a number of years, I would find it very hard to understand why they suddenly had a new unexpected requirement that they didn't foresee in the construction of facilities program.

I think we have met their needs fairly well over the years and I would hardly put that into something that should have been unexpected, but maybe that's a proper place and it ought to be some place else.

Dr. SEAMANS. If, Congressman Wydler, we had perfect forward vision we would have anticipated the need for communication satellites as an integral part of the communications net for the Apollo program. However, the programing of the Apollo mission is a very complex matter and we did not have all the details worked out a year ago. We did have the plan available by mid-calendar 1965 and it was on the basis of this plan that we found we had a requirement which could be met by the use of communication satellites. This in turn meant a requirement for ground and shipborn terminals.

That was the reason that this item came up after the request was made to the Congress for fiscal 1966. This item of $22.5 million is of the same order as are available for reprograming as the Chairman indicated we had $22.65 available in fiscal year 1966. This one item that could have used up that whole amount. It did not only because of the availability of prior year reprograming authority for this purpose. This was possible to use because the ships were in a prior year budget, 1964.

Mr. KARTH. Will the gentleman yield at that point?

Mr. WYDLER. Yes, I would be glad to.

Mr. KARTH. I wonder if I could ask Dr. Seamans how many years back are you allowed to go to pick up previous years authorization for this purpose?

Dr. SEAMANS. I would have to turn to our General Counsel on this question. Mr. Dembling.

Mr. DEMBLING. Generally we have interpreted that R. & D. funds are available, Mr. Karth, as an item which can be used for reprograming into the C. of F. funds.

Mr. KARTH. How much is available then for fiscal year 1967 in addition to those fiscal year 1967 funds that are made available by the Act under the half percent figure?

Mr. DEMBLING. Let me first amplify my prior answer. In the specific case that Dr. Seamans mentioned, funds were authorized and appropriated to modify and equip the ships in that prior year. Funds were later reprogramed for this project.

Mr. KARTH. But, we have very few such examples as you have just indicated, haven't we?

I mean, most of these things have been funded for a period of years and as a result of that it seems to me that NASA does have the authority to go back and pick up from prior year funding many, many millions of dollars. I hesitate to make a guess at this point, but I would say probably 40 or 50 million. This appears to be quite a substantial amount of money and should really take care of the unexpected occurrences that Dr. Seamans alludes to as a possibility.

Mr. DEMBLING. As long as there is money available in the original fund.

The CHAIRMAN. With the information directed, there is not appropriated but there is authorized under those conditions not used, $141 million.

Mr. KARTH. Thank you.

Mr. DADDARIO. Mr. Chairman, doesn't NASA have flexibility within 3 years to pick up those funds in the amounts of which you have just referred to?

The CHAIRMAN. On funding.

Mr. WYDLER. Could I just ask one more question, Mr. Chairman. Are will still going to utilize the instrumented aircraft in the Apollo mission?

Dr. SEAMANS. Yes, we are, Congressman Wydler. We are planning to us eight aircraft for communication purposes in the Apollo program.

Mr. WYDLER. In other words, this satellite system will not be in addition or in place of.

Dr. SEAMANS. No; the satellite is to give us the communication capability that is required between and among our ground and shipborn terminals and mission control. The aircraft are used to give us communication with the command module in which the astronauts will be flying.

Mr. WYDLER. And, prior to the time we discovered the need for a satellite, how would that have been done?

Dr. SEAMANS. Prior to that time we were going to use cables wherever we could, and where we couldn't use cables, we would have had to use high frequency radio. It was this second item that was felt not to be of sufficient reliability for our purposes in the Apollo program.

It would require too many different HF channels to achieve the same reliability that could be obtained at the ultra high frequencies at which the satellite operates.

The CHAIRMAN. I think, Mr. Wydler, it is quite encouraging and quite fitting that they should use the satellite that is developed by NASA in carrying out NASA's work, demonstrating to the world that this is the most practical and surest way of communication.

Any other questions?

Mr. ROUSH. Which item, Mr. Chairman?

The CHAIRMAN. We are still on this reprograming.

Mr. ROUSH. No, sir.

Dr. SEAMANS. Could I just say one other thing, Mr. Chairman.

The reprograming figures that you have just put into the record are of course, based on the figures that we have submitted and are in exact agreement with the figures that I have before me. If you add up the unused authorization for transfer, you do come to a substantial figure.

But, there is also a question of what is appropriate for NASA to do in reprograming actions. We felt it was appropriate to use prior year authority to solve the Apollo communications problem because the Apollo ships were in the 1964 budget. I would question the propriety of doing this unless the item had been initiated either in R&D or CofF in prior year.

We think it would be much more straight forward in our relation with the committee to have it on a matching year basis.

The CHAIRMAN. I appreciate that.

Mr. Wolff?

Mr. WOLFF. Mr. Chairman, I would like clarification, if I might get it. Did I understand that there was $141 million that was available to NASA in authorized funds that had not been appropriated?

The CHAIRMAN. There is authority for it.

Mr. WOLFF. Authority for it.

Dr. SEAMANS. I believe that we have $21.7 million remaining in 1966, $78.8 million in 1965, $36.2 million in 1964 and $10.7 million in the prior years for a total of $147.4 million. This compares with the same figure that the Chairman just used.

The CHAIRMAN. Well, my computer showed it a little different than that. Then, Doctor, Colonel Gould passed me a note, but we accept $147 million.

Mr. WOLFF. If that is true, that could be used I take it then at any time in the future? Is that true, Doctor Seamans?

Dr. SEAMANS. This is a matter I will refer to our General Counsel to answer if you don't object.

Mr. DEMBLING. Yes, sir; the answer to that is yes but only to the extent that funds are available.

Mr. WOLFF. If that is true, why isn't the appropriation then reduced by that amount since you have the money available?

Dr. SEAMANS. Let me make it absolutely clear. We don't have it available.

Mr. WOLFF. Since you have the authorization.

Dr. SEAMANS. On the matter of reprograming R. & D. funds for construction of facilities, to repeat what I just said a moment ago, it seems it would be more appropriate to match these actions to the

appropriate year basis except in those cases where we are using prior year, because the authority for it is tied in with prior year authorization for R. & D. or C. of F.

Mr. WOLFF. Why wouldn't it then be proper for those funds, for those authorizations to be withdrawn at this point since you want to go on the record with the new appropriation——

Dr. SEAMANS. This is something the committee might carefully consider where this would be appropriate. It would certainly involve great risk if you were to make such a change and also keep the fiscal year 1967 level at one-half of one percent.

Mr. WOLFF. The point seems to be that you want us to have this as a standby authorization and yet you also want to come to us and put on the record any of the new programing that you want, so it seems to be somewhat contradictory.

Dr. SEAMANS. I don't think it is at all contradictory. We are managing a very large research and development program about which we learn more each day, including the certainty of uncertainty. We learned a tremendous amount last Wednesday in the flight of Gemini VIII. Some of the things we learned may require us to make programatic changes that involve either additional use of R. & D. funds or will require additional facilities. This makes us feel that we must have reasonable flexibility for reprograming authority and funds and consequently we believe that the one percent is a more reasonable figure than the one-half of one percent.

Mr. WOLFF. How about the add-ons that the committee has made from time to time, that haven't been used by NASA?

Dr. SEAMANS. This is an entirely different subject, Congressman Wolff. You are talking about adding authorization for projects that are not contained in our request. In the main these have been added through authorization but the funding, the total funding eventually appropriated has remained the same or been less. The net result is, of course, to put us in the position of not doing certain programs that the President has recommended in order to carry out the projects that the Committee feels appropriate. You can see the difficulty then in that decision-making process, I'm sure.

Mr. WOLFF. I'm sure I do, but I also see the fact that the same situation is true on the other side of the coin, Dr. Seamans, where we have recommended certain things that have not been taken into account at all. It seems that we are just as I have said before, whistling into the wind somewhat by adding on authorizations for you.

The CHAIRMAN. I think if the gentleman realizes, that this criticism for not using these cannot be on NASA. I think your fight is with the Bureau of the Budget to allow this refunding.

Mr. WOLFF. I don't know who it is with——

The CHAIRMAN. I think this is always important to know who your enemy is.

Mr. WOLFF. I don't think anyone is our enemy, Mr. Chairman.

The CHAIRMAN. A good member one time carried on a lot of criticism and found that he was whistling into the wind and he was fighting the wrong person.

Mr. WOLFF. I agree, Mr. Chairman, on this point. I wouldn't say enemy. I would say who the adversary is. [Laughter.]

The CHAIRMAN. There is some that would not be that gentle when it comes to another agency of government, but not NASA.

Dr. SEAMANS. Mr. Chairman, could I add one point that I may not have made clear on this reprograming.

This matter of reprograming is authority within the total authorization. Unused authority in prior years, of course, is of no use if the total appropriation of funds for those prior years has already been used. That is something to remember in connection with unused authority. I'm sure that we do not have $147 million of unused funds from prior years.

The CHAIRMAN. I appreciate that.

Any other questions?

If not, we will go on to the next item. This is the new section of the bill which would permit the administrator to enter into contracts for architectural and engineering services without regard to limitation of the six percent fee as provided by law. This is Section 5 of the bill. As I understand it, the only other agency of Government that enjoys this is the Atomic Energy Commission, and the limitation is put on you by general law governing all agencies, the Federal Administrative Properties Act.

So, would you like to address yourself to this, Doctor? Let me ask you, do you consider this six percent limitation which goes back in law to 1939 to be outmoded by virtue of the state of the art and technology? Do you think the statute requires review with the view toward revision towards better definition?

Dr. SEAMANS. We are bringing this up at this time really because of for two reasons: The first is the experience we encountered in connection with the so-called E–MAD building in Nevada for our nuclear propulsion program. The Comptroller General found that under his interpretation the six percent statutory limitation on the cost of architect-engineer contracts was exceeded by NASA in the design of this facility.

The Atomic Energy Commission is not subject to this six percent limitation. Since this is a project that is run jointly with the AEC there was a thought, at first, that by putting NASA funds into the joint office, it would then be appropriate to go over the six percent figure.

However, in reviewing this we did not feel this to be appropriate. And, in addition, to get to my second reason, in GAO's review of our overall practices in this area they have raised some questions about our interpretations of the statutory limitation. It has been our policy and practice to stay within the six percent limitation with respect only to those things that are clearly relevant to the production and delivery of plans, drawings, etc. But there are A–E services connected with certain special technical problems that are associated with highly complex facilities which we do not consider subject to the six percent limitation. These services we consider to be additional to the production of blueprints and so the limitation would not apply to them.

The GAO took issue with this interpretation and because of this difference of opinion and because the GAO recommended it we bring this problem before this committee with the recommendation that we be authorized under certain conditions to exceed the six percent figure in connection with these highly technical facilities.

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The CHAIRMAN. Personally I see no objection to it. It is given to AEC, and I think you find yourself exactly in the same position they find themselves in with respect to this and I think that it is better to do this directly than it is to go through the circumvention of funding money to AEC that is doing it through the back door. Mr. Fulton?

Mr. FULTON. Is there any limit on the amount of funds in this category?

Dr. SEAMANS. There would be no dollar amount; but, of course, this is work done either under our facility planning account or under one of our specific C. of F. line item accounts each of which are limited. There would be no other dollar limitation.

Mr. FULTON. It is a really open ended authorization you are asking for?

Dr. SEAMANS. I am sorry, Congressman Fulton, did you ask me a specific question?

Mr. FULTON. Yes. I was talking about the limits on this type of funding, limits have been set, may be set or should be set. Should we have some method of limiting this so that it keeps it within bounds. A person who makes a decision that this is complex and technical is also going to spend the money.

Dr. SEAMANS. What we are recommending, Congressman, is to bring NASA in line with the AEC.

Mr. FULTON. So you think this is tied down enough so that it will not get out of hand?

Dr. SEAMANS. That is correct. Obviously it is not in our interest to use all of our funds for A. & E. We want the facilities and we must use the major portion of these funds for this purpose.

Mr. FULTON. That is all.

The CHAIRMAN. Any other questions?

Mr. Daddario?

Mr. DADDARIO. I think Mr. Fulton has raised an extremely important point here, Mr. Chairman. I wonder if it wouldn't be possible to limit this activity in the flexibility the administrator could have to those facilities which you would develop together with the Atomic Energy Commission.

Dr. SEAMANS. That's the reason Congressman Daddario, that I raised the two points. One, the specific situation which we ran into with the nuclear facility; and two the question that the GAO raised with regard to the manner in which we are procuring A. & E. services for other NASA facilities of a complex nature. We have been splitting out the A. & E. activity into those parts that are clearly considered to be subject to the statutory limitation—such as the brick and mortar, and items of this sort and, those that are considered special consulting and other services required for certain technical facilities which we have considered not to be subject to that six percent.

It is the GAO's recommendation that we seek legislation and that we be given the authority to go over the six percent in order to adequately fund both parts of the A. & E. effort.

Mr. DADDARIO. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Wydler?

Mr. WYDLER. Now do I understand that the only places exist in regard to work that NASA is doing on Atomic Energy matters?

Dr. SEAMANS. No, Congressman Wydler, this came up as a very specific issue with regard to the nuclear program, but it also has been raised in a GAO report with regard to other highly complex technical facilities that NASA requires.

Mr. WYDLER. What you are really asking for here has nothing to do with the Atomic Energy portion of NASA's work. You are asking for a general authorization to pay any architect that the administrator determines, more than six percent; isn't that right?

Dr. SEAMANS. Yes.

Mr. WYDLER. On any type of an architectural contract at all.

Dr. SEAMANS. No; only on a contract for the design of a complex technical facility such as the space propulsion facility at Lewis or a special hypersonic wind tunnel or any other facility which might be sufficiently complex that additional work must be done by the A. & E., who is the best person to do it.

Mr. WYDLER. And, particularly, of course, it would refer to the electronics research center in Boston, wouldn't it?

Dr. SEAMANS. There could be special facilities there that would require more than the six percent, yes.

Mr. WYDLER. Have there actually been any cases where you couldn't get architects at 6 percent in any of your other facilities?

Dr. SEAMANS. Well, as I have indicated the manner in which we have carried out the contracting with the A. & E. has led to in quite a few cases, A. & E. costs exceeding the six percent of the estimated construction figure. But, we have stayed within the six percent by virtue of segregating out some of the costs. Those that are clearly for traditional A. & E. type work, the brick and mortar type work have always been, of course, less than the six percent, but there have been special consultant type work that the A. & E.'s have done for us that we have not included. This practice has raised questions by the GAO. They recommended that we request authorization to go over the six percent so that the total work done by the A. & E. could be clearly identified and so that you would know exactly how much of that effort was being done by the AE as a percentage of the total construction cost.

Mr. WYDLER. In other words, Doctor, if I understand, although the explanation that you present here is all written in terms of Atomic Energy Research that really has nothing to do with this at all, does it?

Dr. SEAMANS. It has a great deal to do with it. This is one specific problem that we think identifies for us and for the committee of the general type we face.

Mr. WYDLER. You wouldn't be willing to have it limited to the Atomic energy type work, though, would you?

Dr. SEAMANS. We think that it ought to cover other technical facilities and this is the recommendation of the GAO.

Mr. WYDLER. Thank you.

Mr. FULTON. Would you yield?

Mr. WYDLER. I yield.

Mr. FULTON. The question comes up on how to determine the complexity and how to determine the fee of the architect based on the degree of complexity where possibly, man hours or technical competence. How will you do that? Isn't it likely that everything will fall

into this when there is a favored architect working on a complex job up at Cambridge for instance? He may be a friend of somebody up there in Cambridge and get a bigger fee.

Dr. SEAMANS. We are not talking here about profit-fee. There is a 15 percent maximum limitation on that kind of fee.

Mr. FULTON. I realize.

Dr. SEAMANS. In NASA's case, by internal regulation it is 10 percent, except in those cases specifically approved by the Administrator.

Mr. FULTON. But, the difference between six and 15 is quite a difference.

Dr. SEAMANS. But, six percent is six percent of the construction cost for A. & E. work which is a different matter than the fee that is earned on the construction or R. & D. type contract.

Mr. FULTON. I think the committee wants to make sure that this does not get to be a grab bag of architects fees and that certain favorites can be given either extra compensation or glamorous jobs that will be given without anybody being able to tell anything about the degree of complexity other than that's a tough job somebody said. Now, how do we get away from that? To be very open about it, how about political favoritism?

Dr. SEAMANS. I would like to make it clear that the profit-fee situation is no different, would be no different for these A. & E. contracts than on any other contracts that NASA lets. We are talking about the overall investment that the government makes in A. & E. work as a percentage of the construction cost which is also called "fee".

Mr. FULTON. The committee is talking about the method of limiting it so that it is not a wide open avenue that can be either misused or abused and we aren't saying that you are going to, but I feel if the general accounting office has been dissatisfied with your program, now possibly when we open the door we should be careful.

Dr. SEAMANS. I believe, Congressman Fulton, that the fee considerations are completely covered. I think the question of how large the percentage for the A. & E. work to be in comparison with the construction is a matter that should be considered carefully and our recommendation is that we follow the same practice as the Atomic Energy Commission.

The CHAIRMAN. Mr. Conable?

Mr. CONABLE. Mr. Chairman, Dr. Seamans, apparently the GAO has done this before and has approved it. Isn't there some advantage in having a restraint of their approval on something of this sort?

Dr. SEAMANS. No, GAO has raised a real question as to whether our practice is appropriate. And, it has recommended that we should change our practice provided we can obtain sufficient authorization to do so.

Mr. CONABLE. Well, have they recommended that you change your practice by removing the limitations?

Dr. SEAMANS. They have recommended that the six percent be increased so that the total A. & E. work can be done within the figure that is prescribed.

Mr. CONABLE. They have been critical of this process of separating out special technical requirements beyond this; strictly A. & E., is that it?

Dr. SEAMANS. They have definitely raised questions about this practice, yes.

The CHAIRMAN. I think in view of the report on this, it is suggested that some action be taken to help NASA out of a dilemma in which it finds itself with respect to this, and this is the evidence, and of course, I realize we can all speculate what could happen, but we give the administrator of this agency and other agencies a good deal of flexibility from time to time. All you are doing here is giving the Administrator of NASA the authority and putting it up to him to make these decisions. I can envision several instances.

The one that we spoke of, the laboratories that are going to be necessary to receive people who come back from the Moon. This is very serious because the Public Health Service and other agencies come into the picture. I can see that when we begin to develop engines that are going to use some of these sophisticated fuels it's going to be necessary to do a lot of engineering to make sure that you can hold the power, and you can't walk into the shop of the fellow who is designing a room and tell him what steel is necessary because this is all done by the steel companies.

Mr. FULTON. Did you mention either cesium or other fuels?

The CHAIRMAN. I just said sophisticated fuels because I looked at the clock and I think if I mentioned any in particular, we would be here a little later on.

Any other questions?

Mr. FULTON. Can I have just a closing question?

Why does the General Accounting Office think that your procedure is wrong if it is right that you do it?

They think this should be done. Why in the present setup isn't it right?

Dr. SEAMANS. I would just like to read part of the material that was submitted for the record: It states:

> The above described method of applying a statutory limitation had definite support in past opinions of the Comptroller General. However, the June 1965 report of the Comptroller General has given rise to questions as to how the statutory limitation is to be applied in the future to complex research and development facilities.

Since the building of such facilities today involves far more than the traditional architect-engineering services to which the six percent limitation had originally been intended to apply, it is evident that a need exists for clarifying legislation.

Mr. FULTON. We previously had many discussions with the Senate. So it has been a custom in the past. I am surprised it is brought up at this date.

Mr. WYDLER. Mr. Chairman?

The CHAIRMAN. Time is of the essence.

Mr. WYDLER. I realize that, Mr. Chairman. If I might conclude with this comment, I had some experience in this particular matter relating to the school system in the city of New York, and the question of architect fees, where they had such a device where the administrator could in fact make an exception for particularly hard cases, and it turned out inevitably that every school was a special exception to the case, and nobody got the regular architect fees, but they all got something that the administrator finally determined was the proper

fee, and I'm sure that the administrator might want to take another quick look at this particular provision because it may open up on him an assault from every architect that in the future will look for a contract with NASA.

The CHAIRMAN. I might say to the gentleman, perhaps the practices in New York are not the practices of the Federal Government. The General Accounting Office and Bureau of the Budget is carefully looking down everyone's throat on these matters.

Mr. WYDLER. That is a matter of judgment, Mr. Chairman.

The CHAIRMAN. Well, thank you very much, Dr. Seamans.

Mr. HECHLER. Mr. Chairman, are you going to take up reasons for omissions from this bill?

On page 8 of this statement there are language differences. Could I ask a question on that?

The CHAIRMAN. Go ahead.

Mr. HECHLER. Dr. Seamans, I notice on page 8 that you propose to omit from the bill, section 5, which reads:

> It is the sense of Congress that it is in the national interest that consideration be given to geographical distribution of Federal research funds whenever feasible, and that the National Aeronautics and Space Administration should explore ways and means of distributing its research and development funds whenever feasible.

I note you make the observation that you feel that this was a one-time pronouncement. If this is withdrawn from the bill, would NASA then feel that this was a definite retreat from this particular position taken in last year's bill?

Dr. SEAMANS. The answer to that is no. It was our feeling as we indicate on page 8, that the Congress had made its position clear, that we should use every best effort to see that the total resources of the country are used in the program and that we should not only do that, but we should also build up competence in the country by properly carrying out the effort on a nationwide basis. Our intention is to do this.

Of course, we all recognize that we also have the responsibility to carry out very complex projects and we cannot jeopardize the project in order to obtain a geographical distribution. But, in the long term effort we must build up and cause to grow on a state by state basis the ability to conduct advanced technological work.

Mr. HECHLER. There is a clause in the bill which reads:

> The National Aeronautics and Space Administration should explore ways and means of distributing its research and development funds.

Has such exploration been made, Dr. Seamans?

Dr. SEAMANS. We have been exploring a wide variety of means for doing this. Certainly many of the grants that have been made to aproximately 150 universities have been with this intention. Certain of these grants which we call seed grants are for the purpose of giving a university with one highly competent man a chance to expand this effort, to gather around him additional competent people, to increase the educational program. We believe that this is one very valid way of causing this type of growth on a statewide basis. Admittedly, this is experimental but we believe this is one of the very important avenues that is open to us.

Mr. HECHLER. I was very anxious to make this legislative history to indicate our desire for a continuing effort by NASA in carrying out the principle of geographic distribution. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Mr. ROUSH. Mr. Chairman, may I speak to that point, for just a moment?

The CHAIRMAN. Yes, I want to warn you gentlemen, I would like to try to get into parts of Dr. Seamans' other statement. We don't want to hold him more than two days.

Mr. ROUSH. Mr. Chairman, I'll not belabor the point. I thank my colleague, Mr. Hechler for his observation. As author of this section I did not consider it myself a one-time pronouncement. I was hopeful that it could be included each year in the authorization bill in order that we might make it quite clear that we are hopeful that NASA will become a little more enthusiastic about this matter of looking into ways and means of having a more equitable distribution of research funds.

I certainly will take your word for it, Dr. Seamans, that you will continue to make these efforts and I will also be looking forward to the results that might come from that effort and I would like to have the record show that if results are not forthcoming then I will next year insist that language be inserted in the bill again in order that we might make it quite clear what the sense of Congress is in this regard.

I realize that you operate under some extreme difficulties in certain areas because of competencies which are required, because of skills which are required.

On the other hand, I think NASA could show a little more enthusiasm for this particular venture. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you. All right, Doctor, thank you very much.

Will you proceed now with your general statement?

Dr. SEAMANS. Yes.

Mr. Chairman and members of the Committee. I should like to direct my remarks today to the basic problems of programing in NASA, touching upon examples that have been of specific interest to this Committee and elaborating upon the over-all question of the Administrative Operations appropriation and its role in the total NASA effort.

The NASA budget that lies before you represents a whole, integrated program directed toward carefully selected and clearly stated objectives. The budget estimates themselves represent the best judgment of the agency at a point in time of the level of resources required for each program element during the next fiscal year. Each of the three appropriations—Research and Development, Construction of Facilities, and Administrative Operations—interlocks with each of the others in terms of the kind of work needed to reach our objectives.

It is important to note that the appropriation distinctions have been selected to facilitate the management of the total effort but that, in fact, all must be viewed together as representing a single work plan; adequate resources in each area are indespensable to the effective achievement of our goals.

I wish to stress that these are estimates, and estimates that were made with the full understanding that it would be six months after their submission to the Congress before the twelve months' worth of

effort projected therein could actually be started. In the dynamic field of aeronautics and space exploration, we must be geared to accept change as an inherent and valuable quality of the program we are charged with carrying out; a static program would, by its nature, be the antithesis of progress and achievement. This expectation of change is reflected in every aspect of the agency's operating structure.

The maximum flexibility has been provided to each management level through delegation of authority sufficient to provide the latitude in choice of action and application of resources necessary to carry out the program responsibility as signed.

Internal agency information and management control systems have been designed to provide visibility of operations to highlight problems and need for action at the proper management levels.

As the Agency has recognized the need for providing maximum flexibility in dealing with the evolutionary process which is characteristic of research and development activity, so the Congress has recognized this application of basic management principles by providing NASA with the authority to make those adjustments which become necessary during the year to maintain program balance and momentum.

The NASA programing cycle is a continuous one; it must encompass the day-to-day decision-making demanded by the execution of the approved and on-going plans as well as the establishment of those new plans that are reviewed and analyzed as part of the budget cycle. Based upon the resources in hand, the actual status of each on-going element, the options and opportunities for future activity that we can foresee, and the constraints that are becoming visible as part of the next cycle, we develop and support a single agency program. Adjustments to meet changing conditions are made continuously on the basis of the best technical and management skill available to make the optimum use of available resources for the achievement of selected goals. This process of reassessment and redefinition must be continuous and cannot be limited to the annual budget cycle; opportunities are missed, resources are wasted, and the integrated structure of the entire NASA program is threatened when flexibility in the internal allocation of resources is limited.

As examples, I would like to take up specific program aspects from the fiscal year 1966 operating plan and from the FY budget and describe the constraints and considerations that have gone into our decisions and recommendations.

I'll start with administrative operations.

The job of NASA is management in the broad sense of the word. It is our responsibility to develop, support and execute a program of enormous complexity and of tremendous national significance. This management responsibility depends upon people; competent, dedicated, skilled men and women in the Federal service working together in well-led teams. In NASA we are developing such teams and such leadership. Our record of accomplishment is a real one.

The NASA centers are working at the forefront of many fields of research and technology. They have the task of managing over 130 major research and development projects. They must direct, schedule, coordinate, and supervise the activities of over 400,000 people in universities and in industry. Most importantly, they are, in the final analysis, responsible for the success or failure of the United States

in the national response to the challenges posed by the unknowns of aeronautics and space.

I would like to add another paragraph here to clarify this point.

In order to assume this management responsibility in the broad sense I have indicated, NASA must and should participate in the activities specifically, and for example NASA teams must conduct certain of the basic research particularly where unique facilities are involved.

NASA must participate in the design and test of new critical hardware and NASA must conduct a flight in space operations.

Ours is not solely a responsibility for procurement and contract administration and planning, although this is important, but also of day to day operation and decisionmaking in the complex and scientific activities for which we have responsibility.

The resources we need to properly manage the NASA effort are budgeted in our Administrative Operations appropriation. Inadequate resources in this appropriation directly affect the quality of the job we are capable of doing.

These resources must not only be adequate to provide the best competence in terms of personnel, but to provide these personnel with the right facilities, equipment, and support services to most effectively capitalize upon their talents.

Any characterization of the Administrative Operations appropriation as primarily an "overhead" account in its relation to the R&D and facilities construction programs with their more visible hardware output is a misconception of the role we assign to our management activities in the execution of the total NASA effort.

Perhaps the most complex management issue at hand lies in the full understanding and appreciation of the problems inherent in the programing and execution of our annual Administrative Operations appropriation. For this reason, I wish to present a fairly detailed discussion of our Administrative Operations program.

This appropriation funds two major categories of costs. The salaries and personnel benefits for the 35,000 man NASA organization represents over 60 percent of the appropriation. The rest of the appropriation may be conveniently referred to as the "Other Objects," including service contracts; rents, communications and utilities; the supplies and materials consumed in our center operations, travel of NASA personnel, and the purchase of equipment that is needed to make our centers effective, including our large automatic data processing systems.

Also included within this category of costs are certain minor construction projects and modifications to our center facilities, costs of transportation on Government bills of lading, printing and reproduction costs for our publications, and a small allowance for possible claims and indemnities.

With regard to the fiscal year 1966 Operating Plan I will now go on.

Since there has been considerable interest shown in the fiscal year 1966 operating plan for Administrative Operations, I should like to treat this initially and touch upon the major aspects of the recent reprograming notification.

In the fiscal year 1966 budget, the reqest for the conduct of NASA's Administrative Operations was $609.4 million. In the Authorization Act of fiscal year 1966, this amount was reduced to $591.049 million.

The operating plan presented in the reprograming notification totals $611.820 million. Although it is above the authorization level, this current operating plan was developed only after the most careful examination of NASA's fund requirements and is an attempt to conform in every practical way with the intentions of the authorizing committees.

The reduction in Administrative Operations funding in the Authorization Act was $18.351 million. NASA made this reduction in the "Other Objects" category of expenses for all Centers except the Kennedy Space Center, as summarized in the following table:

This table show that all centers except the Kennedy Space Center had a budget request of $200.093 million, the Operating Plan is $181.763 million for a reduction of $18.330 million.

The Kennedy Space Center, the budget request was $39.907 million, the operating plan is $49.248 million, for an increase of $9.340 million, so that the agency totals show $240 million in the budget request, $231 million in the operating plan, for a reduction of $8.990 million.

The increase of $9.340 million for the Kennedy Space Center "Other Objects" is the net product of several factors. Operations at KSC have progressed at a much faster rate than was anticipated when the fiscal year 1966 budget was developed. The total number of personnel working for NASA or on NASA projects at the Center in fiscal year 1966 has increased from the budget estimate of 12,684 to a current estimate of 16,510. Most of this increase has been in contractor employees engaged in the launch activities for R. & D. projects handled by the Center.

Remember now that the personnel now at Kennedy is slightly in excess of 2,000 so that you have approximately six to seven times contractor personnel as you have civil service personnel at the Cape.

The support services for these contractors are furnished by NASA on a centralized arrangement. As a consequence of this faster build-up of R. & D. activity, many of the Administrative Operations accounts from which the supporting materials, supplies, and services are funded have had to increase. These increases in fund requirements for fiscal year 1966 were offset to the greatest practicable extent by reducing the lead-time funding of support contractors. In this manner, the interim fiscal year 1966 "Other Objects" fund requirements for KSC were actually reduced $1.695 million below the budget request level. Subsequent to the development of this operating plan, however, an adjustment was made in the accounting base for one support contract which wiped out this reduction and resulted in the apparent $9.340 million increase.

The support service contract with TWA at KSC was initially funded from the R. & D. appropriation. In the spring of 1965 contract funding was extended for another year using fiscal year 1965 R. & D. funds.

At the request of the Bureau of the Budget, provision was made in the fiscal year 1966 Administrative Operations budget for funding further extensions of this contract with the intention that, in fiscal year 1967 and subsequent years, the contract would be wholly funded from Administrative Operations fund sources.

In accordance with the spirit of a recommendation by the Senate Committee on Aeronautical and Space Sciences, NASA decided that

all costs incurred under this contract after July 1, 1965, should be charged to the Administrative Operations appropriation so that the Administrative Operations program would reflect the full cost of this contract in fiscal year 1966 as well as in subsequent years.

To implement this decision, NASA directed that the uncosted amounts of the fiscal year 1965 R. & D. obligation already in force should be transferred as of July 1 to the fiscal year 1966 Administrative Operations Account.

This transfer, totaling $11.035 million, does not represent any change in substantive program content from the plans originally presented to the Congress. When the strictly accounting nature of this contract change is considered, we believe that the "Other Objects" operating plan for fiscal year 1966 meets the intent of the reduction in authorization.

We were not able to hold our operating plan for Personnel Compensation and Benefits at the budget request level. The current NASA program reflects an increase of $11.4 million above the original fiscal year 1966 budget request. This increase has its origin in four separate requirements not foreseen when the budget was initially developed:

(*a*) The pay raise of October 1965 has cost us $8.3 million more for our classified and excepted employees;

(*b*) The implementation of Wage Board surveys have added $400,000 to the personnel costs for our Blue Collar employees;

(*c*) The allocation of 424 additional positions to NASA during fiscal year 1966 to meet the increasing manned space flight operations workload carries with it salary requirements totaling $1.6 million; and

(*d*) A net $1.1 million requirement has been generated as a result of implementation of a personnel management plan that was developed after comprehensive manpower and personnel analysis.

Mr. DADDARIO. Mr. Chairman, may I ask a question at that point?

The CHAIRMAN. All right.

Mr. DADDARIO. Dr. Seamans, could you go into that management plan just a bit so that we might understand the reason for the upgrading of your personnel and the background, whether or not you have Bureau of the Budget support?

Dr. SEAMANS. This plan was done at the request of the Bureau of the Budget. We had requested prior to 1966 some additional manpower. This was not approved by the Bureau of the Budget. Once we were in the fiscal year, we again took before the Bureau of the Budget our concern about the Apollo flight operation, and our felt need for additional people at the Manned Spacecraft Center, at the Kennedy Space Center, and at the Goddard Space Flight Center.

At this point the Bureau of the Budget requested that we make an extremely detailed study of the NASA salaries and expenses. They first asked us to go through in detail the workload at the three centers I have indicated, to review in somewhat less detail the workload in our other centers and Headquarters, to then be able to review with them the total personnel requirement.

We also had to carry out a detail study for them which would show the manner in which the promotions within NASA are affecting our

salaries and expenses, the manner in which our salaries and expenses are affected by our turnover, namely, the manner in which people are recruited into NASA to replace those who leave, and as well as several other of our personnel policies.

And, to do this, we carried out, I believe, the most extensive detail computorized study that has ever been attempted in this area.

Each one of our centers was represented on the computor. It was done in such a way that we could build up our salaries and expenses for each center by category; that is GS–14, GS–15; and so on. We conducted the study using different personnel policies to determine which of these policies have the largest impact on our salaries and expenses.

The results of this total study were reviewed then with the Bureau of the Budget and at that point they approved the addition of the 424 people to NASA.

Mr. DADDARIO. Thank you, Mr. Chairman.

Dr. SEAMANS. Continuing, I should now like to make a few remarks on NASA's fiscal year 1967 request for the Administrative Operations program which has been considered in detail by the several subcommittees. We have applied the most stringent controls in developing estimates which reflect the minimum needs to keep the NASA installations in efficient operation.

Our Administrative Operations fund requirements for fiscal year 1967 have increased $52.1 million over the '66 operating plan. Of this $21.6 million arises from increased personnel costs. The table below indicates the elements of increases in this category of costs; the additional costs of the recent pay raise, the cost of additional man years of employment in fiscal year 1967, the reimbursement to the Air Force for officers detailed to Houston in support of manned flight operations, the reduced allowances for temporary employees and for overtime of all employees, and the net increased costs of statutory within-grade increases and career development promotions as off-set by grade reductions in the replacement of employees separated.

The "Other Objects" cost will increase $30.5 million in fiscal year 1967. No single explanation is applicable across-the-board to explain this increase.

Mr. HECHLER. Mr. Chairman, may I ask a very brief question.

The table on the bottom of Page 11, "Position adjustments," does this indicate largely grade increases?

Dr. SEAMANS. No; this refers to an increase in personnel over the end of fiscal year 1966.

Mr. HECHLER. I thought "additional man-years" took care of that.

Dr. SEAMANS. I'm wrong, and would prefer Mr. Malaga go into detail.

Mr. MALAGA. That represents the total of statutory within grade increases, career development promotions as offset by grade reductions in replacement of employees separated. So it does include those three items.

Mr. DADDARIO. Mr. Chairman, I have one question, please.

You refer to the reimbursement for officers detailed to Houston to support manned flight operations. Would you go into that just a bit.

Dr. SEAMANS. I will be happy to go into that, Congressman Daddario.

We have 128 officers scheduled to work within the Houston complex in mission control. We reviewed with the Air Force approximately a year ago, the possibility that part of the increased personnel that we felt required for the NASA operation could be filled by service personnel. At that time service personnel were no longer required in certain of our ICBM complexes and it was felt that it would be desirable to use these service personnel in our mission control facility, to help us with our operation and also to train these personnel for future space missions that the DOD might have.

The question then came up as to the number available; it turned out to be 128. The next question was how to reimburse DOD for them. After discussion with the Air Force it was decided that the first year's effort by these personnel would be funded by the DOD and the second year by NASA in their two-year tour of duty. The reason for splitting it this way was that, in part, NASA is being assisted by these personnel for future space missions.

Mr. DADDARIO. It was my understanding, Dr. Seamans, that it was a three-year tour.

Dr. SEAMANS. No, it is two years, Mr. Lilly advised me, to be reevaluated at the end of two years.

Mr. WAGGONNER. May I ask a question about compensation of personnel. Dr. Seamans, you have said that in fiscal '66 you were allocating 424 additional positions which cost you about $1.6 million. While we talk here about personnel compensation and benefits, you ask for an additional man years $9.1 million. Does this include additionally allocated personnel positions? If so, how many?

Dr. SEAMANS. Mr. Malaga?

Mr. MALAGA. The 424 additional positions were not approved until after the turn of the year so that you have much less man-years generated by those positions in fiscal year 1966. Now, the additional man-years reflected in fiscal year 1967 reflect the full year employment of those additional 424 in fiscal year 1966 as well as the additional personnel increment in fiscal year 1967.

Mr. WAGGONNER. What will the additional increment in fiscal year 1967 involve in numbers of additional personnel?

Dr. SEAMANS. The total increase in fiscal year 1967, we can determins in just a minute, is over 415 people.

Mr. MALAGA. That's right, there are 742 additional total man-years, which is composed of an increase of 846 permanent man-years offset by a decrease of 104 man-years of temporary employment.

Mr. WAGGONNER. At what level will the bulk of these additionally allocated personnel spaces fall in? Will they be GS–11, GS–12, GS–13, GS–14?

Mr. MALAGA. No, sir, essentially at the agency average, which is about just over GS–10.

Dr. SEAMANS. The actual increase going from fiscal year 1966 to the end of fiscal year 1967 is 415 people. You might be interested to know that we justified an increase of 815 personnel but then agreed to reduce this amount by 400 on the basis of retirement, that all the people who retired would not be replaced.

Mr. WAGGONNER. I ask these questions because with a pencil I found out you were only paying these people an average of $3,737 a year, in

fiscal year 1966, these additional 424, and I wanted to know where you got people that cheap.

Dr. SEAMANS. That is because as Mr. Malaga has said, the lapse rate in fiscal year 1966 is fairly large. This decision was not made until the half-year point to hire them.

Mr. WAGGONNER. That is all.

Mr. DADDARIO. Mr. Chairman, I have just one question to clear up, the military personnel. I seem to remember that you have a two-year agreement subject to negotiation for a third year. When you answered my last question, it seemed that it was for an indefinite period of time. Now, which is it?

Dr. SEAMANS. We have the memorandum of agreement between the Air Force and NASA which I can submit for the record if you would like, signed by Mr. Zukert and Dr. Dryden. It states the Air Force agrees that the tour of duty for the officers detailed on this agreement shall be two years unless subsequently extended by mutual agreement, and it does not as I read this, specify just an additional year. It could be reviewed for more than the one year.

Mr. DADDARIO. Could we have that for the record, Mr. Chairman?

The CHAIRMAN. Without objection this will be submitted for the record.

(The information follows:)

MEMORANDUM OF AGREEMENT BETWEEN THE DEPARTMENT OF THE AIR FORCE AND THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION CONCERNING THE DETAIL OF APPROXIMATELY 128 AIR FORCE OFFICERS TO THE MANNED SPACECRAFT CENTER, HOUSTON, TEXAS

This memorandum of agreement governs the detail of approximately one hundred and twenty-eight (128) Air Force officers to the National Aeronautics and Space Administration for duty commencing in fiscal year 1966 at the Manned Spacecraft Center, Houston, Texas, in accordance with the NASA letter of 6 May 1965 (Admiral Boone to General Stone).

I. GRADE AND NUMBERS

The Air Force agrees to detail approximately 128 officers to the NASA Manned Spacecraft Center, Houston, Texas, for a tour of duty commencing in fiscal year 1966. The numerical breakdown by grade will be approximately as follows:

	Number
Majors	6
Captains	38
Lieutenants	84
Total	128

II. SPECIAL TERMS AND CONDITIONS

The detail of officers covered by this agreement is governed by all of the provisions of the agreement between the Departments of Defense, Army, Navy, and Air Force and National Aeronautics and Space Administration concerning the Detailing of Military Personnel for Service with NASA (effective date April 13, 1959) as amended, except as follows:

A. Since this arrangement is of mutual benefit to NASA and the Air Force, paragraph V(b) of the referenced basic agreement is supplemented for the present purpose by the following additional language.

NASA will reimburse the Air Force for 50 percent of the pay and allowances of the 128 officers detailed hereunder. Since NASA did not budget for these costs for fiscal year 1966, the Air Force will provide full pay and allowances for fiscal year 1966 without reimbursement by NASA. NASA will reimburse the Air Force in full for such pay and allowances for fiscal

year 1967. Costs beyond fiscal year 1967 will be adjusted equitably between NASA and the Air Force on the 50 percent cost-sharing basis.

B. Air Force agrees that the tour of duty for the officers detailed under this agreement shall be two years unless subsequently extended by mutual agreement.

C. NASA agrees that the duties and responsibilities of detailees will be such that they will receive training in the skills required in the operational control of manned spacecraft for subsequent application to Air Force programs (e.g., MOL), which may be controlled at sites other than the Manned Spacecraft Center.

D. For the purposes of this agreement, the reference to "CMLC" and "CMLC member" appearing in the referenced basic agreement, as amended, shall refer to the Deputy Chief of Staff, Personnel, USAF.

III. EFFECT ON OTHER AGREEMENTS

A. Except as specified above for this specific case, the terms and conditions of the referenced basic agreement are not affected by this memorandum.

B. The terms and conditions of the Memorandum of Understanding between the NASA and the Air Force regarding the detail of Air Force officers to the NASA, dated September 15, 1964, are not affected by this memorandum, and those terms and conditions, in turn, have no effect on matters covered by this memorandum.

IV. EFFECTIVE DATE AND TERM OF AGREEMENT

This agreement becomes effective upon signature by both parties and shall remain in effect until superseded or terminated by mutual agreement.

EUGENE M. ZUCKERT,
Secretary of the Air Force.

JULY 16, 1965.

HUGH L. DRYDEN,
Deputy Administrator, NASA.

JULY 22, 1965.

The CHAIRMAN. All right, gentlemen, proceed.

Dr. SEAMANS. The Manned Space Flight centers account for $24.8 million of the total "Other Objects" increase. Increases are required in all cost categories and, in general, can be closely related to the increasing level of R. & D. activities at these centers. Practically all of the personnel travel increase for the agency is allocated to these centers. In addition to the need for greater contract service support and support by other Government agencies, it has been necessary to increase our budget allowance for utilities, supplies and materials, and equipment to properly utilize and support new facilities coming into operation and the increased number of R. & D. contractors using these facilities.

The Space Science and Application centers require a $4.8 million increase in "Other Objects" over the fiscal year 1966 level. Of this $3.5 million arises from increased automatic data process rentals, support services, and procurement. Another $500,000 is directly attributable to additional facilities.

Our OART centers actually have a net reduction of $700,000 in "Other Objects" requirements. This is the result of decreases in the purchase of ADP equipment that off-sets increased requirements for other purposes. About $3.0 million of the off-set increase is required for the continued build-up and operation of the Electronics Research Center. Another $1.0 million is for increased ADP rental and operations at the other OART centers.

Our requirements for Headquarters and the Western Operations Office are described at length in the statement I am filing with the Committee.

As I emphasized earlier we have pared our fiscal year 1967 Administrative Operations requirements to the minimum that we believe is consistent with the efficient support of our centers and their personnel. We have little option in meeting these requirements if we are to discharge our management responsibilities without harmful impacts on our research and development and facilities construction activities.

It is not only in the Administrative Operations area that we face difficult programing decisions. Some examples of programing problems in other areas are as follows:

Apollo Communications Requirements: The mission operations requirements for the conduct of the Apollo flight program include centralized, real-time control from the Houston Mission Control Center. This is the matter we were discussing earlier in this hearing. This means tying together the entire worldwide manned space flight network of tracking and data acquisition ground stations through wideband voice and data communication links.

Reliable cable links are available to most of the remote locations, but six of the key sites had to be tied in through new means.

The advent of commercial communication satellite now makes possible this total network integration. However, in order to take advantage of the satellite technology, the three Apollo tracking ships had to be modified to include appropriate equipment for data reception and transmission via satellite. By using resources available in fiscal year 1966 for this modification work, we were able to initiate the necessary effort at least 9 months earlier than would have been possible had we waited until passage of the fiscal year 1967 authorization and appropriation bills. These 9 months are critical in that the shipborne equipment requires long lead times and the operational ship capability is necessary to support the currently planned Apollo flight program. In cases such as this, where requirements cannot be foreseen or when their delay could have a serious impact upon a major objective, it is important that we have the flexibility to address the real priorities.

Next, with regard to the large solid motor, M–1 engine, and SNAP–8.

When no funds for these three projects in the area of advanced research and development were included in the President's fiscal year 1966 budget request, NASA was faced with the task of assuring that the maximum return to the Nation's technology would be available from the resources already expended, and, at the same time, that whatever options for the future could be foreseen would be kept open until the fiscal year 1967 budget decisions had been made. It would have been possible to recommend continuation of all three projects in the fiscal year 1967 budget if the total national budget constraints would permit a considerable increase over the fiscal year 1966 projections.

As a result of the reprograming action we took, fiscal year 1965 funds were, therefore, reprogramed to permit NASA the option to terminate efficiently any or all of these projects if inadequate support were available in fiscal year 1967. Within the total budget level projected for NASA, it was not feasible to maintain the M–1 effort; this was therefore terminated, permitting an increased level of supporting research and technology work to be applied to other specific high energy liquid propulsion system areas.

The 260-inch and the SNAP–8 projects remained viable under the constraints of the fiscal year 1967 budget, although at reduced levels of effort. The combination of reprogramed fiscal year 1965 resource and the release of fiscal year 1966 funds appropriated for projects outside of the President's original budget request have, therefore, permitted us to assure that both of these important advanced development efforts can be continued and that the technology they represent for future missions will not be discarded.

Next with regard to the Lunar receiving facility.

Another example of the integrated nature of the NASA programing is the current authorization request for a lunar receiving laboratory at the Manned Spacecraft Center at Houston. In this case, we are able to use available design funds during fiscal year 1966 to permit meeting the tight constraints of the 18-month construction schedule.

The facility is needed in operation by the beginning of calendar 1968 for two reasons: First, if it were delayed a year, it would automatically assure that the first lunar landing attempt could not be made before 1969. Second, the facility itself is directly interrelated with the astronaut training functions, the spacecraft design and development areas associated with lunar surface experiments, and with ground support equipment. This ongoing work as Houston requires that the facility be available as soon as possible. The basic requirement for the facility—the need for total biological quarantine of the spacecraft, the astronauts, the lunar samples, and all returning spacecraft equipment—points up the need for a single centralized facility at which adequate tests and analyses can be made to assure that no biological contamination from the moon of the earth is possible, as well as to assure that lunar samples are not themselves contaminated by the earth's environment.

Problems posed by such a requirement are considerable and will require development of specialized equipment and techniques during the next two years. The program constraints upon this facility are tight, but very careful planning permits us as of today to look forward to its availability on time.

Next and finally in the area of unmanned planetary exploration. One of the knottiest programing problems that NASA has faced in the last two years have been the selection of the most appropriate major elements for our continuing effort in unmanned planetary exploration. The enormous success of Mariner IV in returning to the earth the first close-up photographs of Mars and of establishing sound benchmarks, though the occultation experiment, for the measurement of the Martian atmosphere, has provided new data and new impetus for further planetary exploration. At the same time, the clear and unmistakable Soviet commitment to a major planetary program has been underlined. To move forward with an aggressive program in this field, NASA had strongly recommended the initiation in fiscal year 1967 of the Voyager project. Within the guidelines for the total President's budget, a major new start of this magnitude could not be accommodated and a delay until at least fiscal year 1968 had to be accepted. With a fiscal year 1968 initiation, a 1973 Mars mission, including landing capsule, appears to be feasible in terms of schedule if adequate resources are provided.

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I want to make it clear here I am not talking about an automatic biological laboratory, however, in 1973. That could not be carried out until at least 1975.

This decision, then, would have left the United States with no planetary missions between the highly successful Mariner IV and a 1973 flight. To maintain a broad frontal attack in the area of planetary exploration is scientifically important; at the same time, intermediate projects should not jeopardize the possibility of going ahead with the highly desirable, multiple-mission Voyager system. Two intermediate missions were therefore very carefully selected and were included in the Mariner series. The first of these, based on the use of the existing back-up spacecraft for Mariner IV, will be a Venus fly-by mission for 1967. The previous Venus Mariner provided important but incomplete data, and it is believed that the more complete picture can be developed at a minimum cost through this approach. In addition, two modified Mariner spacecraft are planned to be launched at the 1969 Mars opportunity to carry new fly-by experiments. At the time that the planetary program plans were being developed, two major priorities had to be kept in mind:

First, the total effort had to be scheduled and phased in such a way as to assure no interference with the possibility of initiating the Voyager program in fiscal year 1968; second, individual mission success had to be as certain as possible and therefore the problems of already tight schedules, resources limitations, the allocation and management of JPL manpower, and the technical feasibility of alternate approaches were all very carefully considered before selecting these particular missions.

These same priorities hold today.

In conclusion, or in closing, I would like to recapitulate the major points I have made.

First, our stringent budget estimates are drawn as carefully as possible at the points in time at which they must be submitted.

Second, program requirements affecting all three appropriations continue to change dynamically as the activity in the many areas of NASA responsibility meets, exceeds, or falls below original plans; planning adjustments, and with them, reallocations of resources, must be made to maintain program balance and momentum.

Third, we have been prudent and skillful in the management of the resources entrusted to us to meet the objectives selected for the space program and approved by the Congress.

Fourth, our ability to manage the programs and projects that meet these objectives is directly related to the resources available for NASA's own operations, and AO appropriation.

Last, it is imperative that the President's program be authorized at its full amount and with the full understanding that in its execution there must be latitude for changes if we are, as a nation, going to continue to strive for preeminence in aeronautics and space.

The CHAIRMAN. Thank you very much, Dr. Seamans.

Mr. Vivian?

Mr. VIVIAN. Mr. Chairman, I am particularly curious to know the meaning of the phrase on page 19 which you just read a moment ago, about 10 lines down which says:

Second individual mission success had to be as certain as possible and therefore the problems of already tight schedules, resource limitation, the allocation and management of JPL manpower, and the technical feasibility—

et cetera. What does that mean?

Dr. SEAMANS. What I mean by that is that we did not feel that in either the 1967 or 1969 time period we should or could embark on many very ambitious projects. We felt that we had to use much of our already existing experience wherever possible, existing technology, even more existing hardware and that we should not take on projects that would have such elements of risk that we might require unforeseen and large increases in resources because these clearly are not available.

Mr. VIVIAN. Did you increase the staffing at JPL in this past year?

Dr. SEAMANS. I believe we increased by 252 people so it is now at a level of 4,250.

Mr. VIVIAN. For what purpose was that staff increased? What were the commitments?

Dr. SEAMANS. It was a combination of reasons related to responsibility for the network operation, in part they are also assisting on the Apollo program as a back-up role, and part because of the lunar and planetary, specifically a planned build up for Voyager.

Mr. VIVIAN. It was not increased for any other project purpose? In the paragraph you just read from page 19, the build up was not related to this problem?

Dr. SEAMANS. Yes; I would say it was related to the problem. The manpower situation at JPL is recognized to be tight and we did allow them to increase by 252 to take care of the several responsibilities they have. They certainly required at least the same number of people for the Surveyor. There were as you know, some real difficulties in the conduct of that program. The rest are for the operational side, and an attempted buildup for future planetary effort.

Mr. VIVIAN. I would like to ask was any of the buildup for the purpose of the Venus shot?

Dr. SEAMANS. The buildup as I recall was not for the Venus '67 shot. However, that will obviously take some personnel. I can give you that exact figure. It is approximately 230 in fiscal year 1966 specifically that we have allocated for that purpose.

Mr. VIVIAN. Which corresponds almost identically with the amount of people build up at the center?

Dr. SEAMANS. I believe that the history would show that the build up was not for that purpose. That was in anticipation of other things. However, it is true that the 230 does correspond with 252 rather closely.

Mr. VIVIAN. Mr. Chairman, another portion of this document indicates that Voyager is not a separate R. & D. line item. You refer to the Senate committees on the subject. I was interested in that a year ago I defended the request for Voyager against desires to have it cut because I felt it was wise to get a good start, and I discovered it was not spent.

Now, I discover that the Voyager program is pulled out as a line item. At the same time we just heard testimony regarding putting more funds into the construction of facilities account. I am unable to decide why there would be a large build up in construction unless there

were major new programs, and yet your own action indicates that Voyager is being built and money is not available in using Voyager. How does this tie together?

Dr. SEAMANS. Let me see if I can take them in sequence, Congressman Vivian. The original intention was to have a very complete design; that is, a phased Voyager effort that would give us, with our $43 million authorization in fiscal year 1966, an opportunity to go ahead towards a 1971 launch date for Voyager. We looked at this as a major new endeavor, not just for Mars exploration, but for planetary exploration.

Mr. VIVIAN. Excuse me, Dr. Seamans. My question is as follows: Why do you need more money for transfer to construction of facilities when you have virtually no new programs in the budget and therefore presumes that your facilities program is stagnant?

Dr. SEAMANS. If you don't mind, I would like to touch on the other points that you raised as well, very briefly. When it was not then possible to go ahead with the Voyager as we had planned at a level of around $125 million or so in 1967, we then utilized a part of the $43 million for the Mariner 1967 and the Mariner 1969. Now, we certainly would have shown Voyager as another line item for continuing planetary effort if we had come in with the $125 million request. But, since we have not crossed the Rubicon, if you will, in this regard, we felt it wise not to show it as a line item this year.

With regard to transferring C. of F., R. & D. to C. of F., authority, if you are referring to the one and the one-half percent, this is to my mind not directly related to this. This is not saying that we are going to necessarily transfer the funds but we do say we feel that we need the flexibility to transfer the funds.

Mr. VIVIAN. Normally no request is made for flexibility unless something has been distrubing the requester.

Dr. SEAMANS. The $43 million, I am sure you realize is in fiscal 1966. I am up here today with regard to fiscal 1967, so these aren't even in the same budget year.

Mr. VIVIAN. Yes; I realize that.

Dr. SEAMANS. The sum of money that would be involved would be on the order of $22 to $23 million. If we had known or knew where we might need this flexibility, we would have put it in the budget. The one-half percent is, if you will, taking out some we believe, necessary insurance for difficulties that may arise.

Mr. KARTH. Would the gentleman yield? Mr. Chairman, I find, I join my colleague. I find it very difficult to understand the intent of Dr. Seaman's statement; on the one hand he talks about the need to maintain a broad frontal attack in the area of planetary exploration that are scientifically important. At the same time we don't find as a line item in the budget the most important scientific undertaking that NASA has ever involved itself in. And, if we are talking really about a broad frontal attack in this area, it seems to me that a rather obscure and only four-month ago consideration of a Venus flyby would not accomplish that objective.

I find myself somewhat remiss in being able to understand just exactly what NASA's intent is and then what their program objectives are.

I can't really put these two together.

Dr. SEAMANS. The program objectives are really very strongly related to the summer study that was carried out at Woods Hole, little less than a year ago, where the strong recommendation of the scientific community is for a greatly expanded planetary effort, an unmanned planetary effort.

Mr. KARTH. I'm very familiar with their recommendations.

Dr. SEAMANS. They indicated that Mars was particularly interesting because of the chance that there is extra-terrestrial life there on the surface, but they also strongly recommended that additional data be obtained on the Venus atmosphere and that as we progress with the program in the 70's that we explore other planets as well.

Mr. KARTH. Doctor, I think my point is that NASA's budget for fiscal year 1967 does not in any regard show me that they are undertaking a broad frontal attack in the interplanetary area for scientific purposes, none whatsoever. I appreciate that you may well agree with me but can't do so for certain reasons beyond your control, but I find it very difficult to arrive at that conclusion after having given considerable attention to NASA's budget request in this area.

Dr. SEAMANS. I would agree with you here in committee or any other forum that the planetary program that was endorsed by the scientific community, that the program that NASA feels advisable for the 70's does not show in the fiscal year 1967 budget. Also, that what we have in the Venus 1967 is an opportunity for some minimum planetary effort that we feel advisable to carry on until such time as a major effort can be initiated.

Mr. KARTH. Doctor, I hope this committee can help you here. Mr. Chairman, one other thing if I may. I know that time is running, but I'm not sure that I understand the last paragraph. But if I understand it to be that Congress should be the branch of government who is to be nothing more than a superficial stamping branch of the Executive branch of government, then I very vigorously disagree with it. I don't choose to argue the point. I just want to make it a part of the record. If this is the intent, I indicate disagreement.

The CHAIRMAN. Thank you very much, Dr. Seamans.

Tomorrow morning we will go into executive session. I want to ask you all to be here on time. If not, we will turn the heat on those that aren't here and maybe we will catch up some of the time we lost.

Mr. HECHLER. Mr. Chairman, if we are not going to have Dr. Seamans back, I would like to ask one or two very brief questions.

The CHAIRMAN. Well, all right.

Mr. HECHLER. I have a table, Dr. Seamans, which with the consent of the committee I would like to put into the record, which indicates the average GS salary grades for NASA personnel, and selected other government agencies. It shows an increase since fiscal year 1965, in the average GS grade in NASA from 10.3 to 10.4 in fiscal year 1966, and 10.5 in fiscal year 1967.

Likewise in comparison with personnel in the various GS grades between fiscal year 1966 and fiscal year 1967 shows that in the coming year that NASA will increase the ranks of GS–11 and above by 620 people while decreasing the lower ranks GS–1 to GS–10 by 118 people. And, I wonder if for the record Dr. Seamans if you would comment on these observations.

Dr. SEAMANS. I'll be very happy to comment on this for the record and just let me say that in this study that I discussed in answer to

Congressman Daddario's question, the average grade was one of the factors that came out of the study and was a matter of concern as was the number of GS–13's, 14's, 15's, and so on, within NASA. So, these are matters that have been very carefully studied.

(The information follows:)

The NASA position plan for each year as shown in the Budget which causes the change in average GS grade is a product of the NASA Human Resources Study conducted in the spring and summer of 1965. The purpose of the study was to demonstrate both internally and externally average grade and salary levels which would support an adequate career development program. The study was conducted in two parts. First, a review of all organizational elements within the agency to develop staffing plans that would assure that all effort was being conducted at the most economical level. Second, a study of historical trends in personnel which would identify those factors having the greatest effect upon average grade and salary. To accomplish the latter all personnel actions for the preceding two years were analyzed. The analysis revealed that the principal forcing factors are the rate and level of separation, the level of accessions, promotion practices and periodic within grade advancements.

It was concluded that, while it is not practical to establish salaries at a level comparable to industry since beginning rates are generally lower in government, it was possible to develop a plan which would allow the employee to progress at a rate approximating an individual in industry. This would prevent increasing the gap between governmental and nongovernmental salaries. Full comparability was assumed to be a function of Congressional legislation.

A computer assisted technique was developed which would evaluate the necessary management procedures to assure that individual career development could be provided without undue pressure on grade and salary levels. It was found that grade and salary levels were sensitive in varying degrees to the forcing factors. The analysis indicated that the incidence of separation accompanied by the level of accession to replace separations had the greatest effect upon grade and salary. It was also demonstrated that the rate of advancement under an adequate career development policy had lesser effect upon the grade and salary levels.

The study was calculated over a five-year plan, and by applying all reasonable options on the forcing factors, a NASA position management plan was developed, based upon policies which allowed for adequate career development and a reasonable turnover replacement level consistent with the maturing of the work force. This became the basis for the current budget estimate. Through a follow-up system of studying actual actions, any deviations from the estimate can and are being evaluated.

The difference from the fiscal year 1966 plan and the fiscal year 1967 plan for the numbers of GS–1 through GS–10 positions and the number of GS–11 and above positions results from the NASA Position Management System plan for fiscal year 1967 and from the effect of new positions as offset by abolished positions. The change in the number of GS–1 through GS–10 positions due to the NASA Position Management System is the career development of the young professional GS–5, 7 and 9 engineers, scientists and administrative personnel, as partially offset by an increase due to the anticipated downgrading from GS–11 and above turnover. The following table summarizes these changes:

	Net change	Change due to—	
		NASA position management system	Additional positions offset by abolished positions
Number GS–1 through GS–10 positions	−118	−235	+117
Number GS–11 and above positions	+620	+235	+385
Total number GS positions	+502	0	+502

Mr. HECHLER. You have a statement with respect to the three projects which were to have been terminated, but which this committee took the initiative to restore. You note NASA's desire to be sure "that whatever options for the future could be foreseen would be kept open until the fiscal year 1967 budget decisions had been made." I just would like to know how many other programs in NASA may be held up at this time waiting for future budget action and the extent that this may be standard practice.

You may want to supply something on that for the record.

Dr. SEAMANS. Are you referring to what we might call here, major options for future systems?

The CHAIRMAN. You can supply that for the record.

Dr. SEAMANS. I certainly will.

(The information follows:)

FISCAL YEAR 1968 PROGRAM OPTIONS KEPT OPEN THROUGH FISCAL YEAR 1967 REQUESTED FUNDING

The NASA fiscal year 1967 budget request is characterized by a Presidential determination to hold open for another year certain decisions on the future of the program but which cannot reasonably be delayed beyond the period of the Fiscal Year 1968 Budget. Funds are included in the fiscal year 1967 program request which afford options to move forward in fiscal year 1968 in the major areas of Apollo Applications, Voyager, and the Large (260") Solid Rocket Motor Development.

1. *Apollo Applications.*—$41.9 million is included in the NASA fiscal year 1967 program to maintain the option of continuing flight operation of the Apollo hardware at the fully developed production rate. The decision as to whether to maintain this option or whether a different rate is more appropriate can then be made in the context of the 1968 budget. (The $41.9 million is listed in the budget request under Mission Support Activity within the Apollo Program.)

In addition, the 1967 budget includes $25 million within the Space Science and Applications Program for the definition of specific experiment possibilities for incorporation in the alternate Apollo and Apollo Applications flights. For example, we have under way the definition of tracking platform (ATM) and sensors for solar and astronomical measurements. This work will provide the option in fiscal year 1968 for a program decision on the kind and extent of flight hardware developments to be pursued.

2. *Voyager.*—Last year NASA outlined to the Congress a Voyager plan leading to initial orbital and landing capsule missions to Mars starting with the 1971 opportunity. These plans included spacecraft flight tests during the 1969 opportunity. The NASA fiscal year 1967 budget request now allows only $10 million for Voyager. This will support continued project definition work with emphasis on the capsule, but delays definition and development work on other project phases so that initial flights are now planned for 1973. Fiscal year 1967 funding, therefore, provides another decision point in fiscal year 1968 on the pace and scope of Voyager.

3. *Large (260") Solid Rocket Motor Development.*—$3.5 million is included in the fiscal year 1967 program request for this project. Due to budget stringencies in fiscal year 1966, the Administration Program called for phase-out of this effort. Congress, however, authorized $6.2 million against which NASA has been able to fund $4.2 million in fiscal year 1966. Initially, in the face of these severe fund limitations, NASA formulated plans for phasing out the testing program and mothballing the current contractor's facilities. Our current plan is to utilize $2.4 million carried forward from fiscal year 1965, the $4.2 million from fiscal year 1966, and the $3.5 million in fiscal year 1967, to reuse an existing motor case and other existing major hardware to provide a third firing of the 260" motor in June 1967. It is planned that this reloaded motor will have a higher burning rate propellant and a new nozzle design which will deliver a maximum thrust of about 5 million pounds.

The CHAIRMAN. At this time the committee will stand adjourned until 10 o'clock tomorrow morning when we will meet in executive session.

(The following is submitted for the record.)

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS,
Washington, D.C., March 23, 1966.

Hon. GEORGE P. MILLER,
Chairman, Committee on Science and Astronautics,
House of Representatives, Washington, D.C.

DEAR MR. MILLER: The National Society of Professional Engineers strongly supports Section 5 of H.R. 12718, the proposed National Aeronautics and Space Administration Authorization Act for 1967, now pending before the Committee, and hopes that the Committee will take favorable action on this provision of the bill.

Section 5 of H.R. 12718, as introduced, would amend the National Aeronautics and Space Act of 1958, to clarify the authority of the Administrator of NASA to enter into contracts for architectural or engineering services for highly complex research and development facilities without regard to the six percent limitation imposed by Section 10(d) of Title 10 of the United States Code. The need for such clarification has become clear, we believe, in the light of the report of the Comptroller General to the Congress dated June 16, 1965, raising a question about the administrative application of the limitation imposed by 10 U.S.C. 2306(d) to the design of a highly complex research and development facility at the Nuclear Rocket Development Station in Nevada.

Our Society's position on the broader aspects of this problem are summed up in "A Petition to the Congress of the United States for Legislation", prepared by the Government Relations Committee of the Professional Engineers in Private Practice functional section of the Society, and submitted to both the House and the Senate during the first session of this Congress. As stated on pages 13 and 14 of that Petition:

"The present limitations work an undue hardship both upon the Government and engineers and architects. In most instances a proper and fair fee may be negotiated within the six percent limitation. As shown by the survey, 'The Role of the Consulting Engineer in Federal Public Works Projects,' prepared by The Functional Section for Consulting Engineers in Private Practice, National Society of Professional Engineers (1960), the individual contract payments for 1,146 engineering service contracts with 17 agencies by 118 firms varied from 0.5 percent to 14.7 percent of construction cost. It is, therefore, apparent that the Government is handicapped in selecting the most qualified firm for a particular project when the justifiable cost is more than six percent, and that it is unfair to the profession to expect the performance of quality services at a loss. Flexibility in negotiating a fair charge for engineering services is required particularly in situations where the technical content of the project is complex and detailed while the construction cost may be relatively low, or in the case of alteration to an existing structure or facility. Again the cost may be relatively low, but the amount of detailed engineering required is considerably increased compared to design for a new structure or facility. Also, the engineering costs for small jobs invariably are more than six percent of construction cost.

"The Government and the profession have lived with this situation by a number of devices—all unsatisfactory for both. Either the Government has to request the consulting engineer to take a particular job at a known loss with an implied promise to try to 'make it up' through subsequent profitable contracts, or the consultant is required to negotiate additional and separate contracts for what should be the same overall service under one contract for services which are not included in the six percent limitation, e.g., research, inspection of construction, preparation of manuals, etc.

"This is an unsound situation and should be corrected by amendment of the applicable laws to liberalize maximum fee references. Such a proposed change will not open doors to unlimited or unwarranted costs. The Federal agencies all have extensive experience and expert knowledge in the field of engineering services and contract procedures and can be relied upon to negotiate the lowest cost consistent with the need of the Government and fairness to the consultant.

"The basic premise of the exception to competitive bidding for professional services provided in applicable Federal procurement laws is a recognition that professional services are not comparable to standard or 'shelf' items which lend themselves to price comparison. Quality is all-important in professional services and it is a demonstrable fact that a slightly higher professional service charge in the case of engineering and architecture may save the client large sums of money in total project costs by the use of less expensive materials or

techniques. The professional charge is almost always a very small percentage of the total construction or project cost."

We believe these principles are particularly applicable to the problem to which Section 5 of H.R. 12718 is directed, and respectfully urge approval of that Section by the Committee.

Very truly yours,

PAUL H. ROBBINS, P.E.,
Executive Director.

(Whereupon, at 12:25 the committee adjourned until Wednesday, March 23, 1966, at 10 a.m.)

APPENDIX A

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION MINOR CONSTRUCTION (NEW STRUCTURE), MINOR CONSTRUCTION (EXISTING STRUCTURE) AND REPAIR AND ALTERATION PROJECTS FUNDED FROM THE ADMINISTRATIVE OPERATIONS APPROPRIATION

Kennedy Space Center

Project title	Fiscal year 1966		Fiscal year 1967 estimate
	Actual obligations, July 1, 1965, through Dec. 31, 1965	Estimated obligations, Jan. 1, 1966, through June 30, 1966	
Minor construction (new structure) projects:			
Solar Array Test Facility	$69,400		
Sand Blast Facility			$94,000
Hydrogen transfer sampling and storage area			57,500
Oxygen transfer and storage area			80,000
Subtotal	69,400		231,500
Minor construction (existing structure) projects:			
Addition to Propellant Systems Components Laboratory	39,000		
Addition to heating plant	37,900		
Modification to L.C. 5/6 Lunar Orbitor	108,000		
Modifications to pryotechnic building and engine annex for scape suit operations	57,000		
5th floor addition, O. & C. building	77,000		
Cafeteria addition		$142,000	
Security headquarters addition		110,000	
Miscellaneous projects under $25,000	61,960	140,112	22,500
S/C Systems Cleaning Laboratory, fluid test support building			158,000
Addition to fluid test complex support building			155,000
Sewage service to trailers at L.C. 39 and KSC headquarters			40,000
Equipment room			27,000
Fluid and storage building, hangar M			70,000
Extension to heavy equipment shop			85,000
Cold storage facility for photographic materials			68,900
Subtotal	380,860	392,112	626,400
Repair and alteration projects: Miscellaneous projects under $25,000		104,628	102,100
Subtotal		104,628	102,100
Total	450,260	496,740	960,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION MINOR CONSTRUCTION (NEW STRUCTURE), MINOR CONSTRUCTION (EXISTING STRUCTURE) AND REPAIR AND ALTERATION PROJECTS FUNDED FROM THE ADMINISTRATIVE OPERATIONS APPROPRIATION—Continued

Manned Spacecraft Center

Project title	Fiscal year 1966		Fiscal year 1967 estimate
	Actual obligations, July 1, 1965, through Dec. 31, 1965	Estimated obligations, Jan. 1, 1966, through June 30, 1966	
Minor construction (new structure) projects:			
Office space, Corps of Engineers	$50,000		
Vehicle parking for building 45	4,000	$70,500	
Vehicle parking for building 16A	2,800	49,470	
Vehicle parking for buildings 30 and 32		55,450	
Vehicle parking for buildings 5 and 29		31,420	
Vehicle parking for buildings 14 and 45		31,420	
Miscellaneous projects under $25,000	3,210	27,449	$37,000
Central Gas Cylinder Storage Facility			48,600
Industrial waste treatment plant			75,000
Subtotal	60,010	265,709	160,600
Minor construction (existing structure) projects:			
High Pressure Oxygen Compressor Facility	1,600	29,875	
Utility extension for clean room, building 10	14,500	61,900	
Landscaping improvements		27,500	
Addition to fire station, building 25A	7,700	142,150	
Modifications to Astronaut Phsyical Training Facility		38,200	
Modifications to 1st, 2d, 3d floors, building 4		225,000	
Vehicle parking extension, buildings 12 and 30	2,300	42,950	
Miscellaneous projects under $25,000	56,939	223,667	115,830
Micro Reproduction Facility			75,000
Modifications to building 8, 1st floor, for MCC/Philco			35,000
Graphic Services Addition, Printing and Reproduction Facility, building 227			74,900
Modifications to building 10			150,000
Modification to air conditioning system, building 2			50,000
Additional electrical instrumentation and control			50,000
Rehabilitation of EAFB facilities			150,000
Modifications to building 260			122,000
Modifications to building 30			87,500
Subtotal	83,039	791,242	910,230
Repair and alteration projects:			
Roof repairs			50,000
Miscellaneous projects under $25,000			179,170
Subtotal			229,170
Total	143,049	1,056,951	1,300,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION MINOR CONSTRUCTION (NEW STRUCTURE), MINOR CONSTRUCTION (EXISTING STRUCTURE) AND REPAIR AND ALTERATION PROJECTS FUNDED FROM THE ADMINISTRATIVE OPERATIONS APPROPRIATION—Continued

Marshall Space Flight Center

Project title	Fiscal year 1966		Fiscal year 1967 estimate
	Actual obligations, July 1, 1965, through Dec. 31, 1965	Estimated obligations, Jan. 1, 1966, through June 30, 1966	
Minor construction (new structure) projects:			
Substore, Quality Laboratory	$2,070	$22,930	
2d substore, test area		25,000	
Industrial waste treatment lagoon			$75,000
Subtotal	2,070	47,930	75,000
Minor construction (existing structure) projects:			
Air conditioning system, building 4610		90,000	
Substore, Computation Laboratory		37,000	
Cafeteria addition, building 4663		65,000	
Modification of entrance, building 4663		65,000	
Health Center equipment	6,619	34,841	
Miscellaneous projects under $25,000	29,539	38,246	
Utilities improvements			100,000
Facilities and technical support addition, building 4663			95,000
Road improvement, test area			100,000
Modify security building			134,000
Miscellaneous paving and improvements, ME area			40,000
Subtotal	36,158	330,087	469,000
Repair and alteration projects:			
Air conditioning modifications, East End, building 4708		145,000	
Modifications to air conditioning system, building 4708	46,758	28,242	
Air conditioning and lighting modifications, building 4481		75,000	
Partition, air conditioning and utility modifications, building 4201	30,706	4,294	
Modifications to Management Information Center, building 4200	22,408	17,592	
Improvements to air conditioning and ceilings, building 4566		121,000	
Miscellaneous projects under $25,000	52,864	39,891	55,000
Fireproof floors, building 4491			26,000
Modification to Valve Clinic, building 4705			30,000
Modification to East End, building 4481			190,000
Fire alarm system			150,000
Utilities monitoring system			150,000
Alterations to building S–4641			55,000
Subtotal	152,736	431,019	656,000
Total	190,964	809,036	1,200,000
Total OMSF	784,273	2,362,727	3,460,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION MINOR CONSTRUCTION (NEW STRUCTURE), MINOR CONSTRUCTION (EXISTING STRUCTURE) AND REPAIR AND ALTERATION PROJECTS FUNDED FROM THE ADMINISTRATIVE OPERATIONS APPROPRIATION—Continued

Goddard Space Flight Center

	Fiscal year 1966		Estimated, fiscal year 1967
	Actual obligations, July–December 1965	Estimated obligations, January–June 1966	
Minor construction projects (new structures):			
Radiological safety and storage building		$95,000	
Drainage control pond		55,000	
Ventilation shutdown and alarm system		40,000	
Fire alarm system, buildings 14, 15, and 21		25,000	
Sand filters, cooling towers		33,000	
Fire detection system, buildings 2, 11, and 20		18,000	
Truck weighing facility			$8,000
Hazardous material receiving and storage			50,000
Suspect hazardous material facility			15,000
Hazardous material disposal			30,000
Subtotal		266,000	103,000
Minor construction (existing structures):			
ISS, New York	$184,000		
Extend fire alarm system, buildings 22 and 23			15,000
Fire detection system, buildings 1, 6, and 21			18,000
20-kilovolt motor generator at MFCTF			10,000
Ventilation shutdown for radiological safety			10,000
Paint, interior and exterior, buildings 7 and 10			85,000
Mechanical utility improvements			106,000
Remote surveillance and control system			80,000
Air-conditioning system, MFCTF			23,000
Subtotal	184,000		347,000
Total	184,000	266,000	450,000

Wallops Station

	Fiscal year 1966		Estimated, fiscal year 1967
	Actual obligations, July–December 1965	Estimated obligations, January–June 1966	
Minor construction projects (new structures):			
3 steam generators and accessories		$235,000	
Environmental control, instrument room (building F–160)			$30,000
Miscellaneous projects (under $20)			120,000
Subtotal		235,000	150,000
Minor construction projects (existing structures): Extension to area storm drainage system	$27,000		
Repair and alteration projects:			
Miscellaneous projects (under $20)	11,000		
Modify electrical grounding systems	54,000		
Reinforce existing seawall		15,000	
Air-conditioning system (building Y–15)		85,000	
Air-conditioning system (building B–60)		18,000	
Connect ICC to FPS–16 buildings			85,000
Upgrade power systems (building E–2)			60,000
Replace power systems (Wallops Island)			100,000
Modify sounding rocket facility			50,000
Subtotal	65,000	118,000	295,000
Total	92,000	353,000	445,000
Total, OSSA	279,000	619,000	895,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION MINOR CONSTRUCTION (NEW STRUCTURE), MINOR CONSTRUCTION (EXISTING STRUCTURE) AND REPAIR AND ALTERATION PROJECTS FUNDED FROM THE ADMINISTRATIVE OPERATIONS APPROPRIATION—Continued

Ames Research Center

	Fiscal year 1966		Estimated, fiscal year 1967
	Actual obligations, July–December 1965	Estimated obligations, January–June 1966	
Repair and alterations projects			
Minor construction (existing structures):			
Miscellaneous projects under $25,000		$24,000	
Additions to administration building annex	$238,000		
Modification to basement of administration management building		70,000	
Subtotal	238,000	94,000	
Minor construction (new structure):			
Miscellaneous projects under $25,000	56,000		$43,000
Installation of new main water supply			100,000
Security annex and gatehouse			40,000
Subtotal	56,000		183,000
Total	294,000	94,000	183,000

Flight Research Center

	Fiscal year 1966		Estimated, fiscal year 1967
	Actual obligations, July–December 1965	Estimated obligations, January–June 1966	
Minor construction (existing structures): Various projects costing less than $25,000 each			$100,000
Minor construction (new structures): Various projects costing less than $25,000 each		$100,000	
Total		100,000	100,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION MINOR CONSTRUCTION (NEW STRUCTURE), MINOR CONSTRUCTION (EXISTING STRUCTURE) AND REPAIR AND ALTERATION PROJECTS FUNDED FROM THE ADMINISTRATIVE OPERATIONS APPROPRIATION—Continued

Langley Research Center

	Fiscal year 1966		Estimated, fiscal year 1967
	Actual obligations, July–December 1965	Estimated obligations, January–June 1966	
Minor construction (existing structures):			
Addition to building 1195, shipping and receiving warehouse	$225,000	$15,000	----------
Additional paved parking lot and other paved area	----------	60,000	----------
Additional fuel oil storage facility	----------	120,000	----------
Addition to building 1232, pilotless aircraft and fabrication facility	----------	----------	$135,000
Branch cafeteria for EI support area	----------	----------	75,000
Various projects under $25,000 each	----------	50,000	70,000
Subtotal	225,000	245,000	280,000
Minor construction (new structure):			
Plant safety building	----------	----------	95,000
Plant maintenance building	----------	----------	95,000
Subtotal	----------	----------	190,000
Total	225,000	245,000	470,000

Lewis Research Center

	Fiscal year 1966		Estimated, fiscal year 1967
	Actual obligations, July–December 1965	Estimated obligations, January–June 1966	
Minor construction (existing structures):			
Addition to liquid metal components cleaning facility	----------	$38,000	----------
Enlargement of hydrogen gas storage facility	----------	45,000	----------
Expansion of helium storage facility	----------	38,000	----------
Extension of access road to development engine facility	----------	----------	$32,000
Relocation and extension of railroad to plan board	----------	----------	28,000
Extension of shop area, locomotive building (PB)	----------	----------	15,000
Other road extensions	----------	----------	64,000
Various projects less than $25,000 each	----------	32,000	62,000
Subtotal	----------	153,000	201,000
Minor construction (new structures):			
Trailer parking, pad gas-handling area	----------	65,000	----------
New steam trench from chemical area to old trench	----------	32,000	----------
Metals storage building	----------	----------	72,000
Concrete pad at scrap metals collecting area	----------	----------	15,000
Various projects less than $25,000 each	----------	47,000	12,000
Subtotal	----------	144,000	99,000
Total	----------	297,000	300,000
Total, OART	$519,000	$736,000	1,053,000
Total, NASA	1,582,273	3,717,727	5,408,000

National Aeronautics and Space Administration

BUDGET ESTIMATES

FISCAL YEAR 1967

SPECIAL ANALYSIS OF REQUIREMENTS
AUTOMATIC DATA PROCESSING EQUIPMENT

59-640 O—66—pt. 1——19

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Fiscal Year 1967 Estimates

Automatic Data Processing Equipment

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Automatic Data Processing Equipment
General Statement

In the conduct of the space program, the computer has been and will continue to be a vital and essential tool. Without computers, it would have been impossible to conceive, design, test, or fly our present complex spacecraft, or to achieve rendezvous between Gemini VI and VII. As NASA extends its missions to Apollo and beyond to operations around and on the planets, the computer will become an even more vital part of the mission. Control and accuracy requirements become more critical as mission complexity increases. Requirements are increasing and computer costs represent a growing portion of the NASA budget. It is important, therefore, that there be an understanding of the computer effort and that close coordination and control of this effort be achieved.

NASA has realized that close central control of this essential resource is necessary and in July of this year, NHB 2410.1 (Management Procedures for Automatic Data Processing Equipment) was issued in draft form and a revised version will be ready soon. This handbook spells out the basic responsibilities of all levels of management for requirements control, equipment acquisition, utilization and disposal.

Our computer uses extend into every phase of the space program. The more familiar uses are for solution of scientific/engineering problems, data reduction, simulation, mission control and administrative applications. The large, general purpose computers are utilized for these tasks. Within NASA, equipment utilized for such uses are placed in Category A and close control is maintained on acquisition and utilization. Computers are also utilized for other than just computational tools. It has become economical to utilize the switching and decision making abilities in large electronic systems, where use of the computer is tied completely to the actual system and cannot easily be divorced from it for other uses. In NASA, such equipment is placed in Category B and control of these systems are not separated from the overall systems. However, control is exercised over the placement in Category B because of the gray area that may exist between the two categories.

NASA intends to place strong emphasis on planning in depth in the use of ADP. It has recognized the importance of achieving the most economic utilization of its ADP resources and intends to probe every possible method of achieving this result.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Analysis of Automatic Data Processing Equipment

FY 1965 - Summary (Categories A & B)

(In Thousands of Dollars)

	Purchase	Lease	Maintenance	Total
Research and Development				
Ames Research Center	496	61	3	560
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	17	17
Goddard Space Flight Center	16,727	---	1,337	18,064
Headquarters	---	---	---	---
Jet Propulsion Laboratory	3,917	3,251	220	7,388
Kennedy Space Center	216	318	34	568
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	1,144	7,990	101	9,235
Marshall Space Flight Center	346	5,686	3	6,035
Space Nuclear Propulsion Office	---	71	---	71
Wallops Station	---	---	---	---
Total, R&D	22,846	17,377	1,715	41,938
Administrative Operations				
Ames Research Center	---	1,850	---	1,850
Electronics Research Center	---	---	---	---
Flight Research Center	951	181	25	1,157
Goddard Space Flight Center	30,977	5,121	228	36,326
Headquarters	675	364	12	1,051
Jet Propulsion Laboratory	17,034	---	---	17,034
Kennedy Space Center	---	701	---	701
Langley Research Center	1,018	2,386	38	3,442
Lewis Research Center	4,145	1,094	33	5,272
Manned Spacecraft Center	8,710	4,515	26	13,251
Marshall Space Flight Center	7,053	6,084	60	13,197
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	1,731	184	1	1,916
Total, AO	72,294	22,480	423	95,197

FY 1965 Summary (Categories A & B) Cont'd

	Purchase	Lease	Maintenance	Total
Construction of Facilities				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	3,505	---	---	3,505
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	---	---	---
Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	---	---	---	---
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, CoF	3,505	---	---	3,505
SUMMARY ALL APPROPRIATIONS				
Ames Research Center	496	1,911	3	2,410
Electronics Research Center	---	---	---	---
Flight Research Center	951	181	42	1,174
Goddard Space Flight Center	51,209	5,121	1,565	57,895
Headquarters	675	364	12	1,051
Jet Propulsion Laboratory	20,951	3,251	220	24,422
Kennedy Space Center	216	1,019	34	1,269
Langley Research Center	1,018	2,386	38	3,442
Lewis Research Center	4,145	1,094	33	5,272
Manned Spacecraft Center	9,854	12,505	127	22,486
Marshall Space Flight Center	7,399	11,770	63	19,232
Space Nuclear Propulsion Office	---	71	---	71
Wallops Station	1,731	184	1	1,916
Total	98,645	39,857	2,138	140,640

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Analysis of Automatic Data Processing Equipment

FY 1966 - Summary (Categories A & B)

(In Thousands of Dollars)

	Purchase	Lease	Maintenance	Total
Research and Development				
Ames Research Center	1,065	69	116	1,250
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	17	17
Goddard Space Flight Center	6,096	---	1,305	7,401
Headquarters	---	---	---	---
Jet Propulsion Laboratory	6,503	4,011	565	11,079
Kennedy Space Center	260	792	347	1,399
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	2,301	12,106	182	14,589
Marshall Space Flight Center	---	6,915	37	6,952
Space Nuclear Propulsion Office	---	176	---	176
Wallops Station	314	---	---	314
Total, R&D	16,539	24,069	2,569	43,177
Administrative Operations				
Ames Research Center	344	1,767	20	2,131
Electronics Research Center	---	27	---	27
Flight Research Center	---	78	28	106
Goddard Space Flight Center	161	5,650	88	5,899
Headquarters	---	98	24	122
Jet Propulsion Laboratory	---	---	---	---
Kennedy Space Center	---	806	---	806
Langley Research Center	4,638	2,954	146	7,738
Lewis Research Center	2,821	365	80	3,266
Manned Spacecraft Center	---	5,489	332	5,821
Marshall Space Flight Center	---	4,415	330	4,745
Space Nuclear Propulsion Center	---	---	---	---
Wallops Station	---	63	50	113
Total, AO	7,964	21,712	1,098	30,774

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FY 1966 - Summary (Categories A & B) Cont'd

	Purchase	Lease	Maintenance	Total
Construction of Facilities				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	1,091	---	---	1,091
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	---	---	---
Kennedy Space Center	5,581	---	---	5,581
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	---	---	---	---
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, CoF	6,672	---	---	6,672
SUMMARY ALL APPROPRIATIONS				
Ames Research Center	1,409	1,836	136	3,381
Electronics Research Center	---	27	---	27
Flight Research Center	---	78	45	123
Goddard Space Flight Center	7,348	5,650	1,393	14,391
Headquarters	---	98	24	122
Jet Propulsion Laboratory	6,503	4,011	565	11,079
Kennedy Space Center	5,841	1,598	347	7,786
Langley Research Center	4,638	2,954	146	7,738
Lewis Research Center	2,821	365	80	3,266
Manned Spacecraft Center	2,301	17,595	514	20,410
Marshall Space Flight Center	---	11,330	367	11,697
Space Nuclear Propulsion Office	---	176	---	176
Wallops Station	314	63	50	427
Total	31,175	45,781	3,667	80,623

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Analysis of Automatic Data Processing Equipment

FY 1967 - Summary (Categories A & B)

(In Thousands of Dollars)

	Purchase	Lease	Maintenance	Total
Research and Development				
Ames Research Center	2,580	54	219	2,853
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	22	22
Goddard Space Flight Center	686	---	1,929	2,615
Headquarters	---	---	---	---
Jet Propulsion Laboratory	3,027	5,878	611	9,516
Kennedy Space Center	1,130	114	300	1,544
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	5,686	11,005	416	17,107
Marshall Space Flight Center	---	7,108	50	7,158
Space Nuclear Propulsion Office	---	226	---	226
Wallops Station	200	---	---	200
Total, R&D	13,309	24,385	3,547	41,241
Administrative Operations				
Ames Research Center	---	2,195	10	2,205
Electronics Research Center	---	543	---	543
Flight Research Center	---	---	19	19
Goddard Space Flight Center	862	7,100	144	8,106
Headquarters	---	89	24	113
Jet Propulsion Laboratory	---	---	---	---
Kennedy Space Center	---	828	---	828
Langley Research Center	1,982	3,277	402	5,661
Lewis Research Center	---	121	123	244
Manned Spacecraft Center	---	5,070	430	5,500
Marshall Space Flight Center	---	5,152	400	5,552
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	46	75	121
Total, AO	2,844	24,421	1,627	28,892

FY 1967 Summary (Categories A & B) Cont'd

	Purchase	Lease	Maintenance	Total
Construction of Facilities				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	---	---	---	---
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	---	---	---
Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	---	---	---	---
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, CoF	---	---	---	---
SUMMARY ALL APPROPRIATIONS				
Ames Research Center	2,580	2,249	229	5,058
Electronics Research Center	---	543	---	543
Flight Research Center	---	---	41	41
Goddard Space Flight Center	1,548	7,100	2,073	10,721
Headquarters	---	89	24	113
Jet Propulsion Laboratory	3,027	5,878	611	9,516
Kennedy Space Center	1,130	942	300	2,372
Langley Research Center	1,982	3,277	402	5,661
Lewis Research Center	---	121	123	244
Manned Spacecraft Center	5,686	16,075	846	22,607
Marshall Space Flight Center	---	12,260	450	12,710
Space Nuclear Propulsion Office	---	226	---	226
Wallops Station	200	46	75	321
Total	16,153	48,806	5,174	70,133

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Analysis of Automatic Data Processing Equipment

FY 1965 Category A (General Purpose Use)

(In Thousands of Dollars)

	Purchase	Lease	Maintenance	Total
Research and Development				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	---	---	138	138
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	3,115	121	3,236
Kennedy Space Center	216	318	34	568
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	7,593	---	7,593
Marshall Space Flight Center	170	5,360	1	5,531
Space Nuclear Propulsion Office	---	71	---	71
Wallops Station	---	---	---	---
Total, R&D	386	16,457	294	17,137
Administrative Operations				
Ames Research Center	---	1,850	---	1,850
Electronics Research Center	---	---	---	---
Flight Research Center	951	181	25	1,157
Goddard Space Flight Center	30,482	4,360	205	35,047
Headquarters	675	364	12	1,051
Jet Propulsion Laboratory	17,034	---	---	17,034
Kennedy Space Center	---	701	---	701
Langley Research Center	1,018	2,386	38	3,442
Lewis Research Center	4,145	1,094	33	5,272
Manned Spacecraft Center	8,710	4,515	26	13,251
Marshall Space Flight Center	6,074	5,559	52	11,685
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	1,731	184	1	1,916
Total, AO	70,820	21,194	392	92,406

FY 1965 Category A (General Purpose Use) Cont'd

	Purchase	Lease	Maintenance	Total
Construction of Facilities				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	---	---	---	---
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	---	---	---
Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	---	---	---	---
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, CoF	---	---	---	---
SUMMARY ALL APPROPRIATIONS				
Ames Research Center	---	1,850	---	1,850
Electronics Research Center	---	---	---	---
Flight Research Center	951	181	25	1,157
Goddard Space Flight Center	30,482	4,360	343	35,185
Headquarters	675	364	12	1,051
Jet Propulsion Laboratory	17,034	3,115	121	20,270
Kennedy Space Center	216	1,019	34	1,269
Langley Research Center	1,018	2,386	38	3,442
Lewis Research Center	4,145	1,094	33	5,272
Manned Spacecraft Center	8,710	12,108	26	20,844
Marshall Space Flight Center	6,244	10,919	53	17,216
Space Nuclear Propulsion Office	---	71	---	71
Wallops Station	1,731	184	1	1,916
Total	71,206	37,651	686	109,543

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Analysis of Automatic Data Processing Equipment

FY 1966 Category A (General Purpose Use)

(In Thousands of Dollars)

	Purchase	Lease	Maintenance	Total
Research and Development				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	---	---	377	377
Headquarters	---	---	---	---
Jet Propulsion Laboratory	149	3,813	384	4,346
Kennedy Space Center	260	792	347	1,399
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	600	11,524	---	12,124
Marshall Space Flight Center	---	6,633	19	6,652
Space Nuclear Propulsion Office	---	176	---	176
Wallops Station	314	---	---	314
Total, R&D	1,323	22,938	1,127	25,388
Administrative Operations				
Ames Research Center	344	1,767	20	2,131
Electronics Research Center	---	27	---	27
Flight Research Center	---	78	28	106
Goddard Space Flight Center	161	4,974	58	5,193
Headquarters	---	98	24	122
Jet Propulsion Laboratory	---	---	---	---
Kennedy Space Center	---	806	---	806
Langley Research Center	4,638	2,954	146	7,738
Lewis Research Center	2,821	365	80	3,266
Manned Spacecraft Center	---	5,489	332	5,821
Marshall Space Flight Center	---	4,415	274	4,689
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	63	50	113
Total, AO	7,964	21,036	1,012	30,012

FY 1966 Category A (General Purpose Use) Cont'd

	Purchase	Lease	Maintenance	Total
Construction of Facilities				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	---	---	---	---
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	---	---	---
Kennedy Space Center	5,581	---	---	5,581
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	---	---	---	---
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, CoF	5,581	---	---	5,581
SUMMARY ALL APPROPRIATIONS				
Ames Research Center	344	1,767	20	2,131
Electronics Research Center	---	27	---	27
Flight Research Center	---	78	28	106
Goddard Space Flight Center	161	4,974	435	5,570
Headquarters	---	98	24	122
Jet Propulsion Laboratory	149	3,813	384	4,346
Kennedy Space Center	5,841	1,598	347	7,786
Langley Research Center	4,638	2,954	146	7,738
Lewis Research Center	2,821	365	80	3,266
Manned Spacecraft Center	600	17,013	332	17,945
Marshall Space Flight Center	---	11,048	293	11,341
Space Nuclear Propulsion Office	---	176	---	176
Wallops Station	314	63	50	427
Total	14,868	43,974	2,139	60,981

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Analysis of Automatic Data Processing Equipment

FY 1967 Category A (General Purpose Use)

(In Thousands of Dollars)

	Purchase	Lease	Maintenance	Total
Research and Development				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	---	---	507	507
Headquarters	---	---	---	---
Jet Propulsion Laboratory	700	5,675	424	6,799
Kennedy Space Center	1,130	114	300	1,544
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	5,686	10,480	125	16,291
Marshall Space Flight Center	---	6,826	32	6,858
Space Nuclear Propulsion Office	---	226	---	226
Wallops Station	200	---	---	200
Total, R&D	7,716	23,321	1,388	32,425
Administrative Operations				
Ames Research Center	---	2,195	10	2,205
Electronics Research Center	---	543	---	543
Flight Research Center	---	---	19	19
Goddard Space Flight Center	862	6,504	114	7,480
Headquarters	---	89	24	113
Jet Propulsion Laboratory	---	---	---	---
Kennedy Space Center	---	828	---	828
Langley Research Center	1,982	3,277	402	5,661
Lewis Research Center	---	121	123	244
Manned Spacecraft Center	---	5,070	430	5,500
Marshall Space Flight Center	---	5,152	340	5,492
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	46	75	121
Total, AO	2,844	23,825	1,537	28,206

FY 1967 Category A (General Purpose Use) Cont'd

	Purchase	Lease	Maintenance	Total
Construction of Facilities				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	---	---	---	---
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	---	---	---
Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	---	---	---	---
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, CoF	---	---		---
SUMMARY ALL APPROPRIATIONS				
Ames Research Center	---	2,195	10	2,205
Electronics Research Center	---	543	---	543
Flight Research Center	---	---	19	19
Goddard Space Flight Center	862	6,504	621	7,987
Headquarters	---	89	24	113
Jet Propulsion Laboratory	700	5,675	424	6,799
Kennedy Space Center	1,130	942	300	2,372
Langley Research Center	1,982	3,277	402	5,661
Lewis Research Center	---	121	123	244
Manned Spacecraft Center	5,686	15,550	555	21,791
Marshall Space Flight Center	---	11,978	372	12,350
Space Nuclear Propulsion Office	---	226	---	226
Wallops Station	200	46	75	321
Total	10,560	47,146	2,925	60,631

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Analysis of Automatic Data Processing Equipment

FY 1965 Category B (Special Purpose Use)

(In Thousands of Dollars)

	Purchase	Lease	Maintenance	Total
Research and Development				
Ames Research Center	496	61	3	560
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	17	17
Goddard Space Flight Center	16,727	---	1,199	17,926
Headquarters	---	---	---	---
Jet Propulsion Laboratory	3,917	136	99	4,152
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	1,144	397	101	1,642
Marshall Space Flight Center	176	326	2	504
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, R&D	22,460	920	1,421	24,801
Administrative Operations				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	495	761	23	1,279
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	---	---	---
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	979	525	8	1,512
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, AO	1,474	1,286	31	2,791

*Category B equipment at KSC funded by other NASA installations.

FY 1965 Category B (Special Purpose Use) Cont'd

	Purchase	Lease	Maintenance	Total
Construction of Facilities				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	3,505	---	---	3,505
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	---	---	---
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	---	---	---	---
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, CoF	3,505	---	---	3,505
SUMMARY ALL APPROPRIATIONS				
Ames Research Center	496	61	3	560
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	17	17
Goddard Space Flight Center	20,727	761	1,222	22,710
Headquarters	---	---	---	---
Jet Propulsion Laboratory	3,917	136	99	4,152
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	1,144	397	101	1,642
Marshall Space Flight Center	1,155	851	10	2,016
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total	27,439	2,206	1,452	31,097

*Category B equipment at KSC funded by other NASA installations.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Analysis of Automatic Data Processing Equipment

FY 1966 Category B (Special Purpose Use)

(In Thousands of Dollars)

	Purchase	Lease	Maintenance	Total
Research and Development				
Ames Research Center	1,065	69	116	1,250
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	17	17
Goddard Space Flight Center	6,096	---	928	7,024
Headquarters	---	---	---	---
Jet Propulsion Laboratory	6,354	198	181	6,733
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	1,701	582	182	2,465
Marshall Space Flight Center	---	282	18	300
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, R&D	15,216	1,131	1,442	17,789
Administrative Operations				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	---	676	30	706
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	---	---	---
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	---	---	56	56
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, AO	---	676	86	762

*Category B equipment at KSC funded by other NASA installations.

FY 1966 Category B (Special Purpose Use) Cont'd

	Purchase	Lease	Maintenance	Total
Construction of Facilities				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	1,091	---	---	1,091
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	---	---	---
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	---	---	---	---
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, CoF	1,091	---	---	1,091
SUMMARY ALL APPROPRIATIONS				
Ames Research Center	1,065	69	116	1,250
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	17	17
Goddard Space Flight Center	7,187	676	958	8,821
Headquarters	---	---	---	---
Jet Propulsion Laboratory	6,354	198	181	6,733
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	1,701	582	182	2,465
Marshall Space Flight Center	---	282	74	356
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total	16,307	1,807	1,528	19,642

*Category B equipment at KSC funded by other NASA installations.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Analysis of Automatic Data Processing Equipment

FY 1967 Category B (Special Purpose Use)

(In Thousands of Dollars)

	Purchase	Lease	Maintenance	Total
Research and Development				
Ames Research Center	2,580	54	219	2,853
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	22	22
Goddard Space Flight Center	686	---	1,422	2,108
Headquarters	---	---	---	---
Jet Propulsion Laboratory	2,327	203	187	2,717
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	525	291	816
Marshall Space Flight Center	---	282	18	300
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, R&D	5,593	1,064	2,159	8,816
Administrative Operations				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	---	596	30	626
Headquarters	---	---	---	---
Jet Propulsion Laboratory	----	---	---	---
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	---	---	60	60
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, AO	---	596	90	686

*Category B equipment at KSC funded by other NASA installations.

FY 1967 Category B (Special Purpose Use) Cont'd

	Purchase	Lease	Maintenance	Total
Construction of Facilities				
Ames Research Center	---	---	---	---
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	---	---
Goddard Space Flight Center	---	---	---	---
Headquarters	---	---	---	---
Jet Propulsion Laboratory	---	---	---	---
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	---	---	---
Marshall Space Flight Center	---	---	---	---
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total, CoF	---	---	---	---
SUMMARY ALL APPROPRIATIONS				
Ames Research Center	2,580	54	219	2,853
Electronics Research Center	---	---	---	---
Flight Research Center	---	---	22	22
Goddard Space Flight Center	686	596	1,452	2,734
Headquarters	---	---	---	---
Jet Propulsion Laboratory	2,327	203	187	2,717
*Kennedy Space Center	---	---	---	---
Langley Research Center	---	---	---	---
Lewis Research Center	---	---	---	---
Manned Spacecraft Center	---	525	291	816
Marshall Space Flight Center	---	282	78	360
Space Nuclear Propulsion Office	---	---	---	---
Wallops Station	---	---	---	---
Total	5,593	1,660	2,249	9,502

*Category B equipment at KSC funded by other NASA installations.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Summary (Categories A & B)

		Large	Medium	Small	Total
6/30/64	Purchase	---	6	73	79
	Lease	20	22	64	106
	P/L	9	2	7	18
	Total	29	30	144	203
6/30/65	Purchase	4	27	121	152
	Lease	14	24	64	102
	P/L	15	5	8	28
	Total	33	56	193	282
6/30/66	Purchase	8	52	252	312
	Lease	15	31	54	100
	P/L	22	6	9	37
	Total	45	89	315	449
6/30/67	Purchase	10	58	284	352
	Lease	16	25	49	90
	P/L	26	5	8	39
	Total	52	88	341	481

Explanation of terminology

Large refers to large scale computers costing more than $1,500,000,
Medium $450,000 to $1,500,000,
Small less than $450,000.

Purchase refers to equipment that is owned,
Lease to equipment leased and
P/L denotes a combination of components, some owned, some leased.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Summary Category A (General Purpose Use)

		Large	Medium	Small	Total
6/30/64	Purchase	---	---	2	2
	Lease	20	21	55	96
	P/L	7	2	5	14
	Total	27	23	62	112
6/30/65	Purchase	4	2	16	22
	Lease	14	22	54	90
	P/L	13	3	5	21
	Total	31	27	75	133
6/30/66	Purchase	7	3	19	29
	Lease	15	28	47	90
	P/L	17	3	5	25
	Total	39	34	71	144
6/30/67	Purchase	9	3	20	32
	Lease	16	21	43	80
	P/L	21	2	4	27
	Total	46	26	67	139

Summary Category B (Special Purpose Use)

6/30/64	Purchase	---	6	71	77
	Lease	---	1	9	10
	P/L	2	---	2	4
	Total	2	7	82	91
6/30/65	Purchase	---	25	105	130
	Lease	---	2	10	12
	P/L	2	2	3	7
	Total	2	29	118	149
6/30/66	Purchase	1	49	233	283
	Lease	---	3	7	10
	P/L	5	3	4	12
	Total	6	55	244	305
6/30/67	Purchase	1	55	264	320
	Lease	---	4	6	10
	P/L	5	3	4	12
	Total	6	62	274	342

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category A (General Purpose Use)

		Large	Medium	Small	Total
Ames Research Center, Moffett Field, Calif.					
6/30/64	Purchase	---	---	---	---
	Lease	1	2	3	6
	P/L	---	---	---	---
	Total	1	2	3	6
6/30/65	Purchase	---	---	---	---
	Lease	1	2	6	9
	P/L	---	---	---	---
	Total	1	2	6	9
6/30/66	Purchase	---	---	---	---
	Lease	---	2	8	10
	P/L	1	---	---	1
	Total	1	2	8	11
6/30/67	Purchase	---	---	---	---
	Lease	---	2	13	15
	P/L	1	---	---	1
	Total	1	2	13	16
Electronics Research Center, Cambridge, Mass.					
6/30/64	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/65	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/66	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/67	Purchase	---	---	---	---
	Lease	1	1	---	2
	P/L	---	---	---	---
	Total	1	1	---	2

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category A (General Purpose Use)

		Large	Medium	Small	Total
Flight Research Center Edward Air Base Base, Calif.					
6/30/64	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	1	1	2
	Total	---	1	1	2
6/30/65	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	1	1	2
	Total	---	1	1	2
6/30/66	Purchase	---	1	---	1
	Lease	---	---	---	---
	P/L	---	1	1	2
	Total	---	2	1	3
6/30/67	Purchase	---	1	---	1
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	1	---	1
Goddard Space Flight Center Greenbelt, Md.					
6/30/64	Purchase	---	---	---	---
	Lease	---	1	3	4
	P/L	6	1	4	11
	Total	6	2	7	15
6/30/65	Purchase	---	---	---	---
	Lease	1	1	4	6
	P/L	6	2	4	12
	Total	7	3	8	18
6/30/66	Purchase	---	---	---	---
	Lease	---	1	6	7
	P/L	9	2	4	15
	Total	9	3	10	22
6/30/67	Purchase	---	---	---	---
	Lease	---	---	4	4
	P/L	13	2	4	19
	Total	13	2	8	23

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category A (General Purpose Use)

		Large	Medium	Small	Total
Goddard Space Flight Center					
Institute for Space Studies					
New York, N. Y.					
6/30/64	Purchase	---	---	---	---
	Lease	---	---	1	1
	P/L	1	---	---	1
	Total	1	---	1	2
6/30/65	Purchase	---	---	---	---
	Lease	---	---	1	1
	P/L	1	---	---	1
	Total	1	---	1	2
6/30/66	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	1	---	---	1
	Total	1	---	---	1
6/30/67	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	1	---	---	1
	Total	1	---	---	1
NASA Headquarters					
Washington, D. C.					
6/30/64	Purchase	---	---	---	---
	Lease	---	1	2	3
	P/L	---	---	---	---
	Total	---	1	2	3
6/30/65	Purchase	---	1	---	1
	Lease	---	---	2	2
	P/L	---	---	---	---
	Total	---	1	2	3
6/30/66	Purchase	---	1	---	1
	Lease	---	---	2	2
	P/L	---	---	---	---
	Total	---	1	2	3
6/30/67	Purchase	---	1	---	1
	Lease	---	---	1	1
	P/L	---	---	---	---
	Total	---	1	1	2

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category A (General Purpose Use)

		Large	Medium	Small	Total
Jet Propulsion Laboratory Pasadena, Calif.					
6/30/64	Purchase	---	---	1	1
	Lease	3	1	4	8
	P/L	---	---	---	---
	Total	3	1	5	9
6/30/65	Purchase	---	---	1	1
	Lease	---	1	6	7
	P/L	3	---	---	3
	Total	3	1	7	11
6/30/66	Purchase	---	---	1	1
	Lease	1	1	9	11
	P/L	3	---	---	3
	Total	4	1	10	15
6/30/67	Purchase	---	---	3	3
	Lease	1	1	7	9
	P/L	3	---	---	3
	Total	4	1	10	15
Kennedy Space Center, NASA Kennedy Space Center, Fla.					
6/30/64	Purchase	---	---	---	---
	Lease	---	2	---	2
	P/L	---	---	---	---
	Total	---	2	---	2
6/30/65	Purchase	---	---	---	---
	Lease	1	3	1	5
	P/L	---	---	---	---
	Total	1	3	1	5
6/30/66	Purchase	1	---	1	2
	Lease	---	5	2	7
	P/L	---	---	---	---
	Total	1	5	3	9
6/30/67	Purchase	1	---	2	3
	Lease	---	4	2	6
	P/L	---	---	---	---
	Total	1	4	4	9

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category A (General Purpose Use)

		Large	Medium	Small	Total
Langley Research Center, Hampton, Va.					
6/30/64	Purchase	---	---	---	---
	Lease	1	1	5	7
	P/L	---	---	---	---
	Total	1	1	5	7
6/30/65	Purchase	---	---	2	2
	Lease	1	2	1	4
	P/L	---	---	---	---
	Total	1	2	3	6
6/30/66	Purchase	1	---	2	3
	Lease	2	1	1	4
	P/L	---	---	---	---
	Total	3	1	3	7
6/30/67	Purchase	2	---	2	4
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	2	---	2	4
Lewis Research Center, Cleveland, Ohio					
6/30/64	Purchase	---	---	---	---
	Lease	1	1	4	6
	P/L	---	---	---	---
	Total	1	1	4	6
6/30/65	Purchase	1	1	5	7
	Lease	---	---	1	1
	P/L	---	---	---	---
	Total	1	1	6	8
6/30/66	Purchase	1	1	5	7
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	1	1	5	7
6/30/67	Purchase	2	1	3	6
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	2	1	3	6

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category A (General Purpose Use)

		Large	Medium	Small	Total
Manned Spacecraft Center, Houston, Texas					
6/30/64	Purchase	---	---	---	---
	Lease	9	2	---	11
	P/L	---	---	---	---
	Total	9	2	---	11
6/30/65	Purchase	3	---	---	3
	Lease	7	2	2	11
	P/L	---	---	---	---
	Total	10	2	2	14
6/30/66	Purchase	4	---	---	4
	Lease	9	3	2	14
	P/L	---	---	---	---
	Total	13	3	2	18
6/30/67	Purchase	4	---	---	4
	Lease	8	1	1	10
	P/L	---	---	---	---
	Total	12	1	1	14
Marshall Space Flight Center, Hunstville, Alabama					
6/30/64	Purchase	---	---	---	---
	Lease	3	5	27	35
	P/L	---	---	---	---
	Total	3	5	27	35
6/30/65	Purchase	---	---	7	7
	Lease	1	5	24	30
	P/L	2	---	---	2
	Total	3	5	31	39
6/30/66	Purchase	---	---	9	9
	Lease	1	6	11	18
	P/L	2	---	---	2
	Total	3	6	20	29
6/30/67	Purchase	---	---	9	9
	Lease	3	7	10	20
	P/L	2	---	---	2
	Total	5	7	19	31

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category A (General Purpose Use)

		Large	Medium	Small	Total
Marshall Space Flight Center					
Michoud Assembly Facility					
New Orleans, La.					
6/30/64	Purchase	---	---	1	1
	Lease	2	5	5	12
	P/L	---	---	---	---
	Total	2	5	6	13
6/30/65	Purchase	---	---	1	1
	Lease	2	5	5	12
	P/L	---	---	---	---
	Total	2	5	6	13
6/30/66	Purchase	---	---	1	1
	Lease	2	8	6	16
	P/L	---	---	---	---
	Total	2	8	7	17
6/30/67	Purchase	---	---	1	1
	Lease	3	4	5	12
	P/L	---	---	---	---
	Total	3	4	6	13
Space Nuclear Propulsion Office					
Jackass Flats, Nevada					
6/30/64	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/65	Purchase	---	---	---	---
	Lease	---	1	---	1
	P/L	---	---	---	---
	Total	---	1	---	1
6/30/66	Purchase	---	---	---	---
	Lease	---	1	---	1
	P/L	---	---	---	---
	Total	---	1	---	1
6/30/67	Purchase	---	---	---	---
	Lease	---	1	---	1
	P/L	---	---	---	---
	Total	---	1	---	1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category A (General Purpose Use)

		Large	Medium	Small	Total
Wallops Station, Wallops Island, Va.					
6/30/64	Purchase	---	---	---	---
	Lease	---	---	1	1
	P/L	---	---	---	---
	Total	---	---	1	1
6/30/65	Purchase	---	---	---	---
	Lease	---	---	1	1
	P/L	1	---	---	1
	Total	1	---	1	2
6/30/66	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	1	---	---	1
	Total	1	---	---	1
6/30/67	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	1	---	---	1
	Total	1	---	---	1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category B (Special Purpose Use)

		Large	Medium	Small	Total
Ames Research Center, Moffett Field, Calif.					
6/30/64	Purchase	---	---	3	3
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	3	3
6/30/65	Purchase	---	---	6	6
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	6	6
6/30/66	Purchase	---	---	8	8
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	8	8
6/30/67	Purchase	---	---	8	8
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	8	8
Electronics Research Center, Cambridge, Mass.					
6/30/64	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/65	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/66	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/67	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category B (Special Purpose Use)

		Large	Medium	Small	Total
Flight Research Center Edwards Air Force, Calif.					
6/30/64	Purchase	---	---	1	1
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	1	1
6/30/65	Purchase	---	---	2	2
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	2	2
6/30/66	Purchase	---	---	4	4
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	4	4
6/30/67	Purchase	---	---	4	4
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	4	4
Goddard Space Flight Center Greenbelt, Md.					
6/30/64	Purchase	---	---	13	13
	Lease	---	---	6	6
	P/L	---	---	2	2
	Total	---	---	21	21
6/30/65	Purchase	---	---	17	17
	Lease	---	---	5	5
	P/L	---	1	3	4
	Total	---	1	25	26
6/30/66	Purchase	---	6	25	31
	Lease	---	---	5	5
	P/L	---	1	4	5
	Total	---	7	34	41
6/30/67	Purchase	---	6	26	32
	Lease	---	---	4	4
	P/L	---	1	4	5
	Total	---	7	34	41

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category B (Special Purpose Use)

		Large	Medium	Small	Total
Goddard Space Flight Center Tracking Stations					
6/30/64	Purchase	---	---	23	23
	Lease	---	---	3	3
	P/L	---	---	---	---
	Total	---	---	26	26
6/30/65	Purchase	---	---	27	27
	Lease	---	---	3	3
	P/L	---	---	---	---
	Total	---	---	30	30
6/30/66	Purchase	---	---	90	90
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	90	90
6/30/67	Purchase	---	---	97	97
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	97	97
Goddard Space Flight Center Other Location					
6/30/64	Purchase	---	---	10	10
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	10	10
6/30/65	Purchase	---	---	11	11
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	11	11
6/30/66	Purchase	---	---	10	10
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	10	10
6/30/67	Purchase	---	---	10	10
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	10	10

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category B (Special Purpose Use)

		Large	Medium	Small	Total
Jet Propulsion Laboratory Pasadena, Calif.					
6/30/64	Purchase	---	---	10	10
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	10	10
6/30/65	Purchase	---	---	14	14
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	14	14
6/30/66	Purchase	---	---	23	23
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	23	23
6/30/67	Purchase	---	---	24	24
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	24	24
Jet Propulsion Laboratory Tracking Stations					
6/30/64	Purchase	---	3	1	4
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	3	1	4
6/30/65	Purchase	---	5	7	12
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	5	7	12
6/30/66	Purchase	---	5	27	32
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	5	27	32
6/30/67	Purchase	---	5	33	38
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	5	33	38

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category B (Special Purpose Use)

		Large	Medium	Small	Total
Kennedy Space Center, NASA Kennedy Space Center, Fla.					
6/30/64	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/65	Purchase	---	---	2	2
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	2	2
6/30/66	Purchase	---	---	14	14
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	14	14
6/30/67	Purchase	---	---	26	26
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	26	26
Langley Research Center Hampton, Va.					
6/30/64	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/65	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/66	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/67	Purchase	---	---	3	3
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	3	3

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category B (Special Purpose Use)

		Large	Medium	Small	Total
Lewis Research Center Cleveland, Ohio					
6/30/64	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/65	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/66	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/67	Purchase	---	---	1	1
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	1	1
Manned Spacecraft Center Houston, Texas					
6/30/64	Purchase	---	2	6	8
	Lease	---	---	---	---
	P/L	2	---	---	2
	Total	2	2	6	10
6/30/65	Purchase	---	18	14	32
	Lease	---	1	2	3
	P/L	2	1*	---	3
	Total	2	20	16	38
6/30/66	Purchase	1	35	27	63
	Lease	---	3	2	5
	P/L	5	2*	---	7
	Total	6	40	29	75
6/30/67	Purchase	1	41	27	69
	Lease	---	3	2	5
	P/L	5	2*	---	7
	Total	6	46	29	81

* 1 - CDC 3200 located at White Sands Test Facility, New Mexico.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category B (Special Purpose Use)

		Large	Medium	Small	Total
Marshall Space Flight Center Huntsville, Alabama					
6/30/64	Purchase	---	1	2	3
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	1	2	3
6/30/65	Purchase	---	2	3	5
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	2	3	5
6/30/66	Purchase	---	2	3	5
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	2	3	5
6/30/67	Purchase	---	2	3	5
	Lease	---	1	---	1
	P/L	---	---	---	---
	Total	---	3	3	6
Marshall Space Flight Center Michoud Assembly Facility New Orleans, La.					
6/30/64	Purchase	---	---	1	1
	Lease	---	1	---	1
	P/L	---	---	---	---
	Total	---	1	1	2
6/30/65	Purchase	---	---	1	1
	Lease	---	1	---	1
	P/L	---	---	---	---
	Total	---	1	1	2
6/30/66	Purchase	---	1	1	2
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	1	1	2
6/30/67	Purchase	---	1	1	2
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	1	1	2

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of Year Inventory of Computers
Category B (Special Purpose Use)

		Large	Medium	Small	Total
Space Nuclear Propulsion Office					
Jackass Flats, Nevada					
6/30/64	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/65	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/66	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
6/30/67	Purchase	---	---	---	---
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	---	---
Wallops Station					
Wallops Island, Va.					
6/30/64	Purchase	---	---	1	1
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	1	1
6/30/65	Purchase	---	---	1	1
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	1	1
6/30/66	Purchase	---	---	1	1
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	1	1
6/30/67	Purchase	---	---	1	1
	Lease	---	---	---	---
	P/L	---	---	---	---
	Total	---	---	1	1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AMES RESEARCH CENTER
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	496	1,409	2,580
Lease	1,911	1,836	2,249
Maintenance	3	136	229
Total	2,410	3,381	5,058
Number of Personnel:			
Civil Service	65	65	65
Contracting Firm	27	40	51

Contractor Identification

Name of Firm	Service Performed
Computer Services Corp.	Programming
Massey Temp. Services	Key Punching
Massey Temp. Services	Data Processing
EAI	Maintenance
Honeywell	Maintenance
IBM	Maintenance

NARRATIVE EXPLANATION

FY 1965

ADP requirements at Ames include wind tunnel data reduction and analysis, and studies in areas of flight simulation, theoretical aerodynamics and Supersonic Transport. Computer work load requirements show a steady growth with increased research engineering and management support particularly for projects Pioneer and Biosatellite. The large scale 7094 direct coupled computer system is used for implementing mathematical models representing specific problem areas of investigations. Wind tunnel data reduction and analysis requires full time utilization of the H 800/200 system. Administrative support activities utilizes the 1401 system on a share basis with the U.S. Naval Air Station. Present equipment was being utilized on a 2½ shift basis, Monday through Friday.

FY 1966

Wind tunnel programs reflect a 15 to 20 percent increase in data reduction and analysis work load. Additional increases in data reduction work load will result from Biomedical experiments and from the Pioneer project as it progresses into flight phases. Increased requirements for scientific and engineering data processing result from expanded research projects, including human performance, planetary atmospheres and mission analysis.

The 7094 DCS was converted from lease to purchase and four high speed remote computing stations have been installed in strategic locations throughout the center. This action provides capability for direct use of the central computer complex by scientists, and increase their efficiency in research activity. Equipment was utilized on a 3 shift basis, Monday through Friday.

FY 1967

Data reduction work load will continue to increase during flight phases of projects Pioneer and Biosatellite. Data reduction work load from current wind tunnel projects will show some increase and tend to stabilize at a fairly constant level. Additional requirements for scientific and engineering ADP work include trajectory computations, support for space flight simulation and increased mission analysis demands.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
ELECTRONICS RESEARCH CENTER
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	---	---	---
Lease	---	27	543
Maintenance	---	---	---
Total	---	27	543
Number of Personnel:			
Civil Service	2	8	18
Contracting Firm	---	11	36

Contractor Identification

Name of Firm	Service Performed
Wolfe R&D, Inc.	Numerical Analysis
Computer Applications, Inc.	Programming
Research Calculations, Inc.	Programming

NARRATIVE EXPLANATION

FY 1965

The major effort during FY 1965 was devoted to determining ERC computing requirements.

FY 1966

ADP applications at ERC are presently concentrated in two areas: scientific computation; and administrative data processing. In both of these areas there will exist significant requirements for data acquisition, and information storage and retrieval. Large scale data reduction tasks are now beginning to materialize as a result of the build-up of data acquisition installations within the individual laboratories. In the area of scientific applications, forty-two different mathematical programs are now being generated. They vary in size and complexity from auto-correlation/power spectra analysis of optics data to long-term complex studies in guidance and control. Ten administrative data programs of medium to large size are currently in the debugging and checkout stages.

FY 1967

A first-phase modular computer configuration capable of solving large-scale administrative/scientific problems is planned for acquisition and partial implementation in FY 1967. Basically the system will be a digital machine with about 35 consoles for remote on-line operations.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FLIGHT RESEARCH CENTER
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	951	---	---
Lease	181	78	---
Maintenance	42	45	41
Total	1,174	123	41
Number of Personnel:			
Civil Service	19	19	19
Contracting Firm	5	5	6

Contractor Identification

Name of Firm	Service Performed
GE	Keypunching Data Processing Operations (FY 67 only)
IBM	Maintenance
GE	Maintenance
EAI	Maintenance

NARRATIVE EXPLANATION

FY 1965

ADP requirements are primarily data reduction, data analysis, and flight performance studies, using the IBM 704/GE 225 computer system. Data reduction results from aeronautics projects such as X-15 and B-70. Scientific work includes flight planning and general theoretical studies, and financial management applications. Action was taken this year to replace the IBM 704/GE 225 system with an IBM 360/40 computer system. Category B equipment is used for telemetry data acquisition, real time range data processing and display, and hybrid simulation.

FY 1966

During the year the new IBM 360/40 will be utilized for the same purposes as stated above for the IBM 704/GE 225 system with biomedical data reduction and analysis added. Category B equipment will include the full time usage of the GE 225 for real time range data processing and display. In addition, the SEL 810 will be utilized as an integral part of the high temperature loads calibration data acquisition facility. The IBM 704 will be disposed of through normal excess procedures.

FY 1967

Data reduction requirements continue to increase as a result of projects such as X-15, B-70, Supersonic Transport and hypersonic research. Improved data acquisition equipment (digital pulse code modulation) is expected to increase the flight data reduction workload by 50% to 100%, effective during FY 1967 and FY 1968. High-Temperature Loads Calibration Facility is expected to be fully operational by FY 1967, providing additional data reduction and analysis requirements. Feasibility studies are being made for a processor/controller to link the IBM 360/40 to the simulation facility with the capability for other real time applications in addition to the FY 1966 usages.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	51,209	7,348	1,548
Lease	5,121	5,650	7,100
Maintenance	1,565	1,393	2,073
Total	57,895	14,391	10,721
Number of Personnel:			
Civil Service	381	449	449
Contracting Firm	572	754	836

Contractor Identification

Name of Firm	Service Performed
Analytical Mechanics	Integrated Mission Analysis Program
Bunker Ramo Corporation	Programming Services
Control Data Corporation	Data Processing System
Datametrics Incorporated	Programming
Computer Applications	Operations and Programming
Computer Control	Maintenance Operation
Dynalectron	Data Processing Services
Datatrol Corporation	Programming Services
General Electric	Operations and Programming
IBM	Programming and Systems Operation
Merle Thomas	Programming Support
Keltec Industries	Data Reduction

NARRATIVE EXPLANATION

FY 1965

In the performance of its scientific and operational mission, GSFC has a vital need for computer support. FY 1965 funds were used for the purchase of both installed and future computing equipment. Purchase of installed equipment, which for FY 1965 consisted largely of the main

frames of three IBM 7094's and one Univac 1107 computer, enabled GSFC to reduce its lease costs by 5.8 million dollars during FY 1965, including the benefit of prior year purchases as well. As the work load grew to saturate the large-scale computing facilities, studies of needs for the next five years were made and these led to the plan for future installation of the next generation computers (super-speed system). The purchase of the main frames of this new equipment (eight IBM 360 computers) was accomplished in FY 1965. It is planned to phase-in the IBM 360 equipment over the next three fiscal years to replace all of the IBM 7094's at GSFC. The main frame of one Univac 1108 was purchased for future replacement of a leased Univac 1107 used for telemetry data processing. Additional purchases of small computers for tracking station and similar purposes were also made, the largest of which was for Univac 642-B computers for Apollo support in the Manned Space Flight Network. Many of the small computers are integral parts of operational systems, for example, the Univac 1218 computers installed in the Manned Space Flight Network for support of Gemini operations.

FY 1966

The requirements for increased large-scale computing facilities are being met by the installation of an IBM 360/75 and 360/65 this fiscal year, which are planned to replace one leased IBM 1410 and one leased IBM 7094 and its peripheral IBM 1401 computer. Increases in the telemetry data reduction requirements are to be provided for by the installation of the UNIVAC 1108 and of the Phase II Satellite Telemetry Automatic Reduction Systems (STARS), each of which incorporate a medium scale CDC 3200 computer.

Additional peripheral equipment and a number of small computers are required at the Manned Flight Tracking locations as part of the overall implementation of this network for the Manned Flight programs. Additional peripheral equipment and small computers are also required in support of NASA scientific satellite programs for ground station support and control center applications.

Civil Service personnel for the year are shown as projected ceiling. Contract personnel are increased due to additional operational requirements to meet Goddard's mission and includes 75 man years of IBM effort provided in support of the new system 360 facility.

FY 1967

Increased computing capability is required due to the normal growth associated with new projects, the fruition of major long-term projects such as the observatory satellites, the research efforts leading to whole new classes of problems, and the need to extend existing studies

to new levels of complexity (taking additional dimensions, and processes into account). As in previous years, computers will be used for orbit computations, telemetry data processing, real-time support for manned spacecraft design, integration and test, flight and other tracking operations, spacecraft operations and experiment control, scientific and applications data analysis, and theoretical studies in the space sciences.

Additional implementation of the super-speed computer plan will occur in FY 1967 when an IBM 360/91 and two IBM 360/65 computers (purchased main frames) will be installed at GSFC. As a result, two IBM 7094's (purchased main frames) will be phased out during this fiscal year. Additional lease funds are required because of overlapping operation of present IBM 7094 systems and their IBM 360 replacements during the period of transition so that on-going NASA operational programs can be adequately supported. (Note: The two super-speed computers, IBM 360/95 and the remaining 360/65, will be installed in FY 1968.)

Further increase in telemetry data reduction requirements will be met by the replacement of the Univac 1107 (purchased main frame) with the more capable 1108 (main frame to be purchased with FY 1967 funds). Additional peripheral equipment will be required to supplement the computers used for station ground support, spacecraft integration, and control center application.

Civil Service personnel for the year are shown as projected ceiling. Contract personnel are increased due to continuing support of the implementation of the system 360 plus increased effort for the manned space program.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HEADQUARTERS
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	675	---	---
Lease	364	98	89
Maintenance	12	24	24
Total	1,051	122	113
Number of Personnel:			
Civil Service	13	12	12
Contracting Firm	44	71	77

Contractor Identification

Name of Firm	Service Performed
Bunker-Ramo	Systems analysis and programming (position management system)
Documentation, Inc.	Systems analysis, programming and computer operation (IBM 1410 - NASA-owned during FY 1966/FY 1967).
IBM	Maintenance and Repair
Bellcomm	Programming and operation

NARRATIVE EXPLANATION

FY 1965

Administrative Operations
During this year NASA Headquarters installed an IBM 1401 with a 16,000-bit memory for exclusive use in administrative operations application. The following general areas were covered: 1) Status of Contracts and Grants Reporting System; 2) Financial Status of Programs Reporting System; 3) Headquarters Accounting; 4) Payroll, and 5) Personnel and Security.

Responsibility for management of ADP administrative operations at Headquarters was consolidated in the Management Information Systems Division.

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Scientific and Engineering

This computer installation performs general scientific calculations to support the manned space flight program. During this year extensive programming and check-out were conducted to prepare the equipment for Gemini engineering analysis that would be encountered during actual flight operations. An on-line printer was added to meet the increasing work load.

FY 1966

Administrative Operations

During this year NASA Headquarters purchased and installed an IBM 1410 system, which formerly had been located at NASA's Manned Spacecraft Center. The major components of the former IBM 1401 system above were transferred to the Office of Economic Opportunity under the GSA disposal service program. The increased capacity of the IBM 1410 installation has greatly expanded the ability to provide timely and current data needed for management decision making; e.g., procurement reports are now completed within one month following the end of the reporting period, whereas formerly there had been delays of up to two and one-half months after the cut-off date. In addition, the probability of requiring additional ADP services to satisfy peak work loads has been reduced to some extent.

Scientific and Engineering

During this year the most significant accomplishment has been to use the computer in mission planning for GT-3 in connection with which the pre-retro maneuver was analyzed by the equipment before incorporation into the final mission operations plan. Current analysis is related to calculation of Gemini versus LEM rendezvous modes in order to simulate an operational environment with the Gemini spacecraft that closely approximates the Apollo Lunar rendezvous requirements.

FY 1967

Administrative Operations

During this year a comprehensive reappraisal of operating systems will be initiated with the objective of optimizing machine utilization to acquire additional capacity sufficient to absorb the expected increase in the work load. This study could indicate the need for additional equipment; however, none is planned for procurement at this time.

Scientific and Engineering

During this year consideration will be given to replacement of the present installation with equipment that can be operated at lower cost and which will have the greater capacity needed to handle the computational requirements of the manned space flight technical staff. This would also permit larger participation by other Headquarters offices in such areas as PERT and funding analysis, space medicine and Apollo launch vehicle data reduction and Apollo mission planning. Over 5,000 separate computer runs are expected to be performed during the year.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JET PROPULSION LABORATORY
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	20,951	6,503	3,027
Lease	3,251	4,011	5,878
Maintenance	220	565	611
Total	24,422	11,079	9,516
Number of Personnel:			
JPL Employees	237	287	314
Contracting Firm	167	224	314

Contractor Identification

Name of Firm	Service Performed
Scientific Data Systems	Programming, Operation, Maintenance
RCA	Programming, Operation, Maintenance
IBM	Programming, Operation, System Analysts
Consultants and Designers	Maintenance
Mesa Scientific Corp. **	Programming, Operation
Bendix	Programming, Operation, Key Punch, Maintenance

** This is a task type contract. The work is performed off-Lab. Consequently, it is not reported on the JPL Monthly Summary Report for contractor resident personnel.

NARRATIVE EXPLANATION

FY 1965

The Jet Propulsion Laboratory is operated by the California Institute of Technology under contract to the National Aeronautics and Space Administration. JPL's primary area of responsibility is for the management of NASA's Lunar and Planetary (L&P) Exploration Projects and the Deep Space Network (DSN) required for spacecraft tracking and data acquisition. During FY 1965, JPL's assigned L&P Projects included Ranger (Lunar

photographs), Mariner '64 (Mars photographs) and Surveyor (Lunar Soft Landing and Surface Science). In addition, to the listed JPL Flight Projects, the DSN has tracking, data acquisition and mission control responsibility for the Lunar Orbiter and Pioneer missions. Five specific areas of Automatic Data Processing are required as an integral part of the assigned JPL tasks.

a. General Scientific and Engineering - A highly skilled staff of engineers and scientists are engaged in broad spectra of directly related Research and Development and Engineering activities, most of which generate problems which require computer solution.

b. Simulation - The generation and utilization of artificial data by computer for testing and "debugging" systems and collections of systems used in the spacecraft and associated ground based installations. Examples include checking out the DSN Mission Control Systems and their operating personnel.

c. Mission Control - Computers are essential to analyze in real time the spacecraft performance in order to generate the spacecraft commands needed to achieve the most successful spaceflight mission.

d. Data Reduction - Automatic Data Processing is used to reduce data produced from a wide range of scientific and research experiments and engineering tests. The other basic area of data reduction is concerned with the data produced by the spacecraft during flight operations.

e. Administration - Computers are used in business areas handling great quantities of financial, inventory, and personnel data and producing detailed reports. Thus a more economic administrative operation is made possible, while greatly decreasing the time needed for each job.

The major ADP acquisition activity in FY 1965 was the purchase of $14,554,000 of previously leased computers for the Space Flight Operations Facility and for the Scientific Computer Facility. This purchase makes possible a reduction of nearly $6,000,000 in leasing cost in FY 1966, and each year thereafter that the equipment is in use.

FY 1966

The Lunar and Planetary Projects presently assigned to the Jet Propulsion Laboratory are Surveyor, Mariner '64 (Mars), Mariner '67 (Venus), Mariner '69 (Mars) and Voyager. In addition to these Flight Projects, the JPL managed Deep Space Network has continuing support for Mission Control of Pioneer and Lunar Orbiter. A JPL breakthrough in the computer enhancement technique for improving telemetered spacecraft data during FY 1966, has resulted in a clarity of detail in the Mariner Mars pictures not previously obtained. Similar computer techniques can be applied to the Ranger Lunar photographs.

During FY 1966, eighteen small computers are being purchased for installation at the DSN tracking stations around the world to meet the increased Tracking and Command Data (TCD) and Digital Instrumentation Systems (DIS) functions required for Lunar Orbiter and Surveyor. The third direct coupled IBM 7094/7040/7044 computer system will be installed in the Space Flight Operations Facility (SFOF), on a lease basis near the end of FY 1966, to provide operational and backup capability for the Surveyor, Lunar Orbiter and Pioneer missions. A computer switching system to allow complete interchangeability of use for the three computer strings is being purchased. During FY 1966, arrangements were completed to transfer two NASA purchased Univac 490 computers from Goddard Space Flight Center to the JPL SFOF for Communications Processing. The additional peripheral ADPE required for the Com-Processors which must be purchased in the next few months is estimated in excess of $1,500,000. An IBM 360 Model 20/30/40 is being leased to replace the present IBM 1401/1410 Business Computer to permit the accomplishment of the administrative computing at lower cost.

The FY 1965 purchase of the large previously leased computer systems being used in the Space Flight Operations Facility and Scientific Computer Facility will result in a saving of nearly $6,000,000 in lease payments during FY 1966.

FY 1967

All the JPL tasks listed for FY 1966 carry over into FY 1967. The Scientific Computer Facility (SCF) (IBM 7094/7044) is presently operating in excess of 2.5 shifts per day with a constantly increasing work load. The replacement of the SCF with a third generation computer is planned on a lease basis late in FY 1967 to meet the growing work load, which now includes the recently assigned Mariner '67 (Venus) and Mariner '69 (Mars) missions. During FY 1967, computer acquisitions to the DSN for the antenna pointing system and other increased performance features are required to meet the higher data rates needed for Mariner '69 (Mars) and later Voyager missions. As the detail scheduling of DSN operations relative to the assigned missions becomes more definite, it will be possible to define certain other ADPE which must be acquired during FY 1967. It is expected that the additional ADPE required to support the new Mariner missions can be defined in the next few months, as soon as the detailed project planning is completed.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
KENNEDY SPACECRAFT CENTER
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	216	5,841	1,130
Lease	1,019	1,598	942
Maintenance	34	347	300
Total	1,269	7,786	2,372
Number of Personnel:			
Civil Service	44	43	44
Contracting Firm	123	321	568

Contractor Identification

Name of Firm	Service Performed
Federal Electric Co.	Programming, Operation, Systems Analysis
Ling-Temco-Vought	Systems Analysis, Programming, Operation

NARRATIVE EXPLANATION

FY 1965

ADP equipment at KSC is used for scientific and engineering computation, for administrative applications, for automatic checkout work and for data reduction and mission control. The computer equipment at KSC is operated "on-line" as a part of the countdown and launch control system for a significant part of its total operating time.

All major vehicle projects are supported, with data reduction and mission control comprising the bulk of the workload. Requirements in this area include:

(a) preflight data reduction and simulation,

(b) real-time telemetry processing,

(c) postflight "quick look" formating and display of critical measurements, and

(d) prelaunch test support.

An additional important ADP function at KSC is the support of automatic checkout systems. The special purpose checkout computers must be supported by general purpose machines for assembling checkout programs, checkout evaluation and tabulating results.

During FY 1965 the above functions were transferred from a GE 415 and GE 235 to a more advanced GE 635. In addition, a Univac 1004 peripheral processor was purchased to provide the necessary input output support for the GE 635 system.

In the administrative area, financial management, supply accounting, automatic checkout support, vehicle configuration control and contractor support make up the bulk of the workload. During FY 1965 an IBM 1440 was leased to provide needed peripheral support to the IBM 1410 in this area.

FY 1966

A second IBM 1410 was leased to handle administrative functions and an IBM 1460 is scheduled for delivery. It may be necessary to upgrade the IBM 1410 to an IBM 7010 before the end of the year.

As reprogramming occurs, these applications are being transferred to the GE 635 because of the greater capacity of the GE machine. When converted, this consolidation should result in a substantial cost saving since separate computers will no longer be necessary for processing administrative functions.

FY 1967

In FY 1967, additional components will be required to upgrade the present GE 635 system. The expanded system will provide the capability of multiple test support and backup during critical phases of the KSC mission. This will readily permit rapid reconfiguration of the system in case of computer malfunction. Lack of this ability would seriously hamper the data reduction functions in the event of a failure during a critical launch phase. The additional equipment to be purchased consists of a disc system, MSU drum, a 128K core memory module and an additional processor.

Other ADP equipment actions planned for FY 1967 are as follows:

1. Microfilm equipment to record computer graphic output on film. Present equipment is unable to handle the load imposed by future requirements.

2. Univac 1004 peripheral processors (2). Lack of this equipment would result in input and output bottlenecks in operation of the GE 635 computer.

3. EAM equipment will be required for off-line card processing and key punching for input to the GE 635.

4. An IBM 7702 communications link is required for data transmission to other NASA centers and contractors concerned with vehicle launch data.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	1,018	4,638	1,982
Lease	2,386	2,954	3,277
Maintenance	38	146	402
Total	3,442	7,738	5,661
Number of Personnel:			
Civil Service	122	123	123
Contracting Firm	21	36	69

Contractor Identification

Name of Firm	Service Performed
Hampton Institute	Read-out
Hayes International Corp.	Key Punching
Hayes International Corp.	Key Punching
IBM	Maintenance
Unselected	Programming

NARRATIVE EXPLANATION

FY 1965

Langley Research Center's electronic digital computing is divided into four separate areas as follows:

a. Analytical and engineering studies. This activity is concerned with studies of structures, trajectories, aerodynamics, thermal analysis, dynamic loads, and system analysis.

b. Data Reduction. Applied to ground test facilities, flight tests, and statistical studies.

c. Administrative.

d. Simulation.

FY 1966

Procurement of new generation equipment to replace existing equipment will be initiated in FY 1966. Installation will cover three fiscal years. Presently, different equipment is used in each of the four areas mentioned above. The new generation equipment will enable LRC to combine all four areas into a single integrated operation. In FY 1966 an IBM 7094 - 7040 Direct Coupled System will be installed on an interim basis to augment the present computers until the installation of new-generation equipment.

FY 1967

The first two phases of the LRC integrated computer complex will be acquired in FY 1967. Installation of the first phase is planned for November 1966, and installation of the second phase is planned for February 1967. The interim IBM 7094 DCS will be discontinued about one month after acceptance of the phase two equipment.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LEWIS RESEARCH CENTER
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	4,145	2,821	---
Lease	1,094	365	121
Maintenance	33	80	123
Total	5,272	3,266	244
Number of Personnel:			
Civil Service	154	154	154
Contracting Firm	---	---	---

Contractor Identification

Name of Firm	Service Performed
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NARRATIVE EXPLANATION

FY 1965

The ADP requirements are primarily wind tunnel data reduction utilizing the modified 1103/160-A system, and scientific and engineering projects on the 7094 DCS system. Additional data reduction and analysis requirements result from taped data acquired from Centaur and Agena launches. Scientific and engineering work includes basic and applied research on space craft power systems. In addition, Lewis has development responsibility for the Atlas-Centaur and the Atlas-Agena launch vehicles. In order to provide adequate capability to process the LeRC experimental data, LeRC was authorized to acquire a new digital computer system to replace the existing system for data reduction.

FY 1966

ADP data reduction requirements include wind tunnel data and component testing of pumps, nozzles, injectors, turbines, etc. Installation of improved digital data recording equipment at Plum Brook increases

the volume of data for reduction and analysis. Additional units are scheduled for installation, with data flow increases as much as six times the present capacity. Scientific calculations utilize the 7094 DCS and support the following OART programs: Nuclear Rocket Propulsion, Research, Nuclear Electric, Space Power and Chemical Propulsion.

Funds were obligated in the first quarter for purchase of the new IBM 360/67, which will replace the 1103, 1401 and 160A.

FY 1967

ADP requirements continue to support research in the areas of advanced propulsion and space power generation systems. This includes data reduction and analysis generated by major research, tools ranging from atmospheric wind tunnels to large space environment facilities.

The FY 1967 scientific and engineering work load will show a 60% increase, to be divided equally on the 7094 DCS and the newly installed 360-67. The data reduction work load will be shifted from the 1103-160 A to the 360-67. Administrative work load will remain about the same and will be retained on the 1620 and 1401.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	9,854	2,301	5,686
Lease	12,505	17,595	16,075
Maintenance	127	514	846
Total	22,486	20,410	22,607
Number of Personnel:			
Civil Service	154	159	160
Contracting Firm	339	800	507

Contractor Identification

Name of Firm	Service Performed
Wolf Research and Development Corp.	Programming, Systems Analysis, Key Punching, Maintenance
Lockheed Missile and Space Corp.	Programming, Systems Analysis, Key Punching, Maintenance

NARRATIVE EXPLANATION

FY 1965

Flight operations or mission control is basically concerned with two things: (a) mission operations direction and (b) support of the vehicle operation. Direction is concerned primarily with ensuring optimum utilization of the vehicle, vehicle subsystem analysis, trajectory analyses, etc. Vehicle operation support consists of actual navigation, guidance and control of the space vehicle (e.g., turning engines on and off) and evaulation of crew status. All of these functions must be performed within limited time frames where frequently the safety margins and degree of optimization is determined by the computer equipment available. Five large scale IBM 7094 computers with associated peripheral and switching processors are assigned to the flight operations mission.

Administrative data processing, data reduction and scientific computations are all within the jurisdiction of the Computation and Analysis Division.

Administrative functions include the usual resources management work. (PERT, cost analysis, personnel, payroll, inventory and supply accounting, procurement and contract status, etc.). In addition, there is a substantial work load concerning biomedical data, information systems, and management, administrative and technical services. During FY 1965 the IBM 1410 used for this work was upgraded to an IBM 7010.

FY 1966

Because of the critical nature of this work the IBM 7094's will be replaced by more advanced IBM 360 systems with conversion starting in late FY 1966. Interim small 360's will be installed first pending delivery of the larger equipment.

It may be necessary to supplement the IBM 7010 with another processor before the end of FY 1966 to accommodate the increased work load.

The Mission Planning and Analysis Division is greatly increasing its computational requirements. Increased work in this area required upgrading the Univac 1107 to an 1108 in FY 1966. The work concerns the development of large scale trajectory programs, the simulation of the ground-to-space-craft loop and the development of software required for mission control.

Computation requirements have also increased in the Structures and Mechanics area. These computations involve space environment simulation, mechanical systems, thermo structures and landing technology. In the data reduction area, enormous amounts of data are obtained from the Gemini flights. This has required the addition of a CDC 3800 during FY 1966.

FY 1967

During FY 1967 all of the IBM 7094's are planned to be released. By the end of FY 1967 we expect to have the conversion completed with five IBM 360/75's and one IBM 360/50 installed for flight operations work.

Increased requirements in the Mission Planning and Analysis Division may require replacing the IBM 7094/7044 and IBM 7040 with a larger system. The two stand alone IBM 7094's may also be replaced in this time frame if forced by increasing work load.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	7,399	---	---
Lease	11,770	11,330	12,260
Maintenance	63	367	450
Total	19,232	11,697	12,710
Number of Personnel:			
Huntsville			
Civil Service	184	174	170
Contracting Firm	493	496	458
Michoud Assembly Facility			
Civil Service	8	10	10
Contracting Firm	658	1,009	900

Contractor Identification

Name of Firm	Service Performed
Huntsville	
General Electric Company	Systems Analysis, Programming, Operation, Maintenance
Michoud Assembly Facility	
The Boeing Company	Service, Programming, Operation, Systems Analysis
Chrysler Corporation Space Division	Systems Analysis, Programming, Operation
Telecomputing Services, Inc.	Operations, Systems Maintenance, Analysis
Ling-Temco-Vought	Systems Analysis, Operations, Maintenance
Mason-Rust	Programming, Operations
General Electric	Programming, Operations
North American Aviation	Programming

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NARRATIVE EXPLANATION

FY 1965

MSFC has a wide variety of analog, hybrid and high-speed digital computers used primarily for data reduction, simulation, and general scientific and engineering applications. This equipment provides MSFC with the computation capability necessary for the research and development of space vehicles and for the efficient administrative management of the Center.

In the area of data reduction, the main computer system, a B5500, was upgraded with a second processor during FY 1965. For real time and post-flight analysis, an analog-to-digital converter system converts analog signals to sampled digital input form. A receiving and recording station receives and records TM and video signal via radio and microwave links from satellites, launch vehicles, and captive test. The system receives, smooths, calibrates and formats the output for over 1,000 measurements for each test or launch.

General scientific and engineering applications are performed on two IBM 7094 II systems. Applications include such problem studies as aerodynamic analysis, flight mechanics, flight performance, dynamics, thermo-dynamics, general support of automatic checkout, PERT, APT, management system models, vibration and acoustical studies, weather and wind tunnel, operations research, and numerical analysis research. In addition to the two main scientific computer systems there are five peripheral processors and 23 small and medium computers in engineering laboratories used for scientific computations.

The analog and hybrid computers are used to perform simulation studies in the areas of rendezvous, orbital docking, reusable boosters, mobile lunar lab., engine start-up, cut-off, including fuel flow, sloshing, heat transfer, flight simulation, lunar traverses and other operations using physical and mathematical models.

Typical administrative applications (supply, procurement, financial management, manpower and personnel accounting) are processed on two IBM 1410's. The peripheral 1401's in this area were replaced by Univac 1004's during FY 1965 at a substantial cost reduction.

The MSFC computer equipment at Slidell, Louisiana, is used to provide computation support for the stage contractors (Boeing and Chrysler) at the Michoud Assembly Facility and to support the Mississippi Test Facility. This installation also furnishes substantial support in the scientific area for MSFC/Huntsville and MSC/Houston during peak workload periods.

Scientific computation primarily concerns structural design, manufacture, evaluation and checkout of the various Saturn vehicle components. The equipment used for scientific computation consists of an IBM 7094/7040 Direct Couple System and an IBM 7094 stand alone. These machines are operated on a three shift basis, six days per week. Computer equipment at Slidell used for administrative functions consists of two H 1800's, two H 800's, two H 200's, and IBM 1401 and an IBM 1440. The contractors generate most of the requirement for this equipment with applications including: financial accounting, PERT, work order control, configuration control, reliability, personnel and procurement.

FY 1966

Increased workload in the administrative area has required the upgrading of the two IBM 1410's to two IBM 7010's. In the scientific area several equipment actions are planned for replacing older leased equipment with newer more capable machines at less cost. Two ASI 210's, an RPC 4000, a RecompII and at least four IBM 1620's are scheduled for replacement with small scientific computers. In addition, a study is underway to determine if savings could be realized by replacing the remaining IBM 1401 peripheral processors with less expensive machines.

An additional computer capacity is needed in the administrative data processing area prior to the end of FY 1966. This could be an additional Honeywell computer or some other machine not yet determined. The stand along 7094 is planned to be replaced by an IBM7094/7040 DCS late in the year.

FY 1967

During FY 1966 the decision was made to centralize all computations into a large computer complex. Phase-in is expected to start in late FY 1967. The centralized configuration should permit expansion if necessary and should substantially reduce costs while increasing reliability. Plans call for the central complex to eventually replace 27 computers in addition to the IBM 7094's.

Increasing workload in both the administrative and scientific areas make it necessary to plan for new computer equipment prior to the end of FY 1967. Because of backup considerations, sharing of resources and similar missions, the large procurements for Huntsville and Slidell scheduled for FY 1967 have been combined. All programming at Slidell is coded in Fortran IV and Cobal to facilitate conversion to the new equipment.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SPACE NUCLEAR PROPULSION OFFICE
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	---	---	---
Lease	71	176	226
Maintenance	---	---	---
Total	71	176	226
Number of Personnel:			
Civil Service	---	---	---
Contracting Firm	17	17	17

Contractor Identification

Name of Firm	Service Performed
Pan American World Airways, Inc.	All ADP Services, e.g., operations, key punching, programming, etc. 1/

1/ Pan American is the Support Services Contractor at NRDS, and ADP is one area of service provided under that contract.

NARRATIVE EXPLANATION

FY 1965

ADP requirements are: (a) data reduction from two Nuclear Rocket Reactor Tests Cells and one Nuclear Rocket Engine Test Stand, (b) data analysis and scientific and engineering calculations supporting development of nuclear rocket systems, (c) administrative applications provide ADP services for channel engineering for approximately 7,000 data and controls channels in three test facilities, and to provide services for general cost accounting, payroll, and warehouse inventory control.

This requirement is met by a CDC 3200 digited computer.

FY 1966

ADP requirements are identified primarily with the PHOEBUS and NERVA projects. The first involves testing advanced nuclear rocket reactors to develop advanced reactor technology. A similar project is responsible for testing a reactor for the NERVA engine. ADP services are required by NERVA to convert raw test data to engineering units as a function of time.

Equipment action scheduled will increase the magnetic tape capability on the CDC 3200 computer system with a corresponding reduction in program operating time.

FY 1967

ADP requirements show a steady increase as development work progresses toward engine systems development phases.

Equipment actions scheduled for FY 1967 are directed to further expansion of the CDC 3200 computer system. The following equipment actions are scheduled:

a. Multi-Channel Controller

b. Additional 16K core storage

c. Two additional I/O channels

d. Fully Buffered Card Punch

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WALLOPS STATION
SUMMARY OF REQUIREMENTS

	FY 1965	FY 1966	FY 1967
Computer Cost (In thousands of dollars):			
Purchase	1,731	314	200
Lease	184	63	46
Maintenance	1	50	75
Total	1,916	427	321
Number of Personnel:			
Civil Service	14	14	14
Contracting Firm	14	28	29

Contractor Identification

Name of Firm	Service Performed
Technitrol, Inc.	Operations
General Electric	Programming and Maintenance

NARRATIVE EXPLANATION

FY 1965

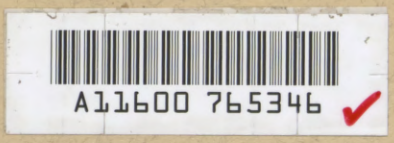
The GE-625 Computer was purchased during the second quarter of Fiscal Year 1965. This system was obtained to provide Wallops with an impact prediction system for range safety and to increase the capabilities for general data processing by replacing the IBM-650. (The IBM-650 was operating on a three-shift basis but the work backlog was steadily increasing.)

FY 1966

The GE-625 was made operational during the first quarter of Fiscal Year 1966 and the IBM-650 was removed. General data processing went back to a one-shift operation. The second shift was used for the real-time system checkout. The computer was expanded by the addition of a 32,000 word memory, an additional printer and two tape handlers. These additional units were needed to effectively utilize the G.E. executive program and give true multiprogramming capability to the system.

FY 1967

The time sharing capability is one of the outstanding features of the GE-625 computer system. System changes to further utilize this capability will greatly expand computer usage and decrease the "data turn around time" of our ADP Center. To provide administrative and engineering organizational groups direct access to the computer, the addition of remote terminal facilities are needed in Fiscal Year 1967. This will allow these people to have simultaneous access to the computer with no apparent interference from any other users. The resulting benefits are savings in time and expense for both the user and the data processing operation.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